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MEETING OF THE

AVIATION TECHNICAL ADVISORY COMMITTEE

Thursday, February 16, 2012
10:00 a.m. – 12:00 p.m.

John Wayne Airport
Eddie Martin Building
Airport Administration
3160 Airway Avenue
Costa Mesa, CA 92626
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If members of the public wish to review the attachments or have any questions on any of the agenda items, please contact Michael Armstrong at 213-236-1914 or armstron@scag.ca.gov

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AVIATION TECHNICAL ADVISORY COMMITTEE
AGENDA

			PAGE #	Time
	"Any item listed on the agenda (action or information may be ***acted upon at the discretion of the Committee"***			
1.0	**<u>CALL TO ORDER</u>**	**Chris Kunze, ATAC Chair**		
2.0	**<u>WELCOME AND INTRODUCTIONS</u>**			
3.0	**<u>PUBLIC COMMENT PERIOD</u>**			
	Members of the public desiring to speak on an agenda item or items not on the agenda, but within the purview of this committee, must notify the Chair and fill out a speaker's card prior to speaking. Comments will be limited to three minutes and the Chair may limit the total time for comments to 20 minutes.			
4.0	**<u>CONSENT CALENDAR</u>**			
	4.1 <u>Approval of Meeting Minutes from October 27, 2011</u> **Attachment**		1	
	4.2 <u>ATAC Membership List and Contact Information</u> **Attachment**		14	
5.0	**<u>PROJECT REVIEW</u>** None			
6.0	**<u>INFORMATION ITEMS</u>**			
	6.1 <u>Update on John Wayne Airport Construction Projects</u>	**John Wayne Airport Staff**		**15 min.**
	6.2 <u>Helicopter Noise Relief Act of 2011</u> **Attachment**	**Larry Welk Professional Helicopter Pilots Association**	16	**10 min.**
	6.3 <u>Optimization of Airspace and Procedures in the Southern California Metroplex— Final Report</u> **Attachment**	**Chris Kunze ATAC Chair**	18	**15 min.**

AVIATION TECHNICAL ADVISORY COMMITTEE
AGENDA

6.0 INFORMATION ITEMS (Cont'd)

6.4	Overview of SCAG's Draft 2012 Regional Transportation Plan/ Sustainable Communities Strategy and Regional Transportation Corridor Projects	**Philip Law** **SCAG Staff**		**20 min.**

7.0 ACTION ITEMS

7.1	Regional General Aviation Demand Forecast for 2012 RTP **Attachment**	**Geoff Gosling** **SCAG Consultant**	150	**25 min.**
7.2	Election of New ATAC Chair and Vice-Chair	**Chris Kunze** **ATAC Chair**		**10 min.**

8.0 MISCELLANEOUS ITEMS/ANNOUNCEMENTS

9.0 FUTURE AGENDA ITEMS

Any committee members of staff desiring to place Items on a future agenda may make such a request. Comments should be limited to three minutes.

10.0 SET NEXT MEETING LOCATION

11.0 ADJOURNMENT

THE FOLLOWING MINUTES ARE A SUMMARY OF THE MEETING OF THE AVIATION TECHNICAL ADVISORY COMMITTEE. AN AUDIO DIGITAL FILE OF THE ACTUAL MEETING IS AVAILABLE FOR LISTENING AT SCAG'S OFFICE.

The Aviation Technical Advisory Committee of the Southern California Association of Governments held its meeting at the SCAG Main Offices, Policy Room A, 818 West Seventh Street, 12th Floor, Los Angeles, CA 90017. The meeting was called to order by Mr. Chris Kunze, ATAC Chair and Staff Advisor, Long Beach Airport.

ATAC Members Present:

Dan Burkhart	NBAA
Lea Choum	John Wayne Airport
Gary Gosliga	March Inland Port Airport Authority
Mark Hardyment	Bob Hope Airport
Bill Ingraham	San Bernardino International Airport
Chris Kunze	Long Beach Airport
Bob Trimborn	Santa Monica Airport

Others Present:

Richard Ayala	City of Ontario
Mike Behan	City of Palmdale (teleconferencing)
Keith Downs	Mead & Hunt
Norm Emerson	Emerson & Associates
Geoff Gosling	Aviation System Consulting
Mustapha Janneh	IGT
Richard Kite	City of Palmdale (teleconferencing)
Richard Norton	URS Corporation
Allyn Rifkin	OLDA/Bob Hope Airport
Bob Rodine	The Polaris Group
Mike Armstrong	SCAG
Alan Thompson	SCAG
Naresh Amatya	SCAG

1.0 CALL TO ORDER

Chris Kunze, Chair, called the meeting to order at 10:05 a.m.

2.0 WELCOME AND INTRODUCTIONS

3.0 PUBLIC COMMENT PERIOD

There were no public comments

4.0 CONSENT CALENDAR

4.1 Approval of Meeting Minutes from July 28, 2011

Chris Kunze had several questions about the minutes. On page 4 of the minutes it discusses the possibility of SCAG sending a letter to the Burbank Airport Authority in support of their work on multi-modal ground access that can serve as a model for the region, and asked Mark Hardyment if they still wanted such a letter. Mr. Hardyment replied that such a letter of support would be welcome. Mr. Kunze responded that he would draft such a letter. Also on page 4, Mr. Kunze commented that the reclassification of Class B to Class C should instead read from Class D to Class C. Dan Burkhart asked whether this was an actual reclassification, or would require building a Class C airspace which is a different process. Mr. Kunze responded that an NPRM will have to be done, and a lot of the Class D would be replaced by Class C airspace. Mr. Kunze remarked that on page 11, "on-house" modeling tools should be replaced by "in-house" modeling tools. Mr. Kunze then asked about the discussion on pg. 13 about the 2012 RTP and its use as a baseline for AQMP updates. Will general aviation be part of that if we include general aviation in the 2012 RTP? Mike Armstrong responded that SCAG provides the growth factors to the SCAQMD for commercial and general aviation so that they can forecast their baseline emission inventory to develop a forecast aviation emission inventory. The last time SCAG developed a general aviation forecast was 2003. With these changes the minutes were approved.

4.2 ATAC Membership List and Contact Information

Bill Ingraham noted that Richard Scanlan is no longer at Rialto Airport. Bob Trimborn stated that his e-mail is now Bob.Trimborn@SMGov.net.

5.0 PROJECT REVIEW - None

6.0 INFORMATION ITEMS

6.1 Approval of Regional Aviation Demand Forecast and Regional Aviation Policies by the SCAG 2012 Regional Transportation Plan (RTP) Subcommittee

Mike Armstrong remarked that SCAG's 2012 RTP Subcommittee, chaired by City of Ontario Councilman Alan Wapner, has been meeting every two weeks to discuss various policy issues relating to the 2012 Regional Transportation Plan, and make recommendations on those issues to SCAG's Transportation Committee. On October 7th the subcommittee took up aviation issues, which are a particular interest of Councilman Wapner. The main issue that was addressed was the ATAC recommendation to adopt the 145.9 million air passengers (MAP) commercial aviation demand forecast to 2035 for the 2012 RTP, with the caveats made by ATAC at the last meeting. These caveats relate to the need to update the forecast on an ongoing basis (particularly for the 2016 RTP), the fact that the forecast does not address the potential impacts of the California High-Speed Rail Project and future forecast updates should incorporate those potential impacts, and the fact that Settlement Agreement constraints at LAX and John Wayne expire in the 2015-2020 time period and future updates to the forecast should incorporate any changes to those constraints that are provided by these airports.

Mike Armstrong stated that the 2012 RTP Subcommittee was satisfied with the forecast and the caveats made by ATAC and approved the recommendation from ATAC. They also approved the Regional Aviation Policies and Action Steps recommended by ATAC without any discussion. The subcommittee is finished with aviation and appeared to be happy with the general direction set by ATAC, so whatever refinements ATAC makes will be incorporated directly into the RTP, including new general aviation forecasts.

7.0 ACTION ITEMS

7.1 Regional General Aviation Demand Forecast for 2012 RTP

Geoff Gosling presented the final results of the regional general aviation demand forecasts developed for the 2012 RTP. He quickly overviewed the forecast approach, which is based on the idea of different components in the general aviation sector having different levels of flying activity (such as personal and corporate flying). A cohort analysis approach was used to capture changes in the activity of the pilot community over time for different age groups, much like demographic analysts model changes in population over time as people grow older and go through different life style changes. This is important since the flying activity of a given age cohort changes over time. The attrition rate and size of the cohort changes over time, and eventually pilots get old enough where they stop flying altogether. The net migration of pilots moving to and from the region also has to be taken into account.

Chris Kunze asked if the AOPA pilot survey was useful in this analysis. Geoff Gosling responded that the data from the survey was essential in estimating the change in flight activity with the different pilot age groups. However, we don't have a very good handle on how flight activity changes with economic cycles because of the lack of data. Dan Burkhart asked if that includes the increased cost of aviation, and the increased burden of regulation. Dr. Gosling responded not explicitly, but these factors likely underlie the changes in the active pilot community that he would discuss later on. The FAA does a very detailed survey every year of general aviation aircraft usage, and it would be very helpful if they would so a similar survey of pilots and the amount of flying that they do.

Geoff Gosling explained that the data for the model comes from two different sources: (1) individual pilot data from the Airmen Registry, although it is not 100% complete because individual pilots can opt to have their data excluded from public release; and (2) the AOPA California Pilot survey, which provides data on how much flying pilots do. Three different sets of input assumptions are needed for the cohort analysis, including new student pilot starts in the future, GDP forecasts, and pilot certificate category transitions. The New Pilot Starts Model is based on national data and is expressed as new pilot certificates per 100,000 people, and reflects GDP per capita (to take into account changes in household income and the prospects of becoming a commercial pilot). However GDP per capita has been increasing over the last decade, but new pilot starts have been decreasing. Things like the increased cost of flying and the increased burden of regulation underlie this, which is implicitly accounted for in the model (the structure of the equation was revised from that presented in an earlier meeting to ensure that this factor was not completely independent from GDP per capita). The county GDP forecasts were derived from published Federal data for metropolitan statistical areas (two in the SCAG Region) and from county income data. GDP forecasts were based on trends over the past ten years, and also compared with GDP forecasts used in the FAA National Aerospace Forecast (that are more aggressive). The data indicates that the GDP per capita is substantially less in the Inland Empire than the rest of the region, and is lagging behind the rest of the region in recovering from its decline. Therefore different assumptions were used in forecasting the future GDP per capita of the LA/Long Beach MSA vs. the Inland Empire MSA, with the latter having a slower rate of recovery.

Geoff Gosling explained that the pilot certificate category transition rates (the proportion of pilots holding one category of certificate who transition to a higher category of certificate in a given time period) were estimated from one year transitions in the individual pilot data. The data is divided into over and under 40 years of age; however, the actual age of the pilots is not available from the data. Data on the validity of the medical certificate can be used to generate transition rates for those two age groups, including transitions between categories within one year. Dr. Gosling noted that the only way the FAA knows a pilot is inactive is if they don’t renew their medical certificate. Bill Ingraham commented that there might be a disproportionate number of older pilots that had begun to fly under a sport pilot certificate that did not require a medical certificate since that alternative has been available for the last 5-6 years. Dr Gosling agreed and noted that the number of sports pilots has been growing. He commented that the data need to be checked in a few years to see how the transition rates may have changed over time.

Geoff Gosling went on to explain that using the cohort analysis as described, a Baseline Forecast was developed that assumed a continuation of the relationship between new pilot starts and GDP per capita observed over the past 10 years, and that the decline continues into the future. Two other scenarios were developed that produces less pessimistic results, called the Reduced Decline Scenario and the Arrested Decline Scenario. The former scenario assumes that the annual reduction continues to 2015, drops to half the level for the next ten years, and then the relationship remains constant after 2025. The latter scenario (which Dr. Gosling characterized as the more heroic scenario) assumes that the decline goes away after 2010 and the relationship with GDP per capita remains constant in the future, which begs the question what would cause that to happen? Forecasts of active pilots and aircraft operations (from average flight hours per operation) were developed by county for each of these scenarios. Projections of local operations were based on student and private pilot flight hours, and those for itinerant operations were based on the commercial and airline transport (general aviation component) flight hours. The rationale is that most of the local operations are driven by flight training and private pilot flying, whereas itinerate operations are dominated by business and professional flying. Airport control towers keep record of local itinerant operations, but there is no way of knowing what certificates are held by pilots flying those aircraft, which is an area that could benefit from further research.

Geoff Gosling said that for the Baseline Scenario, the pilot attrition rates overwhelm the new student pilot entry rates even for counties with high GDP growth, resulting in a reduction of the 2035 active pilot population. The Reduced Decline Scenario shows the decline flattening out with an increase over the last five years, but still not getting back to 2010 levels. The Arrested Decline Scenario shows 25% more active pilots in the region in 2035 because of many more student pilots resulting from GDP growth. For aircraft operations the dynamic is similar for the three scenarios, although in the Arrested Decline Scenario, 2035 aircraft operations do not exceed 2010 levels. This is because much of the increase in active pilots is from the surge in new student pilots who do not fly as much as the commercial and the older private pilots, who are getting older and transitioning out. The commercial and airline pilot are not being fully replaced under this scenario before 2035, although they would beyond that date, since it takes time for the new pilots to become commercial and airline pilots

Bill Ingraham commented that he was concerned about the itinerant operations being driven by business and airline pilots since a significant part of that activity is from private pilots. Also, the transition to commercial and airline pilots is driven by economic factors and need for airline pilots, which should be considered. Commercial activity appears to be a growing percentage of total activity at many GA airports. Geoff Gosling responded that he would look into getting a better handle on itinerant operations by private pilots vs. commercial and airline pilots. Dr. Gosling also agreed that a weakness of the model is that it does not reflect changing demand for professional pilots in the future, and incentives for more people to take up flying in response to the airlines hiring new pilots. New pilot starts are driven only by what happened over the last ten years. Bill Ingraham also noted that the counties with the highest GDP per capita also have less access to reasonably priced flight training. Dr. Gosling added that brings up an important point--the data are for flight hours and operations are for pilots residing in those counties, not where they are doing the flying. Mr. Ingraham noted that a high percentage of Orange County pilots base their aircraft at Chino Airport in San Bernardino County. Dr. Gosling noted that the based aircraft allocation model in Phase II of the study (if it is funded) will respond to the issue of where pilots choose to base their aircraft, and will allocate operations and flight hours to where the based aircraft are, not to where the pilot reside.

Bob Trimborn asked whether the operations data were for the pilot community in the region. Geoff Gosling replied that they were the total operations that were counted or estimated at airports, prorated by the pilots in the region. To the extent they include operations by visiting aircraft, those operations will change in proportion to operations by pilots within the region. Mr. Trimborn then asked if the definitions of local and itinerant are the same as those used by the FAA. Dr Gosling responded they were taken from the tower counts or estimates by airports. Mr. Trimborn observed that at Santa Monica Airport, historically the split has been 60% iterant 40% local, which is opposite from what the data show. Dr. Gosling responded that urban airports like Santa Monica and Van Nuys serve a significant amount of itinerant operations because pilots flying into the region are more likely to land there. Smaller, suburban airports with a lot of flight training activity tend to have a larger ratio of local operations to itinerant operations. Chris Kunze added that Long Beach is also about 40% local operations. Dr Gosling pointed out that the data was at the county level and was not airport-specific.

Bob Rodine remarked that Van Nuys Airport has gone from 500,000 operations to 339,000 operations during this economic cycle. However, turbine operations there have been more stable, and total operations have been distorted by piston planes staying on the ground. Geoff Gosling replied that this analysis doesn’t really capture that. However, historically the vast majority of aircraft operations have been by owners of personal aircraft. Neglecting the increase in business flying compared to personal flying may distort the forecast for the out years, but it will take a while for that effect to get large enough to overwhelm the other components of general aviation activity. It would be nice to separate out these components, but unfortunately the AOPA survey asked people how many hours they flew, but not the purpose of the flight, which should be done the next time the survey is conducted

Chris Kunze asked whether this analysis will be part of the 2012 RTP. Mike Armstrong replied that it can be included if ATAC makes a recommendation. He also suggested that the increased demand for commercial pilots in the future could be used as a justification for selecting the Reduced Decline Scenario. Geoff Gosling agreed, saying that it would be the most likely factor driving a change in the decline, which is a fairly arbitrary assumption in the Reduced Decline Scenario. The forecasts should be caveated by saying that they are based on a number of assumptions that should be further investigated, and in four years when the forecast is updated we should have a much better picture of what is going on in the general aviation sector. It is difficult at the end of a recession to account for the effect of fluctuations that haven't stabilized yet, and make estimates of what is going to happen in the future. Dan Burkhart suggested that airline pilot retirements are a known number, and by knowing the corporate aircraft fleet and making some assumptions about who is flying those aircraft we should be able to get a handle on commercial pilot training needs. Dr. Gosling agreed that is something that could be done.

Chris Kunze remarked that these forecasts represent a sea change in thinking compared to other general aviation forecasts out there that all show growth instead of decline. It is important for us to put this information out to airport operators and planners so that they are aware of it, and for the information to be continually monitored. Mr. Kunze said it was his opinion that the most reasonable forecast to bring to people's attention that should not cause of lot of panic is the Reduced Decline Scenario. Caveats should be listed about the variables that can affect the forecast. Bill Ingraham agreed, stating that one of the caveats should be a reference to the other forecasts that are more positive. Dan Burkhart asked how this forecast compares to the recent GA manufacturer forecasts of 10 year deliveries. Geoff Gosling responded that he was not familiar with those forecasts, and would welcome that information if it could be provided to him.

Bill Ingraham made a motion to approve the Reduced Decline Forecast with the caveats discussed. The motion was seconded and approved.

7.2 Regional Air Cargo Demand Forecast for 2012 RTP

Geoff Gosling reviewed the methodology used to develop new air cargo forecasts for the 2012 RTP. Dr. Gosling remarked that most of the region's air cargo is handled by LAX, and most of the remainder is handled by Ontario. Since most of the air cargo is carried by UPS, which operates a sorting hub at the airport, any growth in share of cargo at the secondary airports has to come from LAX. TransSystems developed a new regional air cargo forecast that was based on GDP growth of the US and its trading partners. It is more conservative than recent industry forecast such as Boeing's, as well as the 2008 RTP forecast, since air cargo has been growing slower than passenger traffic (and in fact has been declining over the last ten years). Dr. Gosling explained that in terms of how much cargo could be diverted from LAX to the outlying airports, much of the cargo at LAX travels in the belly compartments of passenger airlines, and is going to go where the passenger airlines go, particularly international flights. You might get some international cargo at the secondary airports, but likely not very much. Foreign flag carriers have all-cargo freighters, but are not likely to split their freighters from their passengers operations since they use the same airport facilities. Also, a high proportion of domestic freight is connecting between domestic flights and international flights, and a large portion of purely domestic freight is moved by the integrated carriers like FedEx and UPS (that pick up and deliver) and is captive to where they chose to base their hubs.

Geoff Gosling explained that the potential for diversion is limited to domestic freight that has an origin or destination within the region, and is not being handled by the integrated carriers. This leaves freight moving on all-cargo charter flights at LAX that is not connecting with international flights, or about 12% of LAX air cargo (which may be high due to the way cargo is reported). It was assumed that existing air cargo activity at airports other than LAX will increase at the regional growth rate and (somewhat arbitrarily) that 25% of domestic cargo handled by all-cargo charter aircraft at LAX is potentially divertible, while 30% of the international cargo handled by all-cargo charter aircraft at LAX is potentially divertible, and half of the potentially divertible cargo is actually diverted. This resulted in a revised air cargo forecast by airport. The bulk of air cargo will continue to be handled by LAX, but some of the smaller secondary airports will also see a growth of air cargo activity under the revised forecast, with some diversion from LAX.

Chris Kunze remarked that both Long Beach and John Wayne have caps that could impact the cargo growth at those airports. Geoff Gosling responded that there was no consideration in this analysis of that issue--the caps are not expressed in a way that directly affects all-cargo operations. Mike Armstrong noted that the John Wayne cap does specify the allowable number of all-cargo flights (this was confirmed by Kari Rigoni, who said that there are currently two all-cargo flights, and the legal agreement allow for two more, although cargo slots could take over passenger slots if they are available). Bill Ingraham commented that the forecast seems reasonable, but there may be the need to consider physical capacity limitations at LAX in terms of customs ability, perishable goods processing and storage, runway capacity etc.

Chris Kunze moved to approve the Baseline Air Cargo Forecast Scenario, which is the medium forecast that is deemed to be the most likely scenario. The motion was seconded and approved. Chris Kunze suggested that on Table 4 on pg. 49 in the agenda, current air cargo activity should be shown as a basis for comparison.

7.3 Regional Aviation Policies and Action Steps for 2012 RTP

Mike Armstrong noted that the aviation guiding principles/policies and action steps adopted for the 2008 RTP are listed in the agenda packet. All of these should be deleted in favor of a recommended new set of policies and action steps, most of which have been discussed at previous ATAC meetings. Geoff Gosling then presented the new policies and action steps, starting with the category of Regional Aviation Demand, Airport Infrastructure and Airport Ground Access. He noted that the allocation of regional demand to airports needs to account for market forces and constraints, and there needs to be strategies and incentives to encourage airlines to increase service at uncongested secondary airports, such as improved ground access and financial incentives. Also, the suburban airports need to be supported to preserve their future capabilities. An action step for this category recommends that SCAG develop a new and transparent in-house aviation demand allocation model for future RTPs that is integrated with the Regional Transportation Model and airport ground access analysis work. Another action step calls for SCAG to conduct a region-wide air passenger survey on an ongoing basis to better characterize and define the composition of the regional air travel market, and support forecasting and marketing efforts.

Geoff Gosling explained that current Federal law and revenue diversion rules allow for cross-subsidies between airports, but only when they are operated by the same airport authority (e.g. LAWA could subsidize Ontario Airport if it wanted to, but not Burbank Airport). However, the region could pursue a change in the regulations that would allow a joint program between two willing airport authorities that would be treated by Federal revenue diversion rules as if the two airports were run by the same authority. LAWA probably wouldn't be interested in doing something like this now, but may in the future as LAX approaches its capacity constraints. This is an issue in the Bay Area, since SFO realizes that it will run out of capacity before Oakland and San Jose airports, which will limit its ability to serve the more lucrative international traffic. They are therefore giving serious consideration to what it would take financially to incentivize airlines to shift domestic service to Oakland and San Jose, to relieve capacity constraints at SFO so they can serve more international traffic. LAX could find itself in the same position within the 2035 time frame. For smaller airports, particularly general aviation airports, the pursuit of non-aeronautical revenues would be a strategy they could use to help sustain them.

For ground access, Geoff Gosling noted that one action step recommends formation of a Regional Airport Ground Access Task Force that would help plan and promote ground access improvements to airports, including an integrated regional system of rail extensions, express bus service and new remote air terminals ("FlyAways").

For the category of Airport Economics, Finance and Funding, Geoff Gosling described the action steps including a recommendation for SCAG to sponsor new legislation that would allow for more flexible use of off-airport ground access projects by airport operators. Another action step calls for SCAG to coordinate with county transportation commissions and other transportation agencies to promote joint funding of identified airport ground access projects. An additional action step calls for SCAG to support legislation to allow for excess airport property to be used for revenue-generating non-aeronautical uses. The last action step calls for SCAG to conduct regional economic impact studies that would evaluate the impacts of alternative policy options for serving future regional aviation demand.

For the category of Airport Land Use Compatibility and Environmental Impacts, Geoff Gosling described the policies and action steps, which recommend that SCAG should conduct additional airport “smart growth” projects, and integrate “smart growth” land use principles into its regional land use forecasts. Another action step recommends that SCAG should periodically conduct information sharing forums for the region’s Airport Land Use Commissions in cooperation with the Caltrans Division of Aeronautics. Lastly, SCAG should serve as a clearinghouse for aviation environmental “best practices” and should sponsor and support new legislation for creating incentives for airlines to upgrade their fleets to cleaner, quieter and NextGen-compatible aircraft.

Geoff Gosling then described the recommended polies and action steps for the last category of Airspace Planning and New Technologies. Recommended action steps call for SCAG to continue to coordinate and provide input to the FAA’s Optimization of Airspace and Procedures in the Metroplex (OAPM) Program for Southern California, and continue to work with the Southern California Airspace Users Working Group (SCAUWG) on regional airspace issues. Actions steps also call for SCAG to continue to advocate that the region should serve as an early “test bed” for the phased implementation of new airspace technologies that have the potential to reduce airspace conflicts and environmental impacts, incorporate potential airspace constraints in regional aviation demand forecasts, and evaluate how new navigation and air traffic control technologies could contribute to enhancing the region’s airspace capacity.

Chris Kunze asked about the action step under Airport Economics, Finance and Funding that discusses completing Phase II of the General Aviation Demand Forecast Project, and says it would identify airports that will likely have excess airport property in the future that could be used for non-aeronautical revenue-generating uses. Mr. Kunze commented that he wouldn’t want SCAG to saying that an airport’s future operations will be much less and the airport will probably have excess land. Bill Ingraham suggested that the wording be changed to SCAG should support local operators that seek to use their property in non-aeronautical uses. Chris Kunze asked how this issue relates to Phase II of the forecast. Geoff Gosling responded that Phase II will mainly tell us what sort of change in activity we will likely see at general aviation airports in the region. That will provide input to the airport operators on whether or not they will likely have excess property, and if so they can start thinking about what to do with it. Bill Ingraham responded that this is a local issue, and even at the local level he doesn’t support the concept of taking property out of the airport since when it is gone it is gone, and is no longer available to the airport if demand increases in the future. Chris Kunze added that he was concerned about SCAG forecasting GA use at the local airport level, unless invited by the local airport operator. Mike Armstrong responded that Phase II wouldn’t assign exact numbers to airports, but would forecast a range from high to low. The thinking behind this issue is that some airports could become white elephants if the low end of the forecasts materialize, and instead of local governments eventually closing them down because they are big revenue losers, airports could start thinking now about how they can increase their bottom line by allowing them to do other uses that can produce revenues to local governments. Chris Kunze responded that when that is actually happening an airport could ask SCAG to help them with a "smart growth" plan like they did for Chino Airport, as opposed to a top down approach.

Bob Rodine said he agreed with Bill Ingraham, and that this concept is scary to him. For example, about 10 years ago the community was pressing hard to shut down 80 acres at Van Nuys Airport at the old National Guard property to limit the potential for operations there. The land is now being developed as a major piston air park and a helicopter maintenance facility, and there is only one parcel left at the airport that can be dedicated to supporting turbine aircraft activity that has been increasing. The risk of doing forecasts at SCAG is that many of the council people who have an axe to grind with Van Nuys Airport sit on the SCAG Regional Council and can do this outside the City of Los Angeles. Geoff Gosling stated that he was hearing a concern about wording rather than substance—the intent of this measure is not for SCAG to tell an airport authority that they are going to have excess land. The intent is for the forecast to inform the discussion at the airport level, whether in fact they need to be thinking about the issue of excess land. Mike Armstrong added that Van Nuys Airport is in an advantageous position relative to other general aviation airports in the region since it is unlikely to see the significant operational declines that could occur at other airports. Given the sensitivities of this issue, Mr. Armstrong agreed that the action step should be worded differently or eliminated. Dr. Gosling suggested that it should talk about determining future needs for general aviation infrastructure and leave it at that. Dan Burkhart suggested the wording should address preserving the future of general aviation assets, and protecting airport access. Dr. Gosling commented that there are two sides to this issue: some people may use the forecast information to support their desire to close certain airports, even viable ones. However, if we don't do something about airports that are facing declining revenues, they could be closed anyway. Bill Ingraham responded that SCAG isn't going to solve this problem. This is a local issue, and SCAG shouldn't open a crack that people can exploit to hurt airports.

Mike Armstrong asked whether there was still support for the policy of allowing for non-aeronautical uses at airports (several members said yes simultaneously). Gary Gosliga recommended that the term "excess property" be deleted. Properties may be undeveloped but they shouldn't be considered excess. Mr. Gosliga stated his support for working with the FAA to promote more flexibility in allowing non-aeronautical uses, since it is something that they are doing at March Inland Port with a building that was designed for aeronautical use. Chris Kunze suggested that the wording should say SCAG should develop guidelines for general aviation airports which may have property in the future that could be used for revenue-generating non-aeronautical uses. Mr. Kunze also expressed his discomfort with going to the airport-specific level with the forecasts. Bill Ingraham said that he was uncomfortable with this as well, particularly since forecasts drive the airport capital grants. Both San Bernardino and March have an operational baseline close to zero, and they already have difficulty in getting support for airport improvements. Mr. Ingraham commented that there are a lot of competing forecasts out there, and he would hate to see another airport-specific forecast added to the mix.

Mike Armstrong suggested that perhaps SCAG need to re-think doing Phase II of the general aviation forecast. Geoff Gosling replied that this could leave the region with the dilemma of a regional forecast that shows demand declining, but also individual airport forecasts that show activity at every airport is going to increase. Mr. Kunze responded that local airports are accountable to and need to respond to city and county boards and have local roles and missions. If we are looking 20 years out, we need to monitor the trends and adapt to them. Even a forecast range, if it doesn't mesh with local airport plans, could be disruptive.

Bill Ingraham moved to delete the action step that mentions conducting a Phase II general aviation demand study that would identify airports that may have excess airport property, and to change the next action step to read SCAG should support and not sponsor legislation to allow airport property to be used for revenue-generating non-aeronautical uses. The motion was seconded and approved. Mr. Ingraham also moved to approve all of the remaining policies and action steps. Gary Gosliga seconded the motion, but amended to change all references to excess airport property to underutilized airport property (as suggested by Alan Thompson). This amended motion was approved.

8.0 MISCELLANEOUS ITEMS/ANNOUNCEMENTS

Mark Hardyment announced that the Burbank Airport Authority awarded a contract to Coffman & Associates to begin a Part 150 update, for which an FAA grant ($805,000) has been received. A Notice to Proceed has been issued for this project. Chris Kunze announced that the next FAA's Optimization of Airspace and Procedures in the Metroplex (OAPM) Program for Southern California meeting will be held on Thursday November 3 at the FAA Western-Pacific Region offices. About 70 implementation procedures have been identified, and a final list will be discussed at the meeting. Dan Burkhart announced that the NBAA had a very successful convention a few weeks ago, many announcements of new equipment and deliveries, and there looks to be a strong business aviation component going forward.

9.0 FUTURE AGENDA ITEMS

10.0 SET NEXT MEETING LOCATION

The next meeting will be Thursday, February 16 at John Wayne Airport.

11.0 ADJOURNMENT

The meeting was adjourned by Chairman Kunze at 12: 40 pm.

AVIATION TECHNICAL ADVISORY COMMITTEE PHONE/FAX/E-MAIL LIST

Last Update: 2/9/2012

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Last Update: 2/9/2012

MEMBERS: Page 2

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Helicopter Noise Bill Lands in Congress

Complaints about hovering helicopters in the San Fernando Valley prompted a lawmaker's bill

By Jonathan Lloyd

Friday, Jul 29, 2011

NBC Southern California

Residents' complaints about the sound of helicopters over their San Fernando Valley neighborhoods have led to a bill in Congress.

The Los Angeles Residential Helicopter Noise Relief Act landed in the House of Representatives. Rep. Howard Berman, D-Valley Village, introduced the bill Thursday.

It would require the Federal Aviation Administration to establish rules on flight paths and minimum altitudes for helicopters. Law enforcement, emergency responders and the U.S. military would be exempt.

Berman said helicopter traffic has become "ridiculous" in the San Fernando Valley. His 28th District includes the northern San Fernando Valley -- San Fernando, Pacoima, Arleta, Panorama City, Sylmar and North Hollywood.

The slapping noise created by helicopters is caused by blade-vortex interaction. As one rotating blade follows another, it strikes the wake left by the lead blade and generates a pulsating sound.

"Helicopters are hovering right above our homes at all hours of the morning and night," said Richard Close, President of the Sherman Oaks Homeowners Association. "It's the wild, wild West up there."

Larry Welk, president of the Professional Helicopter Pilots Association, said the legislation will not achieve its goal of noise reduction.

"There's a public perception that there's more helicopter traffic," said Welk. "That's just not true. There used to be six, seven traffic helicopters in the air. News stations that used to have two now have one, some have none. The fact is, this legislation exempts 70 percent of the helicopters that generate the noise."

The text of HR 2677 was not immediately available, but Berman told the Daily News his office has received complaints about tour operators, commercial charters and paparazzi. The billl also applies to news organizations' helicopters.

Welk suggested that communities work with organizations like the PHPA to resolve individual problems. The Hollywood Bowl, for example, worked with PHPA to install white strobe lights that warn pilots when they should not fly over the area.

The organization has a contact page on its website.

Both helicopters and airplanes have altitude regulations. Airplanes are required to fly at least 1,000 feet above the nearest obstacle over densely populated areas.

As for helicopters, there also are regulations in place that deal with safety. Helicopters must be operated so they do not create safety issues for people or property on the ground, according to the FAA.

"Safety is always the FAA's top priority, and we aggressively investigate allegations of unsafe aircraft operations by airplane and helicopter pilots," the FAA said in statement released Friday. "The FAA works with helicopter operators and community groups around the country to find ways for these aircraft to operate safely and with minimal community noise impacts."

Federal Aviation
Administration

Optimization of Airspace and Procedures in the Metroplex (OAPM)

Study Team Final Report

Southern California Metroplex

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1 Background

In September 2009, the Federal Aviation Administration (FAA) received the RTCA's Task Force 5 Final Report on Mid-Term NextGen Implementation containing recommendations concerning the top priorities for the implementation of NextGen initiatives. A key component of the RTCA recommendations is the formation of teams leveraging FAA and Industry Performance Based Navigation (PBN) expertise and experience to expedite implementation of optimized airspace and procedures.

Optimization of Airspace and Procedures in the Metroplex (OAPM) is a systematic, integrated, and expedited approach to implementing PBN procedures and associated airspace changes. OAPM was developed in direct response to the recommendations from RTCA's Task Force 5 on the quality, timeliness, and scope of metroplex solutions.

OAPM focuses on a geographic area, rather than a single airport. This approach considers multiple airports and the airspace surrounding a metropolitan area, including all types of operations, as well as connectivity with other metroplexes. OAPM projects will have an expedited life-cycle of approximately three years from planning to implementation.

The expedited timeline of OAPM projects centers on two types of collaborative teams:

- OAPM Study Teams (OSTs) provide a comprehensive but expeditious front-end strategic look at each major metroplex.
- Using the results of the OSTs, Design and Implementation (D&I) Teams provide a systematic, effective approach to the design, evaluation and implementation of PBN-optimized airspace and procedures.

2 Purpose of Southern California Team Effort

The principle objective of the Southern California OST is to identify operational issues and propose PBN procedures and/or airspace modifications in order to address them. This OAPM project for the Southern California Metroplex seeks to optimize and add efficiency to the operations of the area. These efficiencies include making better use of existing aircraft equipage by adding Area Navigation (RNAV) procedures, optimizing descent and climb profiles to eliminate or reduce level-offs, creating diverging departure paths that will get aircraft off the ground and on course to their destination faster, and adding more direct high-altitude RNAV routes between two or more metroplexes, among others.

The OST effort is intended as a scoping function. The products of the OST will be used to scope future detailed design efforts and to inform FAA decision-making processes concerning commencement of those design efforts.

3 Southern California OAPM Study Team Analysis Process

3.1 Five Step Process

The Southern California OST followed a five step analysis process:

1. Collaboratively identify and characterize existing issues:
   a) Review current operations
   b) Solicit input to obtain an understanding of the broad view of operational challenges in the metroplex
2. Propose conceptual procedure designs and airspace changes that will address the issues and optimize the operation:
   a) Use an integrated airspace and PBN "toolbox" (Appendix C)
   b) Obtain technical input from operational stakeholders
   c) Explore potential solutions to the identified issues
3. Identify expected benefit, quantitatively and qualitatively, of the conceptual designs:
   a) Assess the Rough Order of Magnitude (ROM) impacts of conceptual designs
   b) To the extent possible, use objective and quantitative assessments
4. Identify considerations and risks associated with proposed changes:
   a) Describe, at a high-level, considerations (e.g., if additional feasibility assessments are needed) and/or risks (e.g., if waivers may be needed)
5. Document the results from the above steps

Steps 1 and 2 are worked collaboratively with local facilities and operators through a series of outreach meetings. Step 3 is supported by the OAPM National Analysis Team (NAT). The methodology used for the quantitative analysis is described in Section 3.4. The NAT is a centralized analysis and modeling capability that is responsible for data collection, visualization, analysis, simulation, and modeling. Step 4 is conducted with the support of the OAPM Specialized Expertise Cadre (SEC). The SEC provides "on-call" expertise from multiple FAA lines of business, including environmental, safety, airports, and specific programs like Traffic Management Advisor (TMA).

The Southern California OST process and schedule are shown below:

- Kickoff meeting: August 11(at Los Angeles Regional Office)
  – Discuss concepts and proposed schedules
  – Establish facility points of contact

  - Make data requests
- Administrative week: August 15 – 19
- First Outreach: Existing Operations and Planning
  - FAA Facilities: August 22 – 26 at Los Angeles ARTCC (ZLA) and Southern California TRACON (SCT)
  - Stakeholders: August 30 (at Los Angeles Regional Office)
- OST work (focus on operational challenges): August 29 – September 18
- Second Outreach: Enhancement Opportunities
  - FAA Facilities: September 19 – 23 (at SCT)
  - Stakeholders: September 27 (at Los Angeles Regional Office)
- OST work (focus on solutions, costs, and benefits): September 28 – October 28
- Final Outreach: Summary of Recommendations
  - FAA Facilities: November 1 (at Los Angeles Regional Office)
  - Stakeholders: November 3 (at Los Angeles Regional Office)
- Documentation: Final report, briefing, and D&I Team package
  - OST work (completing documentation): November 7 – 17
  - Report due November 18

There were three rounds of outreach to local facilities, industry, and other stakeholders, including Department of Defense, airlines, business and general aviation, airports, and others. The first outreach focused on issue identification, the second on conceptual solutions, and the third on summarizing the analyses of benefits, impacts, and risks. Assessments at this stage in the OAPM process are expected to be high-level, as detailed specific designs (procedural and/or airspace) have not yet been developed. More detailed assessments of benefits, impacts, costs and risks are expected after the D&I phase has been completed.

3.2 Southern California Study Area Scope

The Southern California Metroplex consists of airspace delegated to the SCT and ZLA. Operations at eight airports within the lateral confines of SCT's airspace were examined closely due to the complexity of the interactions between these airports:

- Los Angeles International Airport (LAX)
- San Diego International Airport (SAN)
- Bob Hope Airport (BUR)
- Ontario International Airport (ONT)

- John Wayne Airport – Orange County (SNA)
- Long Beach/Daugherty Field (LGB)
- Santa Monica Municipal Airport (SMO)
- Van Nuys Airport (VNY)

Fuel burn modeling was performed for all of the above airports except VNY and SMO. VNY and SMO were excluded due to low instrument flight rules (IFR) jet traffic counts.

Other satellite airports' operations and issues were also examined, as appropriate, including Fullerton (FUL), Carlsbad (CRQ), Santa Barbara (SBA), Bermuda Dunes (UDD), Camarillo (CMA), Pt. Mugu Naval Air Station (NTD), Oxnard (OXR), Palm Springs (PSP), North Island Naval Air Station (NZY), Brown Field (SDM), and Thermal (TRM), among others.

3.3 Assumptions and Constraints

OAPM is an optimized approach to integrated airspace and procedures projects; thus, the proposed solutions center on PBN procedures and airspace redesign. The OST is expected to document those issues that cannot or should not be addressed by airspace and procedures solutions, as these will be shared with other appropriate program offices. These issues are described in Sections 4.5 and 4.6 of this report.

The OAPM expedited timeline and focused scope bound airspace and procedures solutions to those that can be achieved without requiring an Environmental Impact Statement (EIS) (e.g., only requiring an Environmental Assessment [EA] or qualifying for a Categorical Exclusion [CATEX]) and are within current infrastructure and operating criteria. The OST may also identify airspace and procedures solutions that do not fit within the environmental and criteria boundaries of an OAPM project. These other recommendations then become candidates for other integrated airspace and procedures efforts.

3.4 Assessment Methodology

Both qualitative and quantitative assessments were made to gauge the potential benefits of proposed solutions.

The qualitative assessments are those that the OST could not measure but would result from the implementation of the proposed solution. These assessments included:

- Impact on air traffic control (ATC) task complexity
- Ability to apply procedural separation (e.g., laterally or vertically segregated flows)
- National Airspace System (NAS) impacts of flow deconfliction
- Ability to enhance safety
- Improved connectivity to en route structure

- Reduction in transmissions (flight deck and controller) and related reduction in frequency congestion
- Improved track predictability and repeatability, with associated more accurate fuel planning
- Reduced reliance on ground-based navigational aids (NAVAIDs)
- Increased throughput

Task complexity, for example, can be lessened through the application of structured PBN procedures versus the use of radar vectors, but quantifying that impact is difficult. Reduced communications between pilot and controller, as well as reduced potential for operational errors, are examples of metrics associated with controller task complexity that were not quantified.

For the quantitative assessments, the OST relied on identifying changes in track lengths, flight times, and fuel burn. Most of these potential benefits were measured by comparing a baseline case with a proposed change using both fuel burn tables based on the European Organization for the Safety of Air Navigation (EUROCONTROL) Base of Aircraft Data (BADA) fuel burn model and a flight simulator, which was used to establish a relationship between simulator fuel burn results and BADA tables. The quantitative analyses compared full-time use of current procedures under baseline conditions with full-time use of the procedures proposed by the OST.

3.4.1 Track Data Selected for Analyses

During the study process, a representative set of radar traffic data was utilized in order to maintain a standardized operational reference point.

For determining the number, length, and location of level-offs for the baseline of operational traffic, radar track data from 30 high-volume (70th-90th percentile) days, operating under Visual Meteorological Conditions (VMC) in 2010 and 2011, were utilized. These days were selected using the Airport Specific Performance Metrics (ASPM) operational counts and weather data. Table 1 shows the analysis days utilized by the Southern California OST and the NAT.

Table 1. Radar Track Data Analysis Days

05/07/2010	05/12/2010	05/13/2010	07/132010	07/14/2010	07/15/2010
08/16/2010	08/19/2010	08/20/2010	09/29/2010	10/27/2010	11/01/2010
11/03/2010	11/04/2010	11/05/2010	11/12/2010	12/02/2010	12/03/2010
01/13/2011	02/03/2011	02/04/2011	02/11/2011	02/28/2011	03/09/2011
03/10/2011	03/11/2011	03/18/2011	04/15/2011	04/27/2011	04/28/2011

The historical radar track data were used to visualize the flows and identify where short-cuts were routinely applied, as well as where flight planned routes were more rigorously followed.

The track data were also used as a baseline for the development of several conceptual solutions, including PBN routes and procedures. In many cases, the OST overlaid the historical radar tracks with PBN routes or procedures to minimize the risk of significant noise impact and an associated EIS.

Due to the compressed schedule associated with this study effort, there was not sufficient time to model all Southern California airports. Fuel burn modeling was performed at the six airports with the most IFR jet operations.

The characteristics of the Southern California Metroplex are unique in that most of the airports have a predominant runway configuration (see Table 2). Historically, Southern California airports are in a west flow operation approximately 95% of the time or higher as shown Table 2. The OST focused their benefits analyses on these heavily-used runway configurations.

Table 2. Modeled Runway Configurations at Southern California Airports[1]

Airport	Arrival Runways	Departure Runways	% Time in Flow	% Ops in Flow	Comments
LAX	24L/R, 25L/R	24L/R, 25L/R	98%	98%	24R and 25L typically used for arrivals, 24L and 25R for departures
SNA	19L/R	19L/R	96%	97%	
SAN	27	27	96%	96%	
BUR	08, 15	08, 15	96%	96%	
LGB	30	30	95%	96%	
ONT	26L/R	26L/R	95%	96%	

3.4.2 Analysis Tools

The following tools were employed by the OST and the NAT in the process of studying the Southern California Metroplex:

- Performance Data Analysis and Reporting System (PDARS)
  - Historical traffic flow analysis using merged datasets to analyze multi-facility operations (SCT and ZLA)

[1] Source: Aviation System Performance Metrics, 5/19/2010 – 5/18/2011

- Customized reports to measure performance and air traffic operations (i.e., fix loading, hourly breakdowns, origin-destination counts, etc.)
  - Identification and analysis of level flight segments for SCT arrivals and departures
  - Graphical replays to understand and visualize air traffic operations
  - Verification of level-offs in ZLA and SCT airspace
- Terminal Area Route Generation Evaluation and Traffic Simulation (TARGETS)
  - Comparison of actual flown routes to proposed routes when developing cost/benefit estimates
  - Conceptual airspace and procedure design
- Total Airport and Airspace Model (TAAM)
  - Airport and airspace flow modeling
- Integrated Terminal Research, Analysis, and Evaluation Capabilities (iTRAEC)
  - Identification of location, altitude and magnitude of level-off segments
- Air Traffic Airspace Lab (ATALAB) National Offload Program (NOP) data queries
  - Quantification of traffic demand over time for specific segments of airspace
  - Identification of runway usage over time
- National Traffic Management Log (NTML)
  - Identification of occurrence and magnitude of TMIs
- Enhanced Traffic Management System (ETMS)
  - Traffic counts by aircraft group categories for annualizing benefits
  - Examination of filed flight plans to determine impact of significant re-routes

3.4.3 Determining the Number of Operations and Modeled Fleet Mix

Due to the compressed schedule associated with this study effort, there was not sufficient time to model the entire fleet mix for each airport. A representative fleet mix was developed for each airport that consisted of the primary aircraft types that service that airport.

The analysis determined annual operations for these airports by examining one year of FAA's ETMS arrivals and assuming the same number of departures. Fleet mixes for these airports are shown in Table 3.

Table 3. Southern California Modeled Fleet Mixes

Arrival Counts, 5/19/2010 – 5/18/211	LAX	SNA	SAN	BUR	ONT	LGB
Jets	262,074	54,504	86,502	34,864	33,991	20,003
Non-jets/Unidentified	28,233	13,025	7,438	8,767	7,002	9,016
Total	290,307	67,529	93,940	43,631	40,993	29,019
Modeled AC Type 1	B73s	B73s	B73s	B73s	B73s	A320s
Modeled AC Type 2	B75s	B75s	B75s	CRJs	B75s	CRJs
Modeled AC Type 3	B74s	CRJs	CRJs	LJ35	CRJs	LJ35
Modeled AC Type 4	CRJs	LJ45	--	--	MD11	--

3.4.4 Determining Percent of RNAV Capable Operations by Airport

The principal objective of the Southern California OST was to identify operational issues and propose PBN procedures and airspace modifications in order to address them. The PBN Dashboard was used to determine the percent of operations at each airport that would benefit from these new procedures. The PBN Dashboard is an online tool that reports this percentage through analysis of two sources: the equipment suffix of instrument flight rules (IFR) flight planned operations from ETMS and the percentage of PBN-equipped aircraft by type from a Part 121 avionics database maintained by The MITRE Corporation's Center for Advanced Aviation System Development (CAASD). Due to the incomplete nature of the data sources used, the percentages of RNAV-equipped operations are assumed to be conservative.

Table 4 lists the RNAV equipage percentages assumed for the modeled Southern California airports.

Table 4. RNAV Equipage by Airport

Airport	% of Total Operations RNAV-equipped
LAX	90%
SNA	89%
SAN	93%
LGB	90%
BUR	83%
ONT	89%

3.4.5 Profile Analyses

To determine the current level-offs of arrivals in the Southern California Metroplex, the OST examined track data from the 30 days discussed previously. Using CAASD's iTRAEC toolset, the OST identified the altitudes where level-offs occurred and the average length in nautical miles (NM) that aircraft were in level flight at each altitude. The OST also used TARGETS to calculate the length of the proposed routes compared to the current published routes and actual flown tracks. The reduction in level-offs and the distance savings were then converted into fuel savings by using the BADA fuel flow model, taking into account the modeled aircraft fleet mixes at the metroplex airports. The fuel savings were then annualized, assuming a fuel price per gallon of $2.92, based on fuel costs for May 2011 from Research and Innovative Technology Administration (RITA) Bureau of Transportation Statistics. The resulting benefit numbers were the basis for the minimum potential fuel benefit.

Flight simulations were run on a current arrival procedure as well as the corresponding conceptual design during the Washington D.C. Metroplex prototype OST effort. The flight simulator values were obtained through a US Airways A320 flight simulator fuel burn analysis for two transitions on a proposed versus baseline arrival procedure. Derived values for fuel burn per minute in level flight, idle descent, and less-efficient descent were then used to determine and validate the relationship between the flight simulator fuel saving estimates and the BADA-based fuel burn estimates (calculated in gallons per NM). Essentially, this effort allowed for a determination of the difference between BADA's conservative aircraft performance numbers and what could be achieved with an actual pilot flying the plane. This method was applied to Southern California OST results to determine a maximum fuel savings per flight. Applying both the BADA and flight simulator methods provides for a range of potential benefits:

- Lower bound potential benefit: BADA speed/fuel burn
- Upper bound potential benefit: Flight simulation speed/fuel burn

3.4.6 Cost to Carry (CTC)

Aircraft fuel loading is based on the planned flight distance and known level-offs. Furthermore, airlines must carry extra fuel to compensate for the weight of the total fuel required to fly a route. This extra fuel is known as the Cost to Carry (CTC). CTC can vary widely among airlines, generally ranging from about 2% to about 15%. For this analysis, based on feedback from multiple industry representatives, CTC was assumed to be 10% at LAX and 6% at all other Southern California modeled airports. This means that for every 100 gallons of fuel loaded, CTC is 6 or 10 gallons. CTC is included in all of the fuel burn estimates presented in this report, reflecting the benefits of developing procedures that more closely align with existing aircraft flight paths.

3.4.7 Benefits Metrics

The benefits metrics were generated using the following process:

1. The radar track data from the 30 high-traffic days were parsed into flows into and out of Southern California. These flows were then analyzed to determine geographic location, altitude, and length of level-offs in the airspace. The average overall track flow length was also estimated.
2. Baseline routes were developed that mimic the average vertical and lateral path of the tracks in the flows.
3. Proposed conceptual routes were designed by the OST.
4. The impacts of the proposed conceptual routes were estimated as compared to the current published procedure for the flow, if any, and the baseline route.
    a) Vertical savings: Compare the *baseline* vertical path with its associated level-offs with the *proposed* vertical path, which ideally has fewer and/or shorter level-offs.
    b) Lateral filed miles savings: Compare the length of the *published* procedure or route to the length of the *proposed* procedure of route.
    c) Lateral distance savings: Compare the length of the *baseline* procedure or route to the length of the *proposed* procedure of route.
5. The fuel and cost savings were then estimated based on the above impacts.
    a) Vertical profile savings accrue both fuel savings and CTC savings.
    b) Lateral filed miles savings accrue CTC savings *only*.
    c) Lateral distance savings accrue both fuel savings and CTC savings.

Figure 1 shows published, baseline, and proposed routes for a flow, with the comparisons for lateral savings highlighted, and sample vertical profiles as well.

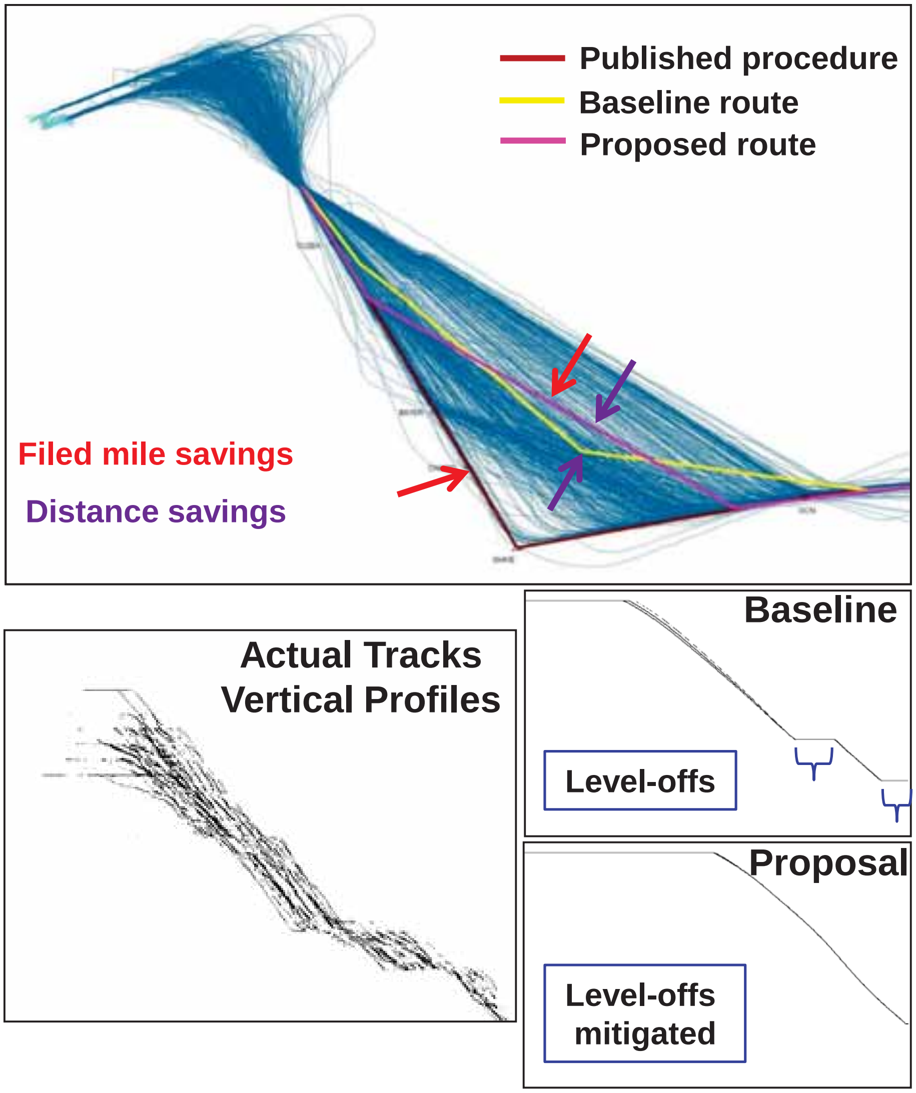


Figure 1. Sample Analysis: Lateral and Vertical Baselines

3.5 Key Considerations for Evaluation of Impacts and Risks

In addition to the quantitative and qualitative benefits assessments described in Section 3.4, the Southern California OST was tasked with identifying the impacts and risks from the FAA operational and safety perspective, as well as from the airspace user perspective. For each individual issue and proposed solution throughout Section 4 of this report, specific impacts and risks are identified. However, there are a number of impacts and risks that generally apply to many proposed solutions, as described below:

- Controller and pilot training: With the increased focus on PBN and the proposed changes in airspace and procedures, controller and pilot training will be a key consideration for nearly all proposals.
- "Descend via" procedure issues: The proposed use of "descend via" clearances will similarly require controller and pilot training, and agreement must be reached during D&I on exactly how procedures will be requested, assigned, and utilized from both the FAA and user perspectives.
- Aircraft equipage: There are challenges with working in a mixed equipage environment, and these risks must be considered during D&I. While procedures have been designed to take advantage of PBN efficiencies, procedures and processes must be developed for conventional operations as well.
- Safety Risk Management (SRM): Safety is always the primary concern, and all of the proposed solutions will require an SRM assessment, which will occur during the Operational and Environmental Review phase.
- Environmental issues: All proposed solutions are subject to environmental review, and the OAPM schedule limits that review to a CATEX or EA rather than an EIS. The OST worked with environmental specialists to determine whether any of the proposed solutions has the potential for significant environmental impacts, and developed mitigation alternatives if necessary.

4 Identified Issues and Proposed Solutions

This section presents the findings and results of the Southern California OST analysis. It reviews identified issues, proposed solutions, benefits/impacts/risks, and analysis results. During the first industry and facility interface meetings, approximately 170 issues were identified. ZLA identified 43 of these issues, SCT and the Air Traffic Control Tower (ATCTs) identified 83 issues, and 44 issues were identified by various industry stakeholders. Similar issues raised by all involved parties were consolidated and categorized by the OST to determine potential solutions:

- Design concepts (see Section 4.1)
- Southern California departure issues (see Section 4.2)
- Southern California arrival issues (see Section 4.3)
- Other Southern California Issues (see Section 4.4)
  - SMO and LAX interactions
  - T-Routes
  - Required Navigation Performance (RNP) approaches

Some issues required additional coordination and input and could not be addressed within the time constraints of the OST process. In addition to those issues that were addressed by the Southern California OST and those that require additional coordination, the OST identified a number of issues that were outside of the OAPM scope. These issues are described in Section 4.6 of this report.

4.1 Design Concepts

The primary goals used by the Southern California OST throughout the conceptual design phase were to use RNAV everywhere and RNP where beneficial. The use of PBN procedures will allow efficiency gains through optimized profile climbs/descents and enhanced lateral paths not reliant on ground based navigation while allowing predictability and repeatability and reducing ATC task complexity and frequency congestion. The OST removed unused transitions to reduce chart clutter and the potential for improper flight planning. Runway transitions were used where practical, while limiting environmental risks during the D&I phase. The OST recommended the use of transitional separation (3 NM increasing to 5 NM) that may increase airspace throughput for departures.

4.2 Southern California Departures

ZLA and SCT controllers rely on an assortment of conventional and RNAV departure procedures. The facilities use both vectors and route structure where necessary to maintain separation and expedite aircraft climbs into en route airspace.

Historical departure tracks demonstrated efficiency when allowed unrestricted climbs. The proposed departure procedures attempt to maintain unrestricted climbs as much as possible, while providing procedural separation where practical from other Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs). It is fully expected that ATC will continue to tactically enable shorter routings and remove climb restrictions, further increasing operator benefits. Additionally, the recommended use of transitional separation by SCT and ZLA may increase throughput at Southern California airports. Transitional separation will allow terminal facilities to provide 3 NM in-trail separation increasing to 5 NM in the en route environment. Any airspace modifications that enable procedural efficiencies will also be considered during D&I.

One of the major issues in the Southern California metroplex area is level-offs from LAX and LGB airports. These level-offs can range from 10 NM to 25 NM, with LGB experiencing the longest of the level-offs. Many of the Southern California SIDs have unused transitions where actual flight tracks do not overfly the current published procedure.

Another major issued raised by both ATC and industry stakeholders is the inefficiency of using the OSHNN SID between 2100 and 0700, which adds between 14 NM to 23 NM to the route compared to the LOOP SID. OST analysis and initial noise screens support continuous use of the LOOP SID.

RNAV procedures were designed for repeatable, predictable paths. Independent SIDs were developed for both east and west flows. The OST recognizes that RNAV off-the-ground procedures may create a disbenefit in track miles flown in certain circumstances. The D&I Team may elect to further evaluate the combination of radar vectors and RNAV off-the-ground SIDs to determine the most beneficial method of departing from Southern California airports.

With respect to the conceptual departure proposals, Figure 2 depicts benefits, impacts, and risks for the FAA and airspace users, as well as environmental considerations.

FAA Operational / Safety	
Benefits	**Impacts / Risks**
• PBN benefits • Increased throughput • Reduced delay vectoring • Reduced track miles • Optimized lateral flight paths	• LOA revisions • Training • Sectorization

Airspace User	
Benefits	**Impacts / Risks**
• PBN benefits • Reduced fuel burn and emissions	• Chart clutter

Environmental Considerations
• Noise screening / analysis • Emissions analysis • Runway transition assessment

Figure 2. Benefits, Impacts, and Risks of the Departure Proposals

4.2.1 LAX Departures

This section describes the operational issues, recommendations, and derived benefits the OST has identified for LAX departures.

4.2.1.1 LAX CASTA Departure

The CASTA accounts for approximately 12% of all jet LAX departures.

- Issues
  - There is a long level-off at 9,000 feet as the departure flow passes beneath the LAX SADDE arrival flow.
  - Actual flight tracks do not follow the current departure procedure.

- Recommendations
  - The conceptual CASTA SID (see Figure 3) provides for a modified departure flow over GMN to segregate the GMN and COREZ departure flows. The proposed en route transitions closely follow the actual flight tracks.
  - The AVE transition was removed due to lack of usage.
  - An earlier initial turn off LAX will minimize or eliminate the level-off and reduce track miles.

Figure 3. Current and Proposed LAX CASTA SID

- Benefits
  - Projected annual savings for the CASTA SID are estimated in Table 5.

Table 5. Proposed LAX CASTA SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$143K	
	Profile	$70K	$283K
	Cost to Carry	$71K	$93K
Total Estimated Annual Fuel Savings (Dollars)		$284K	$519K
Total Estimated Annual Fuel Savings (Gallons)		96K	176K
Total Estimated Annual Carbon Savings (Metric Tons)		960	1.8K

4.2.1.2 LAX HOLTZ Departure

The HOLTZ accounts for approximately 26% of all LAX jet departures.

- Issues
  - The current airspace configuration between SCT and ZLA requires excessive coordination.
  - Runways 24L/R transitions are excessively long and aircraft rarely fly the published route over the DOCAG intersection.

- Recommendations
  – As shown in Figure 4, the OST shortened the transitions from Runways 24L/R by eliminating the DOCAG waypoint from the procedure, thus reducing filed miles by approximately 3 NM.
  – An additional transition fix prior to TRM was added for early turns to PKE when available.

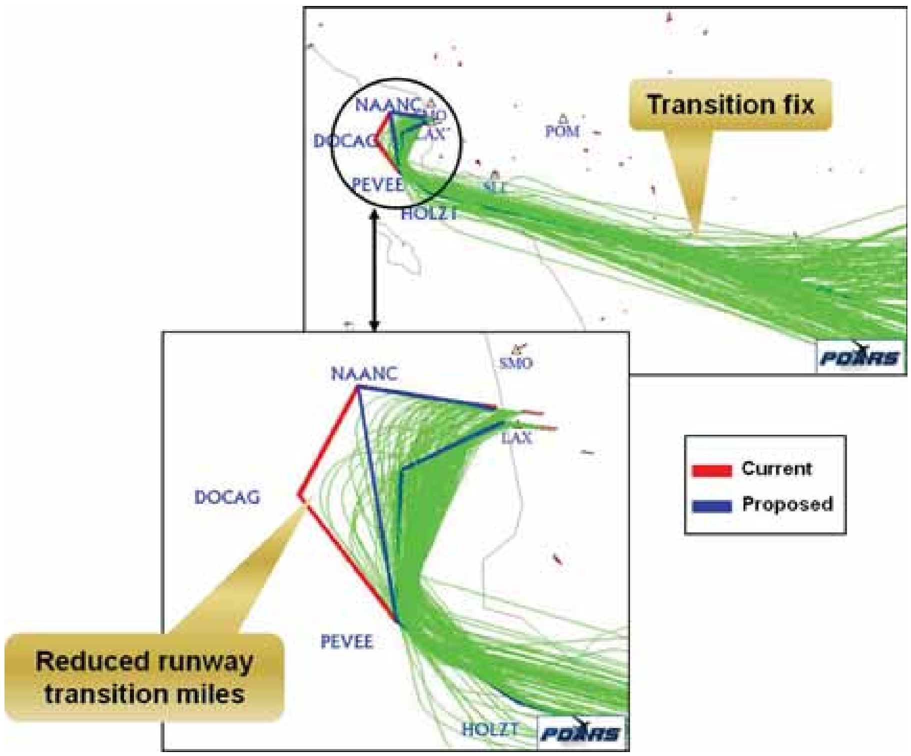


Figure 4. Current and Proposed LAX HOLTZ SID

- Benefits
  - Estimated savings from modifications to the HOLTZ departure are derived from the track mile reduction for aircraft departing Runways 24L/R at LAX. Aircraft departing Runways 25L/R will see no changes.
  - Projected annual savings for the HOLTZ SID are estimated in Table 6.

Table 6. Proposed LAX HOLTZ SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	N/A	
	Cost to Carry	$120K	
Total Estimated Annual Fuel Savings (Dollars)		$120K	
Total Estimated Annual Fuel Savings (Gallons)		41K	
Total Estimated Annual Carbon Savings (Metric Tons)		410	

4.2.1.3 LAX KARVR Departure

The KARVR accounts for approximately 8% of all LAX jet departures.

- Issues
  - There are inefficient lateral paths as aircraft are generally vectored to various fixes prior to the KARVR intersection on the current published route.
  - Runways 24L/R transitions are excessively long, and aircraft rarely fly the published route over the DOCAG intersection.
  - The IPL en route transition on the current published procedure is unused.
  - Heavy traffic congestion over TRM Very High Frequency (VHF) Omnidirectional Range (VOR) creates vectored BLH offloads.

- Recommendations
  - As shown in Figure 5, the Runways 24L/R transitions have been shortened to align the procedure with current flight tracks and the IPL transition has been removed from the procedure due to lack of use, but a transitional fix for PILLO has been added to the procedure to allow aircraft a more direct routing to the southeast.
  - A ZLA requested offload route over BLH has been added to shorten overall track miles and to alleviate congestion over TRM. The traffic over TRM was identified as an issue during the outreach meetings. Numerous restrictions are imposed during peak periods to help mitigate the flows. The restrictions, dictated by ZLA, are given to SCT, which in turn are passed along to LAX, LGB, and SNA.
    - The supporting data was obtained from the NTML Miles-In-Trail (MIT) log for the 2010 calendar year. Restrictions were primarily due to volume (VOL), weather (WX), or equipment/frequency failure (EQ); however, pass-back restrictions from beyond TRM were excluded. The metric used is minute-miles. This is calculated by multiplying the total minutes the restriction was in effect by the imposed MIT value (spacing in miles).
    - Over TRM, the total minute-miles in 2010 were 135,281, with restrictions in place on 129 days. On average, restrictions were in place two days a week. The supporting data is shown in Figure 6.

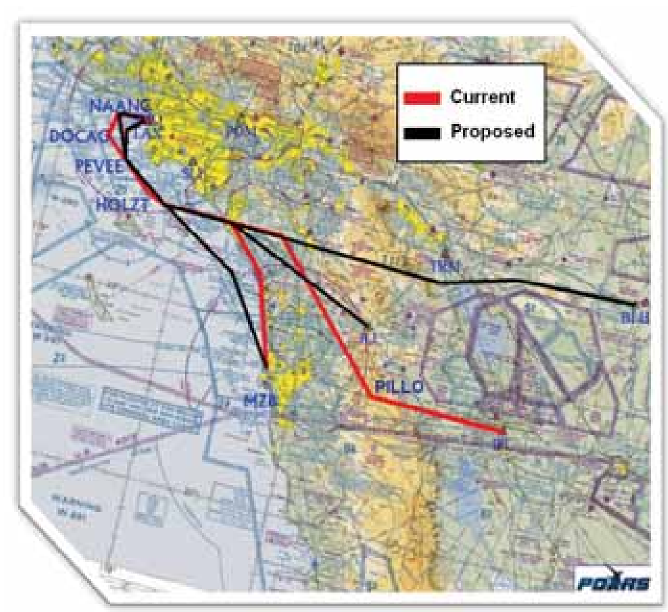
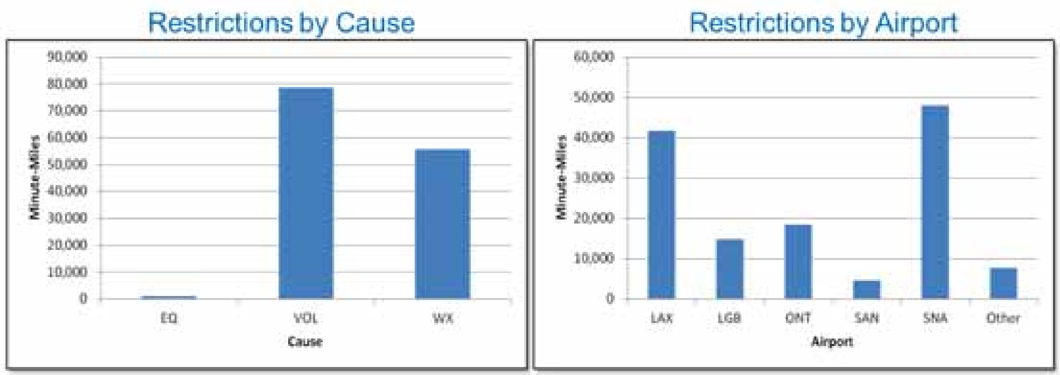


Figure 5. Current and Proposed LAX KARVR SID



Caveats: The data is often subject to entry errors, such as misspelled fix names, inconsistent entries, etc.

Figure 6. TRM MIT Restrictions

- Benefits
  - Since ATC clears aircraft direct to a point along the filed route, the estimated annual fuel savings indicate a disbenefit. This disbenefit could be reduced or mitigated if ATC continues the current practice of providing more direct routings when feasible. With the shortened runway transition, and the addition of the offload route over BLH, this procedure will provide greater flexibility for aircraft flow management.
  - Projected annual savings for the KARVR SID are estimated in Table 7.

Table 7. Proposed LAX KARVR SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	($149K)	
	Profile	N/A	
	Cost to Carry	$5K	
Total Estimated Annual Fuel Savings (Dollars)		($144K)	
Total Estimated Annual Fuel Savings (Gallons)		(50K)	
Total Estimated Annual Carbon Savings (Metric Tons)		(500)	

4.2.1.4 LAX OSHNN Departure

The OSHNN accounts for approximately 6% of all LAX jet departures.

- Issues
  - The OSHNN departure from LAX is an RNAV SID that is primarily used from 2100 to 0700 local, when aircraft are not assigned the LOOP departure.
  - Runways 24L/R transitions are excessively long and aircraft rarely fly the published route over the DOCAG intersection.

– The current routing follows the same path as the HOLTZ and KARVR SIDs from the departure runways via the PEVEE waypoint to the HOLTZ waypoint. The OSHNN procedure then transitions to the DAG VOR, which is also where the LOOP SID terminates.

- Recommendations
  – The OST shortened the transitions from Runways 24L/R by eliminating the DOCAG waypoint from the procedure, thus reducing filed miles by approximately 3 NM as shown in Figure 7.
  – It is envisioned by the OST that the OSHNN would be utilized by those aircraft which would have difficulty meeting the LOOP departure restrictions, such as heavy aircraft with impeded performance capabilities. All other aircraft would be assigned the new LOOP departure.

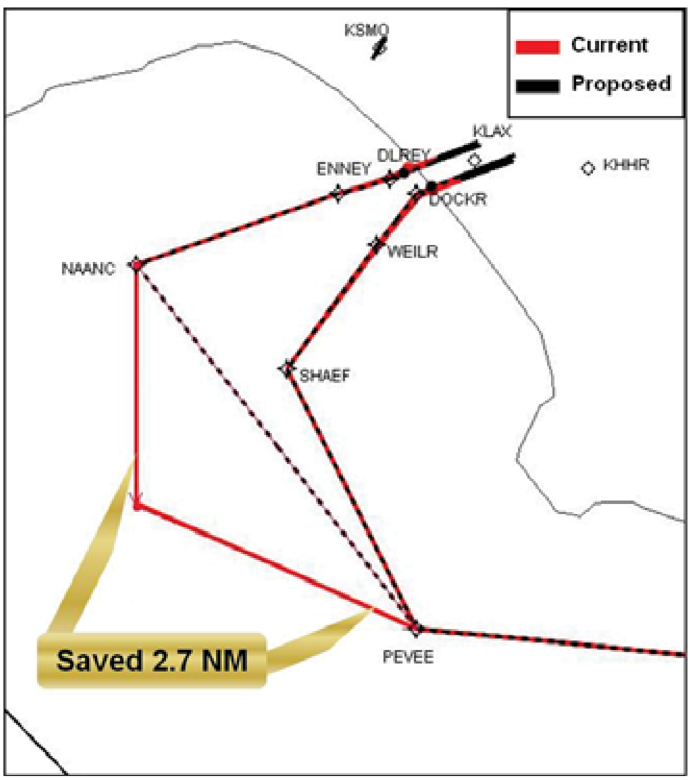


Figure 7. Current and Proposed LAX OSHNN SID

- Benefits
  – Estimated savings from modifications to the OSHNN departure are derived from the track mile reduction for aircraft departing Runways 24L/R at LAX. Aircraft departing Runways 25L/R will see no changes.

– Projected annual savings for the OSHNN SID are estimated in Table 8. This accounts only for aircraft expected to fly the OSHNN between 0700 and to 2100; aircraft that fly the OSHNN between 2100 and 0700 currently are addressed in the next section.

Table 8. Proposed LAX OSHNN SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	N/A	
	Cost to Carry	$10K	
Total Estimated Annual Fuel Savings (Dollars)		$10K	
Total Estimated Annual Fuel Savings (Gallons)		2K	
Total Estimated Annual Carbon Savings (Metric Tons)		20	

4.2.1.5 LAX LOOP Departure

The LOOP accounts for approximately 19% of all LAX jet departures.

- Issues
  – The LOOP SID is a conventional procedure relying upon ground based navigation and radar vectors.
  – Use of the LOOP SID is not authorized between 2100 and 0700 local. Both ATC and stakeholders have requested to utilize this procedure without restriction. Alternate routes that must be used when the LOOP SID is unavailable result in excessive track mileage. Additionally, departure delays are encountered at all Los Angeles Basin airports due to this configuration. LOOP SID traffic is normally shortcut through R2502E when this airspace is released from military use. Assignable RNAV routing has been requested to accommodate a more efficient route when this airspace is available.
  – Figure 8 shows the current LOOP and OSHNN SID flight tracks.

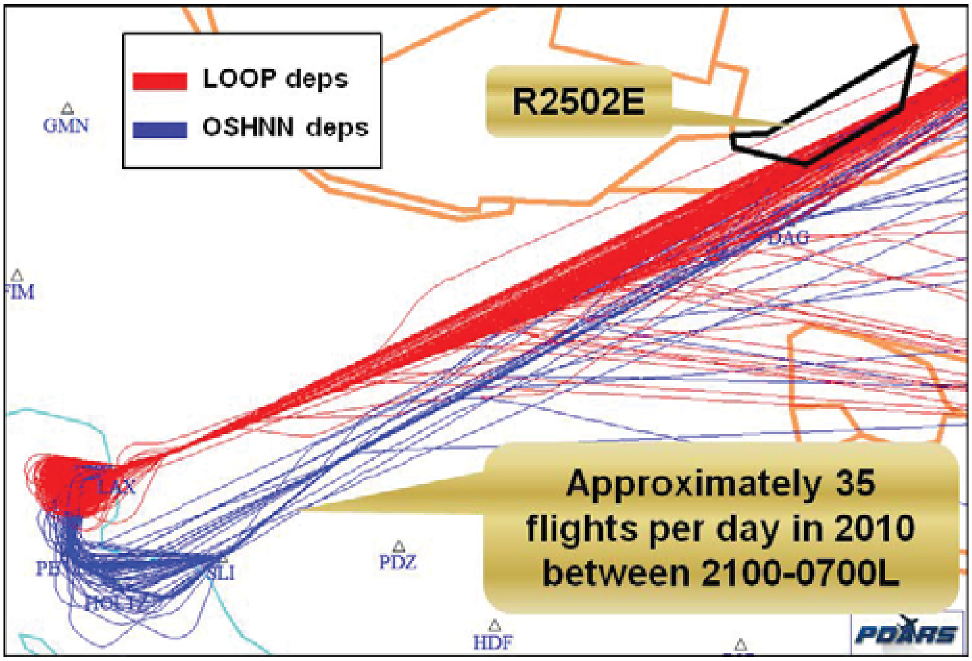


Figure 8. LAX LOOP and OSHNN Departures

- Recommendations
  - The proposed replacement for the LOOP SID is designed as a PBN procedure.
  - Floating waypoints will allow ATC an assignable route through R2502E when the airspace is inactive.
  - The OST recommends 24-hour usage of the RNAV LOOP SID. Initial noise screening supports continuous use of the LOOP. A route reduction of between 14 NM and 23 NM per flight will be realized with unrestricted LOOP availability. Approximately 35 aircraft per day would benefit from this usage.

- Benefits
  - Projected annual savings for the continuous use of the LOOP SID are estimated in Table 9.

Table 9. Proposed LAX LOOP SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$1.94M	
	Profile	N/A	
	Cost to Carry	$194K	
Total Estimated Annual Fuel Savings (Dollars)		$2.14M	
Total Estimated Annual Fuel Savings (Gallons)		700K	
Total Estimated Annual Carbon Savings (Metric Tons)		7K	

4.2.1.6 LAX VTU Departure

The VTU SID accounts for approximately 20% of all LAX jet departures.

- Issues
  - The VTU SID is a conventional procedure relying on ground based navigational equipment and radar vectors.
  - Because of new separation requirements regarding R2519, the conventional VTU procedure is too close to the restricted area.

- Recommendations
  - The proposed replacement for the VTU SID is designed as a PBN procedure as shown in Figure 9 as the dashed black line.
  - The OST recommends the proposed VTU departure as a replacement for the FIXIT SID, which is expected to be published in February 2012.
  - From the runway transitions to FIXIT, the proposed SID follows current flight tracks. After FIXIT, the route proceeds to IKAYE to provide clearance from R2519 when it is active.
  - When R2519 is active, aircraft will fly the full length of the route, approximately 54 NM from FIXIT to RZS. When R2519 is not active, aircraft will be sent direct RZS after FIXIT, approximately 50 NM.

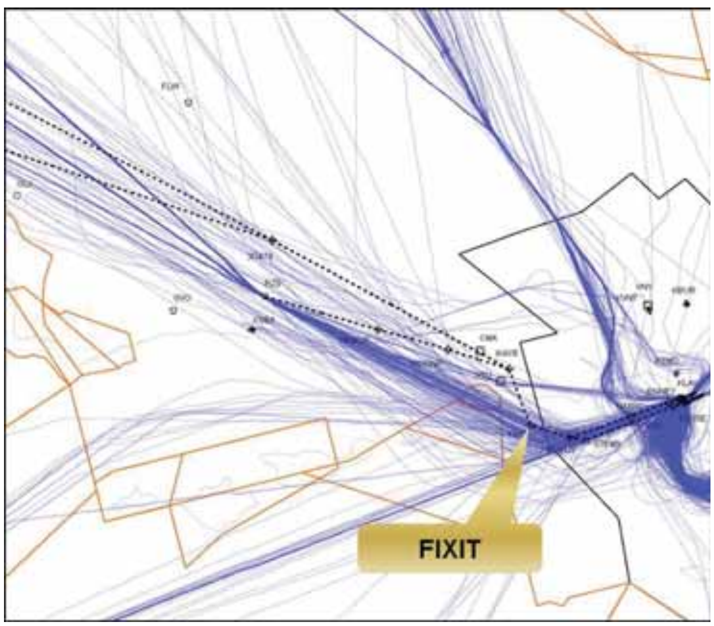


Figure 9. Proposed LAX VTU Departure

- Benefits
  - The flight paths of the proposed RNAV VTU SID mimic the current conventional procedure. Thus, projected annual savings were not modeled.

4.2.1.7 LAX GABRE Departure

The GABRE is an east flow departure that accounts for less than 1% of all LAX jet departures.

- Issues
  - The GABRE SID is a conventional procedure relying on ground based navigation and radar vectors.
  - Actual flight tracks do not follow the current departure procedure.
- Recommendations
  - The proposed replacement for the GABRE SID is designed as a PBN procedure as shown in Figure 10.
  - The proposed procedure will eliminate a sharp "S" turn and replace it with a more optimal route that closely follows current flight tracks. This will reduce filed and flown miles between 8 and 13 NM.
  - The OST design procedurally deconflicts the proposed procedure from other east flow traffic procedures.

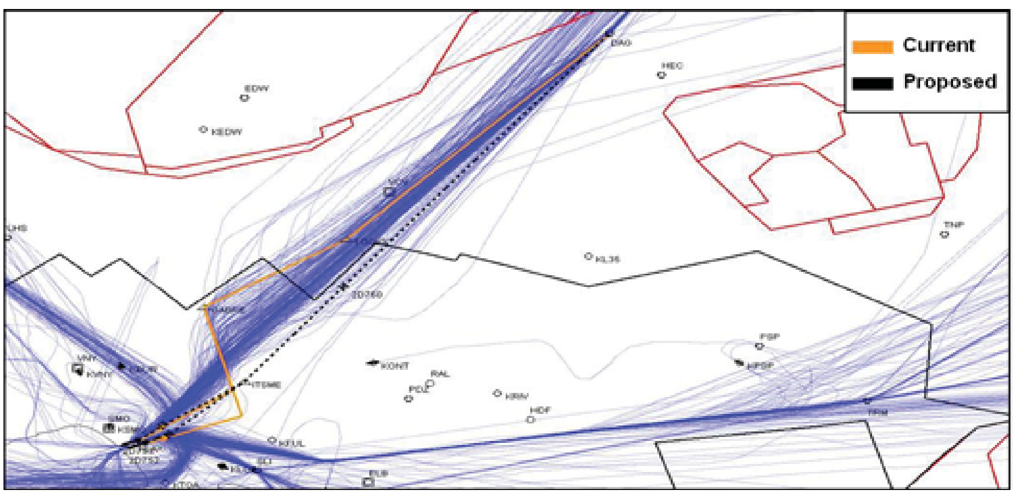


Figure 10. Current and Proposed LAX GABRE SID

- Benefits
  - Due to low traffic counts, no modeling was done for this procedure.

4.2.2 SAN Departures

This section describes the operational issues, recommendations, and derived benefits the OST has identified for departures from SAN.

4.2.2.1 SAN PEBLE Departure

The PEBLE accounts for approximately 33% of all SAN jet departures.

- Issues
  - The PEBLE departure is a conventional SID relying on ground based navigation and radar vectors.
  - Actual flight tracks do not follow the current departure procedure.
  - SAN departures to LAS are required to file the SXC transition, direct LAX, direct DAG, resulting in excessive filed miles.
  - Although there are currently two transitions on this SID, the SLI transition is infrequently filed or assigned.
- Recommendations
  - The proposed replacement for the PEBLE SID is designed as a PBN procedure.
  - Additional transitions were added to closely mimic where aircraft routinely fly.
  - The OST recommends changes to the PEBLE SID that allow for a more direct route to the PEBLE intersection thence transitions to LAX, POM, and RZS (via IKAYE waypoint). This will reduce filed miles significantly, but it is expected aircraft will still be cleared direct DAG when able.
  - Figure 11 shows the current and proposed PEBLE SIDs.

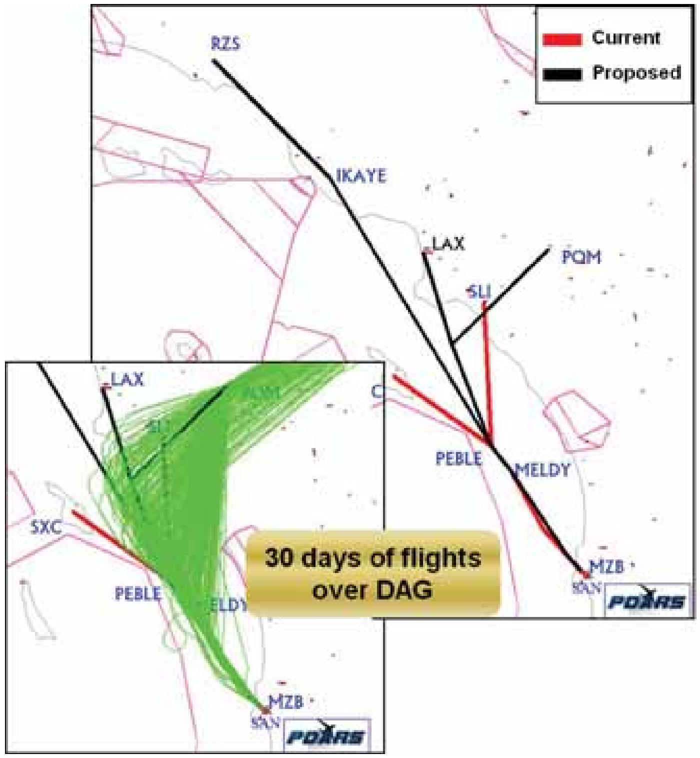


Figure 11. Current and Proposed SAN PEBLE SID

- Benefits
  - Estimated annual fuel savings indicate a disbenefit. This is mainly due to the fact that, when traffic allows, aircraft are cleared direct to a point along their filed route.
  - With conflicting arrival flows in the area south of Long Beach, it is impossible to mimic what ATC does routinely, i.e., going direct POM and then direct DAG. The new procedure will still allow aircraft to be given direct to DAG when possible and it is significantly shorter than the current filed route over SXC.
  - Projected annual savings for the PEBLE SID are estimated in Table 10.

Table 10. Proposed SAN PEBLE SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	($155K)	
	Profile	N/A	
	Cost to Carry	$81K	
Total Estimated Annual Fuel Savings (Dollars)		($74K)	
Total Estimated Annual Fuel Savings (Gallons)		(26K)	
Total Estimated Annual Carbon Savings (Metric Tons)		(260)	

4.2.2.2 SAN POGGI Departure

The POGGI accounts for approximately 52% of all SAN departures.

- Issues
  - There are jump zone interactions on a daily basis, which may constrain aircraft operations eastbound as shown in Figure 12.
  - There are speed restrictions of 230 knots or less over the JETTI and LOWMA intersections.

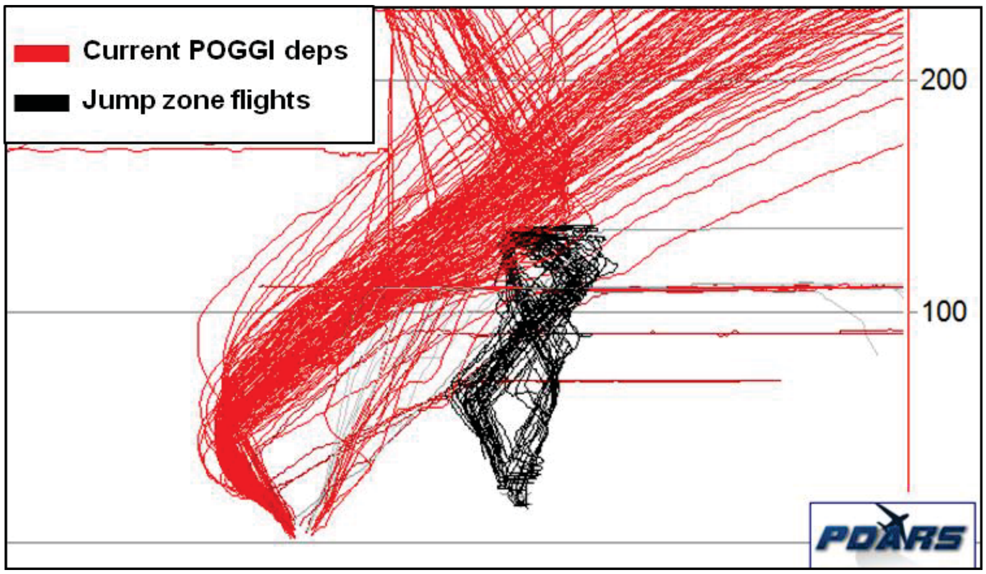


Figure 12. Current SAN POGGI – Jump Zone Interactions

- Recommendations
  - A new waypoint has been added to the procedure approximately 1.5 NM east of the PGY VOR before turning to BROWS intersection. As shown in Figure 13, this will ensure clearance from the jump zones enhancing the safety of the proposed procedure.

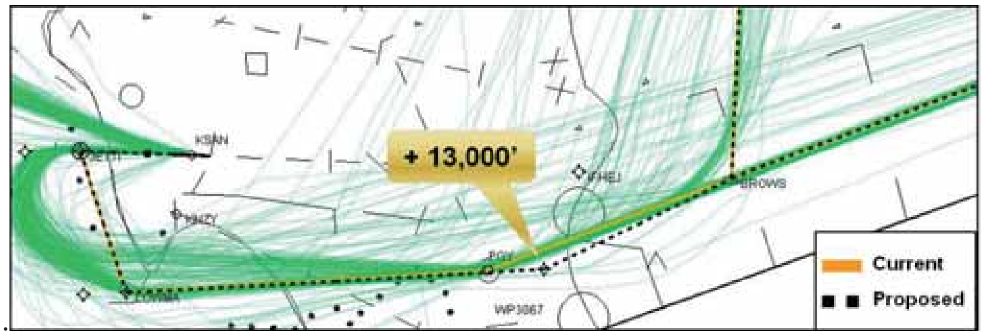


Figure 13. Current and Proposed SAN POGGI SID

- Benefits
  - Although the speed restrictions over JETTI and LOWMA could not be lifted due to criteria constraints, aircraft now departing on the POGGI will be separated from parachuting activity in both jump zones.

4.2.2.3 SAN LNSAY Departure

The LNSAY accounts for less than 1% of all SAN jet departures.

- Issues
  - The LNSAY departure is a conventional SID relying on ground based navigation and radar vectors.
  - The current LNSAY SID is typically used in an east or Runways 09/27 flows, and few aircraft actually follow the current procedure as published.

- Recommendations
  - The proposed replacement for the LNSAY SID is designed as a PBN procedure as shown in Figure 14.
  - Changes include a more direct flight path to the FALCC intersection and thence transitions to SLI and LAX, resulting in a reduction of filed miles.
  - The RNAV route will ensure that aircraft remain within the confines of Class B airspace.

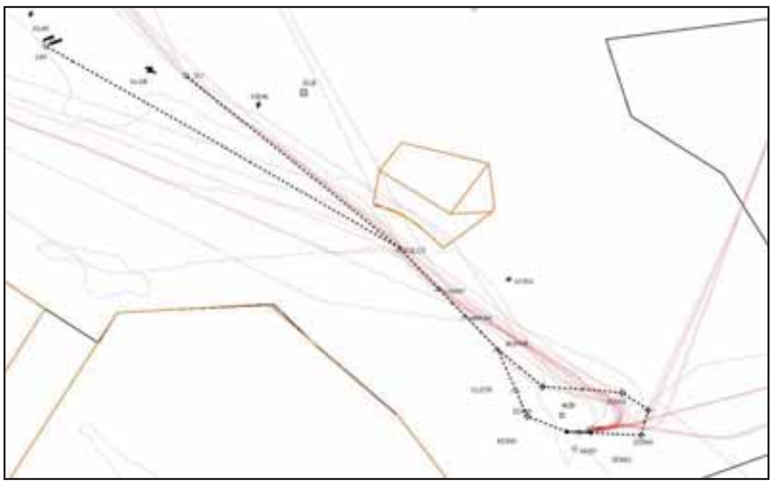


Figure 14. Proposed SAN LNSAY SID

- Benefits
  - Due to low traffic counts on the LNSAY, no modeling was done for this procedure.

4.2.3 LGB Departures

This section describes the operational issues, recommendations, and derived benefits the OST has identified for departures from LGB.

4.2.3.1 LGB New NELLY Departure

The proposed NELLY accounts for approximately 28% of all LGB jet departures.

- Issues
  - There is currently no published procedure for north- and northwest-bound departures from LGB.
  - Departure aircraft must rely on radar vectors, and there is a level-off of approximately 22 NM at 9,000 feet.

– The current procedure for LGB north departures requires aircraft to be sequenced with LAX CASTA departures, thereby creating ground delays.

- Recommendations
  – As shown in Figure 15, the PBN NELLY procedure was designed as a replacement for the radar vector departure procedure used today.
  – The NELLY eliminates the average 22 NM level-off at 9,000 feet by optimizing the route, both vertically and laterally.
  – Compared to the current flight tracks, the proposed NELLY SID significantly reduces the number of track miles flown.
  – The proposed NELLY SID merges with other Los Angeles Basin airport departure flows to the north.

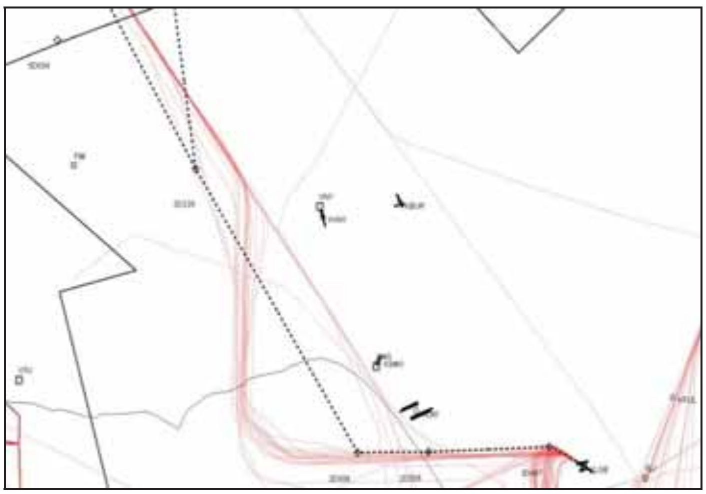


Figure 15. Proposed LGB NELLY SID

- Benefits
  - Initial flight simulations indicate that the NELLY will significantly reduce flight times for these departures.
  - Projected annual savings for the NELLY SID are estimated in Table 11.

Table 11. Proposed LGB NELLY SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$53K	
	Profile	$82K	$225K
	Cost to Carry	$8K	$17K
Total Estimated Annual Fuel Savings (Dollars)		$143K	$295K
Total Estimated Annual Fuel Savings (Gallons)		48K	100K
Total Estimated Annual Carbon Savings (Metric Tons)		480	1K

4.2.3.2 LGB SENIC Departure

The SENIC SID accounts for approximately 53% of all LGB jet departures.

- Issues
  - The SENIC SID is a conventional procedure relying on ground based navigation and radar vectors
  - The current SENIC procedure has an unused en route transition to IPL.
  - There is heavy congestion over TRM due to Los Angeles Basin traffic, creating departure delays.

- Recommendations
  - The proposed replacement for the SENIC SID is designed as a PBN procedure as shown in Figure 16.
  - There is an added BLH transition that will be an offload route for aircraft departing over TRM. The new transition will join the KARVR BLH offload flow.
  - The proposed SENIC eliminates the unused IPL transition.
  - Flight track miles on the TRM transition are reduced due to the shortcut after MOXIE.

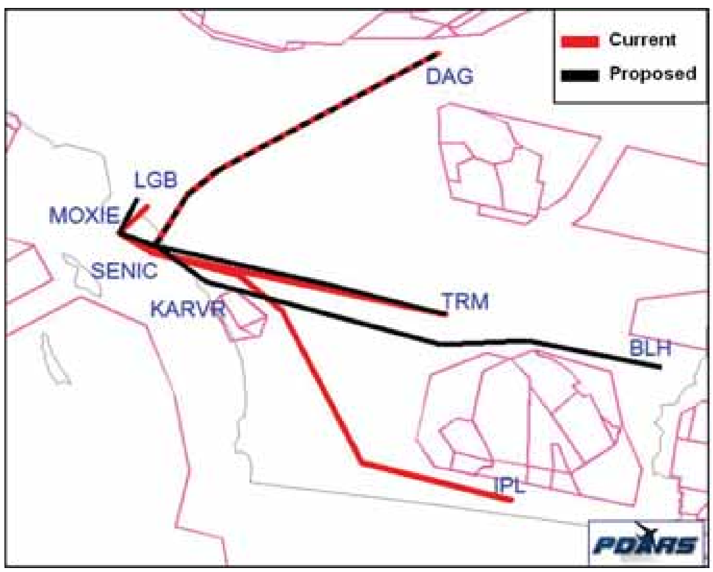


Figure 16. Current and Proposed LGB SENIC SID

- Benefits
  - Initial modeling did not indicate significant savings.

4.2.4 SNA Departures

This section describes the operational issues, recommendations, and derived benefits the OST has identified for SNA departures.

4.2.4.1 SNA CHANL Departure

The CHANL accounts for approximately 37% of all SNA jet departures.

- Issues

– The CHANL SID is a conventional procedure relying on ground based navigation and radar vectors.

– There are unused transitions on the current procedure.

– Due to changes in separation criteria from restricted airspace, the current procedural separation from R2519 is no longer sufficient.

- Recommendations

  – The proposed replacement for the CHANL SID is designed as a PBN procedure.

  – The conceptual CHANL departure reduces filed track miles by mimicking current flight tracks.

  – The proposed CHANL SID provides increased separation from R2519 by routing aircraft over a newly created fix (IKAYE).

  – The proposed CHANL SID will provide dual departure flows to the north over GMN.

  – The current and proposed procedures are shown in Figure 17.

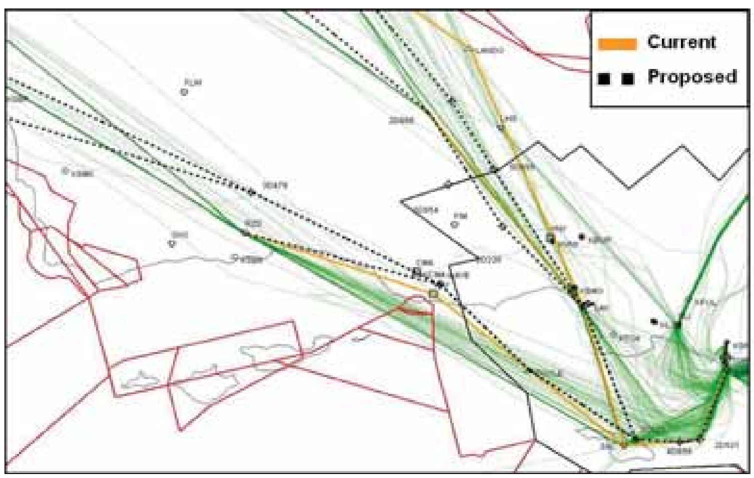


Figure 17. Current and Proposed SNA CHANL SID

- Benefits
  - Projected annual savings for the CHANL SID are estimated in Table 12.

Table 12. Proposed SNA CHANL SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile		
	Cost to Carry	$10K	
Total Estimated Annual Fuel Savings (Dollars)		$10K	
Total Estimated Annual Fuel Savings (Gallons)		4K	
Total Estimated Annual Carbon Savings (Metric Tons)		40	

4.2.5 BUR and VNY Departures

This section describes the operational issues, recommendations, and derived benefits the OST has identified for departures from BUR and VNY.

4.2.5.1 BUR VNY9 Departure

The VNY9 accounts for approximately 81% of all BUR jet departures.

- Issues
  - The BUR VNY9 STAR is a conventional SID relying on ground based navigation and radar vectors.
  - Current flight paths do not fly the initial part of the published procedure, resulting in additional filed miles.
  - Prop aircraft over DAG constrain the route and delay jet aircraft on the same flow.

- Recommendations
  - The proposed replacement for the BUR VNY9 SID is designed as a PBN procedure.
  - The conceptual VNY9 departure optimizes lateral paths, reduces flight track miles, and merges with other GMN area flows.
  - An offload prop route to DAG has been added to alleviate traffic congestion over PMD.
  - The current and proposed procedures are shown in Figure 18.

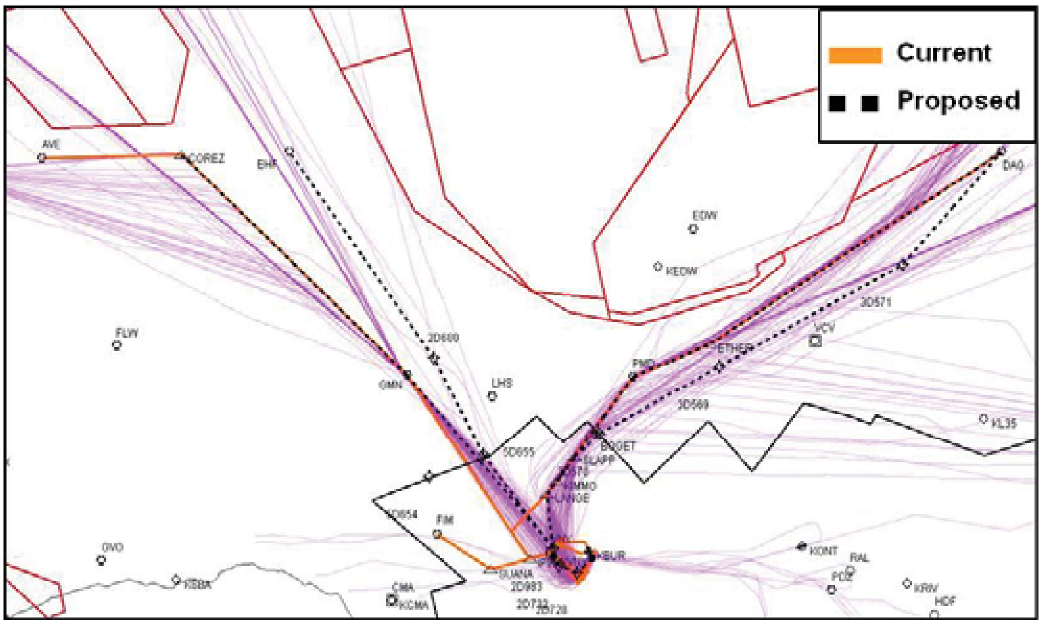


Figure 18. Current and Proposed BUR VNY9 SID

- Benefits
  - The total estimated savings can be attributed to reduced filed miles over the current published procedure.
  - Projected annual savings for the BUR VNY9 SID are estimated in Table 13.

Table 13. Proposed BUR VNY9 SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile		
	Cost to Carry	$40K	
Total Estimated Annual Fuel Savings (Dollars)		$40K	
Total Estimated Annual Fuel Savings (Gallons)		12K	
Total Estimated Annual Carbon Savings (Metric Tons)		120	

4.2.5.2 VNY CANOG and NUAL Departures

The CANOG and NUAL SIDs account for approximately 37% of all VNY jet departures.

- Issues
  - The CANOG and NUAL are conventional procedures relying on ground based navigation and radar vectors.
  - Actual flight paths do not overfly current procedure and there are unused transitions on the procedures.
  - Prop aircraft over DAG constrain the route and delay jet aircraft on the same flow.

- Recommendations
  - The proposed replacement for the CANOG and NUAL, combines two SIDs and is designed as a PBN procedure.
  - The proposed procedure reduces filed miles, provides a dual stream northbound, and merges with other GMN area flows.
  - An offload prop route to DAG has been added to alleviate traffic congestion over PMD.
  - The current and proposed procedures are shown in Figure 19.

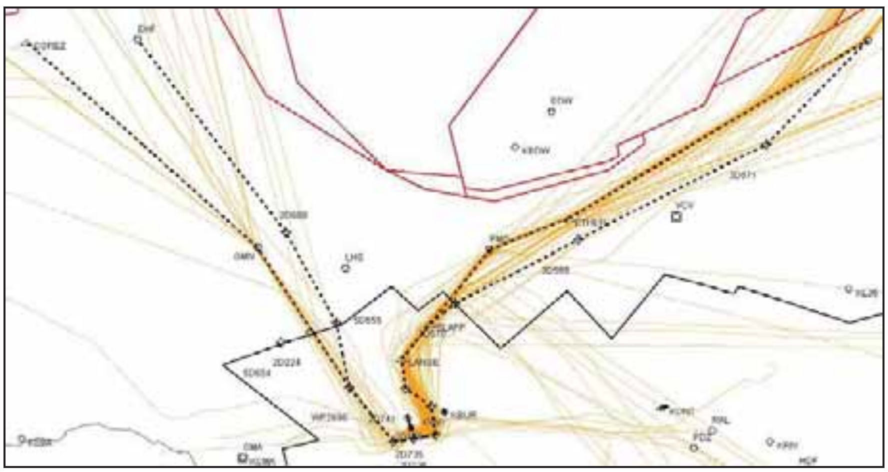


Figure 19. Proposed VNY CANOG/NUAL SID

- Benefits
  - This route was not modeled as VNY was designated as a satellite airport.

4.2.6 ONT Departures

This section describes the operational issues, recommendations, and derived benefits the OST has identified for departures from ONT.

4.2.6.1 ONT POM Departure

The POM SID accounts for approximately 55% of ONT jet departures.

- Issues
  - The POM SID is a conventional procedure relying upon ground based navigation and radar vectors.

– The POM SID has inefficient vertical and lateral paths, and flight paths do not overfly the current procedure.

- Recommendations
  - The proposed replacement for the POM SID is designed as a PBN procedure.
  - The proposed POM SID reduces the filed flight miles by shortening the procedure between POM and FROUN.
  - The current and proposed procedures are shown in Figure 20.

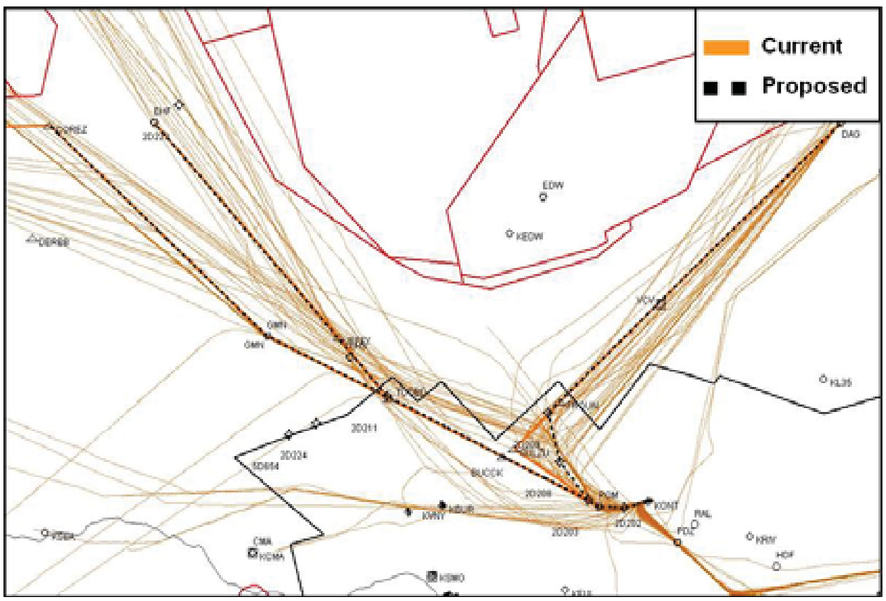


Figure 20. Current and Proposed ONT POM SID

- Benefits
  - Projected annual savings for the ONT POM SID are estimated in Table 14.

Table 14. Proposed ONT POM SID Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile		
	Cost to Carry	$10K	
Total Estimated Annual Fuel Savings (Dollars)		$10K	
Total Estimated Annual Fuel Savings (Gallons)		4K	
Total Estimated Annual Carbon Savings (Metric Tons)		40	

4.2.6.2 ONT PRADO SID

The PRADO SID accounts for approximately 26% of ONT jet departures.

- Issues
  - The PRADO SID is a conventional procedure relying upon ground based navigation and radar vectors.
  - The PRADO SID has inefficient vertical and lateral paths. Flight paths do not overfly the current procedure to MZB.
  - There is no SXC transition on the PRADO SID; therefore, aircraft filed on this route must fly excessive miles from ONT to SXC.

- Recommendations
  - The proposed replacement for the PRADO is designed as a PBN procedure.
  - Runway transitions were developed, and at the stakeholder's request, the OST created a SXC transition.
  - The current and proposed procedures are shown in Figure 21.

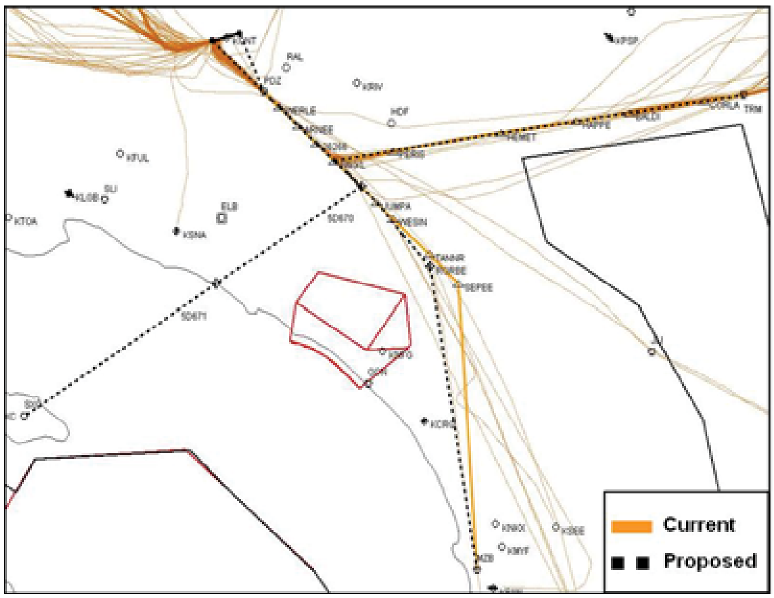


Figure 21. Current and Proposed ONT PRADO SID

- Benefits
  - There are no significant savings on the TRM and MZB transitions.
  - Departing over SXC, UPS currently files PRADO7-MZB-OCN-SXC.
    - By filing the proposed SXC transition, UPS alone could save an estimated $30,000 a week on oceanic flights. This is based on 25 MD11 flights per week filed on the above route (provided by UPS) assumed to be now fly the proposed routing.

4.2.7 Satellite Airport Departures

This section describes the operational issues and recommendations the OST has identified for departures from other Southern California satellite airports.

4.2.7.1 CRQ TRM Departure

- Issues
  - Currently, all departures from CRQ over TRM are radar vectored, resulting in inefficient vertical and lateral paths.
- Recommendations
  - The OST created an RNAV SID off of CRQ that mimics where aircraft fly today. The proposed procedure has one en route transition ending at TRM as shown in Figure 22.

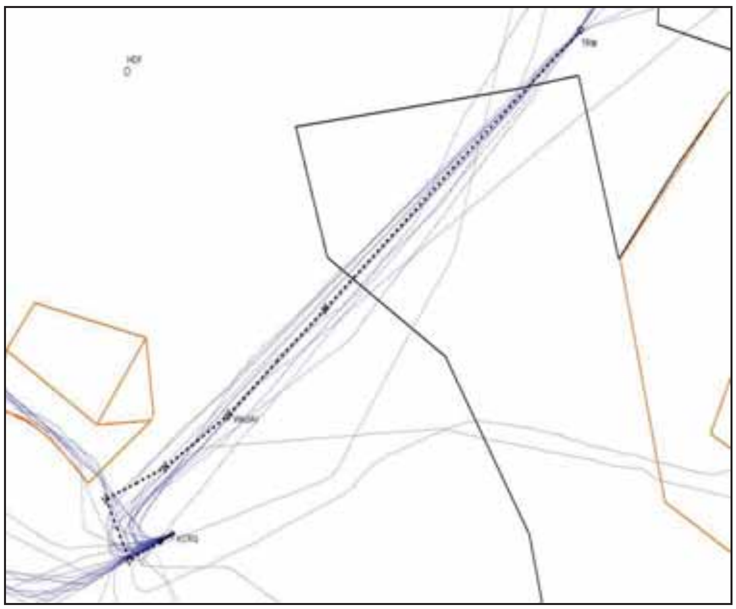


Figure 22. Proposed CRQ TRM SID

- Benefits
  - Due to low traffic volume this route was not modeled.

4.2.7.2 FUL SID

- Issues
  - Currently, all departures from FUL are radar vectored, resulting in inefficient vertical and lateral paths.
  - There are concerns relating to the Disneyland TFR and the ability to fly through it.

- Recommendations
  - The proposed replacement is designed as a PBN procedure and the proposed SID addresses Disneyland TFR concerns as shown in Figure 23.

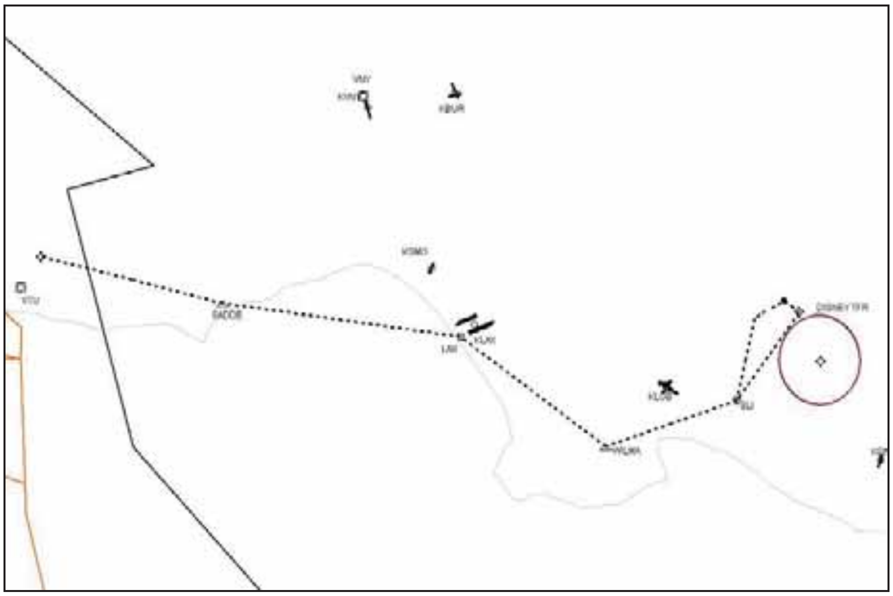


Figure 23. Proposed FUL SID

- Benefits
  - Due to low traffic counts, no modeling was done for this procedure.

4.2.7.3 SBA HARPO SID

- Issues
  - Current eastbound SIDs consist of multiple conventional procedures relying on ground based navigation and radar vectors.
  - There are no published en route transitions. This creates inconsistent flight paths to DAG and TRM.

- Recommendations
  - The proposed HARPO SID is designed as a PBN procedure.
  - The HARPO departure adds en route transitions to both TRM and DAG. These new en route transitions follow current flight tracks.
  - The current and proposed procedures are shown in Figure 24.

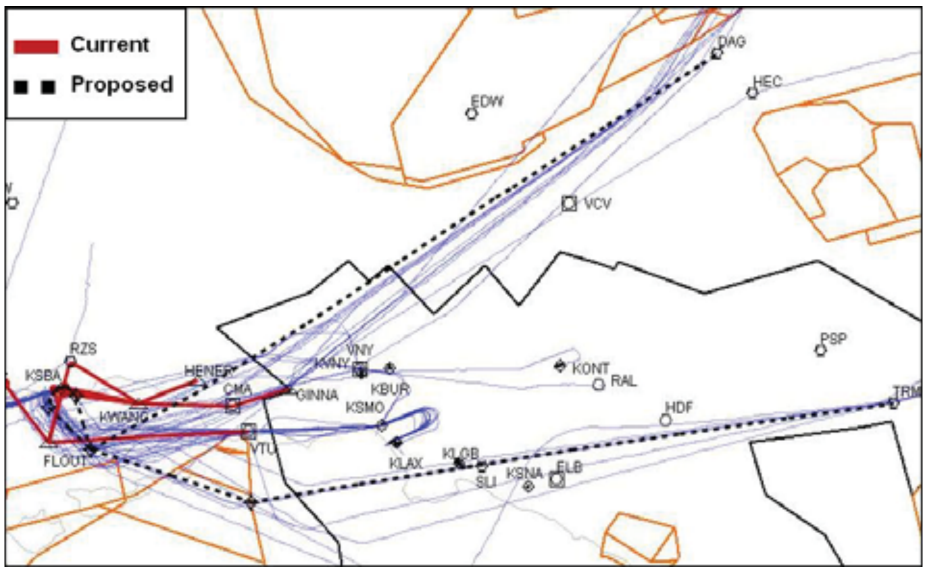


Figure 24. Current and Proposed SBA SIDs

- Benefits
  - Due to a low volume of traffic, this procedure was not modeled.

4.2.8 Summary of Southern California Departure Benefits

In general, the issues associated with the current departures from Southern California airports were related to level-offs and other lateral and vertical path inefficiencies. To address these concerns, the Southern California OST focused on PBN solutions. The OST conceptual proposals for departures included a combination of RNAV off the ground procedures and radar vector procedures to join RNAV routes.

Table 15 shows the total departure benefits for the Southern California proposals as described throughout Section 4.2. Southern California SIDs are expected to provide between $2.5 million and $2.9 million annually in fuel savings. Existing departure tracks are generally efficient when they permit unrestricted climbs. The proposed departure procedures are designed to facilitate unrestricted climbs by removing or mitigating existing level-offs, while providing procedural separation, where practical, from other SIDs and STARs. It is fully expected that ATC will continue to offer shorter routings and remove climb restrictions when feasible, further increasing operator benefits.

The majority of savings for LAX departures are attributed to the unrestricted availability of the LOOP SID. No delay analysis was performed on the impacts of this change on other area airports. The OST believes that continuous use of the LOOP will reduce departure delays over TRM and DAG for these airports.

The D&I team may elect to further evaluate the mixture of radar vectors and RNAV off-the-ground SIDs to determine the most beneficial method of departing from Southern California airports.

Table 15. Total Annual Fuel Burn Benefits for Southern California Departures

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$1.83M	
	Profile	$152K	$508K
	Cost To Carry	$549K	$579K
Total Estimated Annual Fuel Savings (Dollars)		$2.53M	$2.92M
Total Estimated Annual Fuel Savings (Gallons)		831K	963K
Total Estimated Annual Carbon Savings (Metric Tons)		8.3K	9.6K

4.3 Southern California Arrivals

In general, the issues associated with the current STARs to Southern California were related to inefficient lateral and vertical paths, unused en route transitions, and the lack of dual independent finals to Runways 24L/R and 25L/R at LAX.

The OST design concept for arrivals focused on RNAV STARs with Optimized Profile Descents (OPDs). Level-offs result in non-optimal fuel burn and excessive carbon emissions, particularly during flows requiring downwind legs.

In addition to optimizing vertical profiles, lateral paths were shortened where practical; routes were segregated where practical; unused en route transitions were removed; and new runway transitions were proposed. D&I will assess the location of fixes to allow additional transitions to the STARs. STARs at all major and several satellite airports in Southern California were modified. These new STARs are procedurally deconflicted from SIDs and other STARs where possible. STARs were developed with airport, runway or approach transitions. Where approach transitions were developed the OST proposes potential development of RNP Authorization Required (AR) Instrument Approach Procedures (IAPs) at several of the airports.

Current conventional (non-RNAV) STARs may need modification during the D&I process. Any airspace modifications that enable procedural efficiencies will also be considered during D&I. In addition, D&I team members may consider combining flow-specific STARs where it is determined to be advantageous.

Figure 25 depicts benefits, impacts, and risks for the FAA and Airspace users and procedural environmental considerations.

Operational / Safety	
Benefits	**Impacts / Risks**
• PBN benefits • Increased throughput • Multiple runway transitions • Reduced delay vectoring	• Runway transitions • LOA revisions • Training • Sectorization • Fusion integration

Airspace User	
Benefits	**Impacts / Risks**
• PBN benefits • Reduced fuel burn and emissions	• Preferred runway assignment

Environmental Considerations
• Noise screening / analysis • Emissions analysis • Runway transition assessment

Figure 25. Benefits, Impacts, and Risks of the Arrival Proposals

4.3.1 LAX Arrivals

This section describes the operational issues, recommendations, and expected benefits the OST has identified for arrivals to LAX.

4.3.1.1 LAX RIIVR and SEAVU Arrivals

The RIIVR and the SEAVU STARs account for 47% of all LAX jet arrival traffic.

- Issues
  - The RIIVR and SEAVU STARs are arrival procedures with level-offs over the GRAMM and KONZL intersections. These level-offs were specifically identified by the facilities as an issue for these two arrivals.
  - The interaction of these STARs creates a single, dependent flow situation approximately 45 miles east of LAX. Procedural requirements necessitate that traffic on the RIIVR and SEAVU STARs be in trail and delivered as a single flow to SCT. This single flow requirement creates a constraint that is responsible for excessive delay vectors, multiple traffic management restrictions, reduced throughput, and an inability to meet the LAX airport acceptance rate (AAR).
- Arrival fix congestion analysis
  - The RIIVR and SEAVU STARs terminate approximately 45 nautical miles from LAX, as can be seen in Figure 26. Laterally, the termination fixes for these STARs are approximately 4 miles apart, which necessitates a single dependent feed into SCT's airspace from ZLA. This procedural requirement to treat the RIIVR and SEAVU as a single flow creates a complex and inefficient east arrival flow into LAX. This situation was the highest priority challenge identified by both facilities for OST consideration. To alleviate the congestion at this "bottleneck," MIT restrictions and other constraints are introduced into the NAS by ZLA. The OST analyzed MIT restrictions placed upon east LAX arrival fixes to assess the scope of this issue. In particular, HEC, PGS, and TNP were identified as fixes with frequent restrictions attributable to this single flow constraint.

Figure 26. Current and Proposed LAX RIIVR and SEAVU STARs

  - The supporting data was obtained from the NTML MIT log for calendar year 2010. Restrictions were primarily due to volume (VOL), weather (WX), or equipment/frequency failure (EQ); however, pass-back restrictions caused by constraints closer to the airport were not considered. The metric used is minute-miles. This is calculated by multiplying the total minutes the restriction was in effect by the imposed MIT value (spacing in miles).

- Over HEC and MLF the sum of LAX minute-mile restrictions for calendar year 2010 was approximately 110,000. During 2010, restrictions were issued on 106 days, or approximately two days a week. Restrictions by cause and airport can be found in Figures 27 and 28.

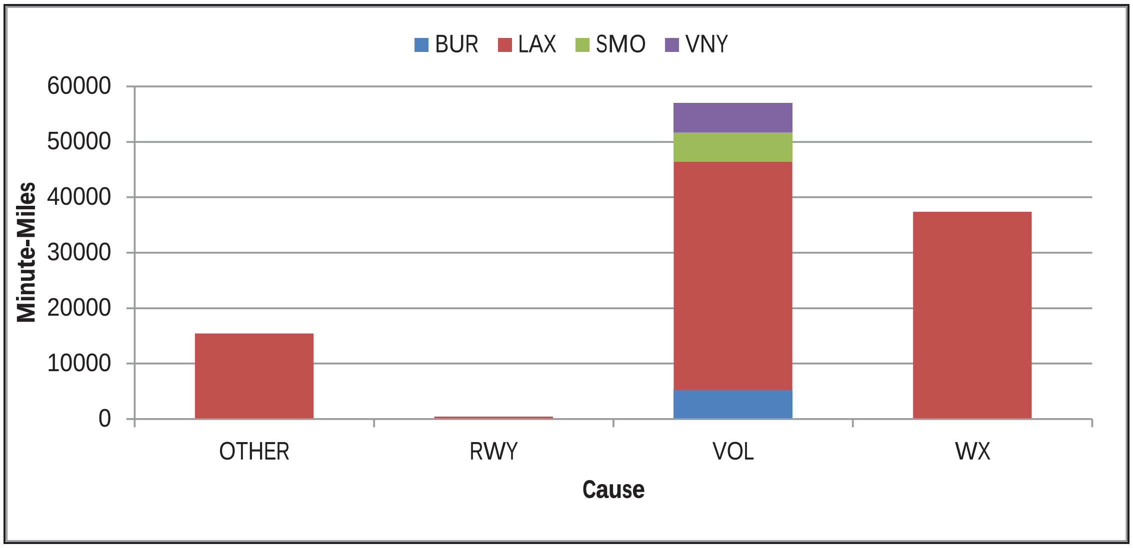


Figure 27. Restrictions over HEC/MLF by Cause

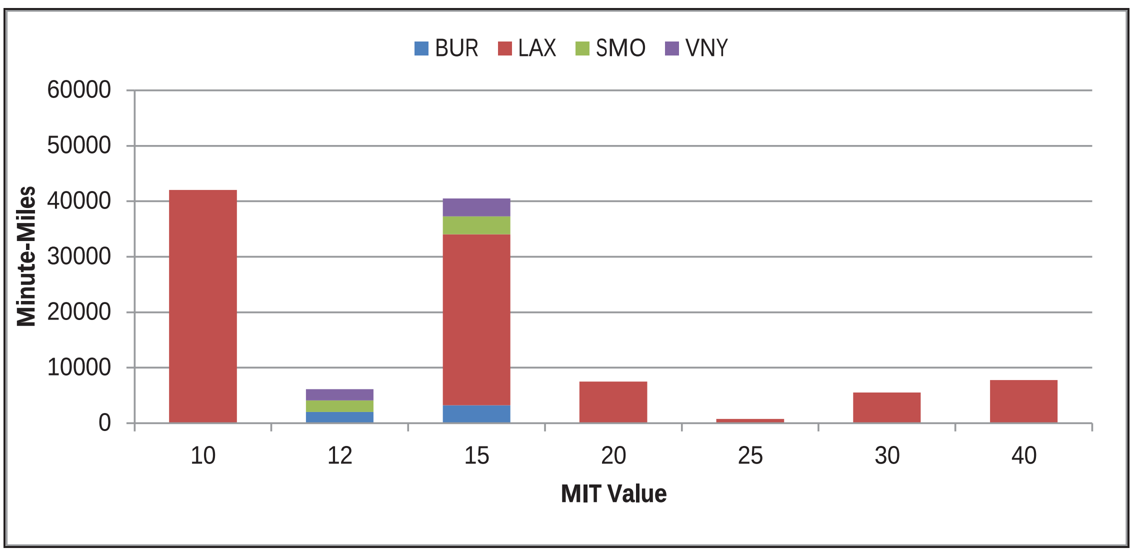


Figure 28. Restrictions over HEC/MLF by MIT Value

- Over PGS and TBC the sum of LAX minute-mile restrictions for calendar year 2010 was approximately 940,000. In 2010, restrictions were issued on 336 days, or approximately 6.5 days a week. Restrictions by cause and airport can be found in Figures 29 and 30.

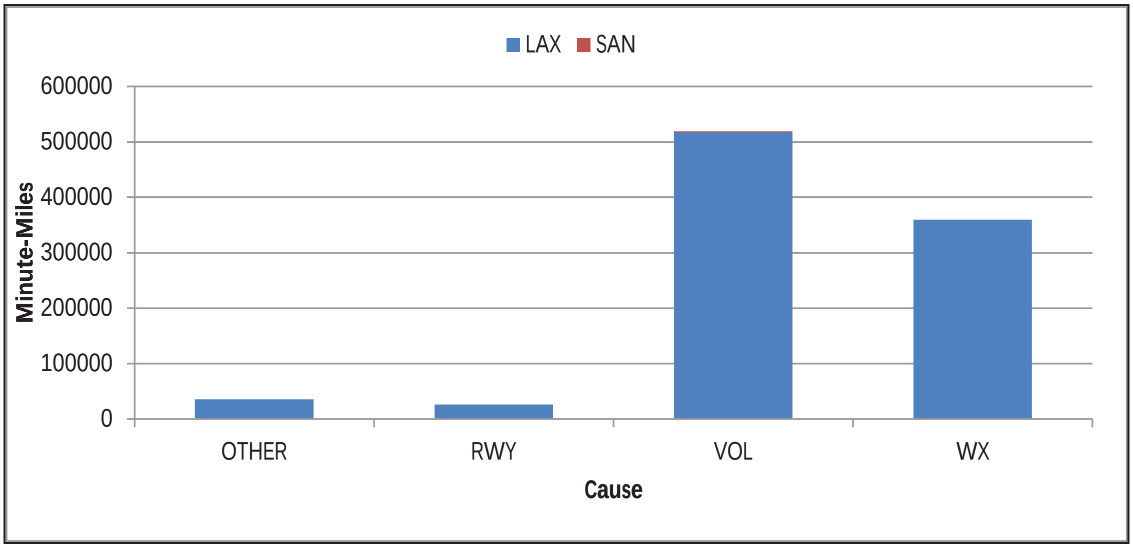


Figure 29. Restrictions over PGS/TBC by Cause

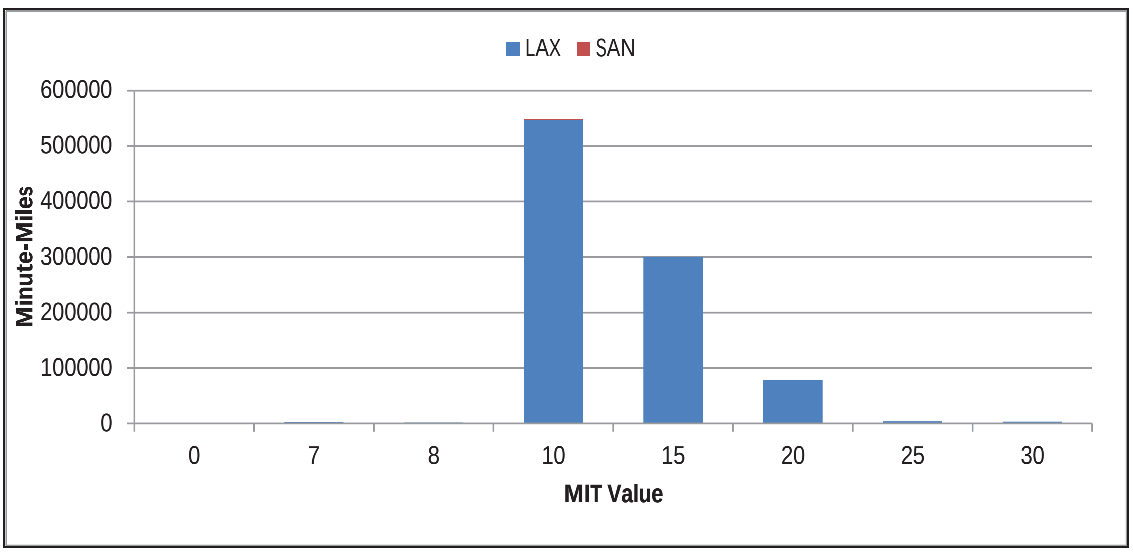


Figure 30. Restrictions over PGS/TBC by MIT Value

- Over TNP, DRK, and on J4, the sum of LAX minute-mile restrictions for calendar year 2010 was approximately 2,500,000. In 2010, restrictions were issued on 362 days, which is essentially an everyday MIT restriction. Restrictions by cause and airport can be found in Figures 31 and 32.

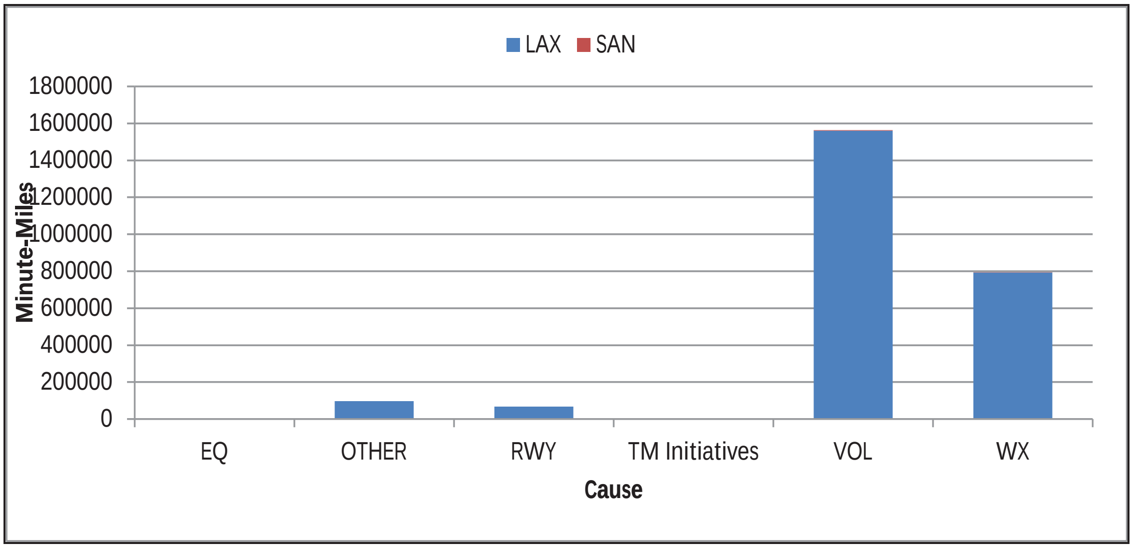


Figure 31. Restrictions over TNP/DRK/J4 by Cause

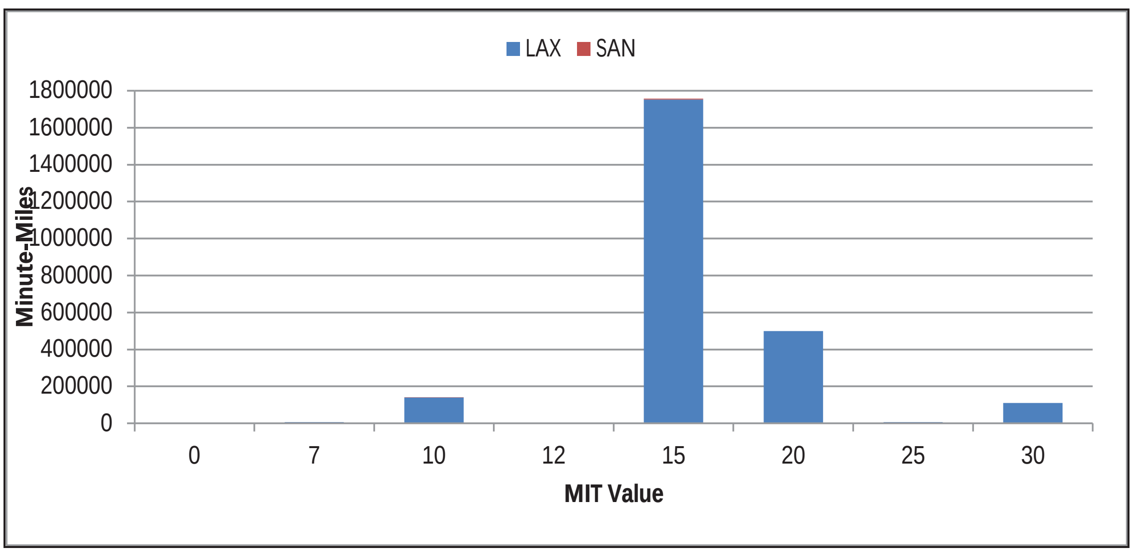


Figure 32. Restrictions over TNP/DRK/J4 by MIT Value

- Recommendations
  - The proposed replacements for the RIIVR and SEAVU STARs are designed as PBN procedures with OPD benefits that operate as dual independent arrivals and maintain procedural separation as shown in Figure 26.
  - These STARs are procedurally deconflicted laterally within ZLA's and SCT's airspace, allowing for deconflicted operations and the subsequent allowance of dual independent final operations. The current RIIVR and SEAVU STARs terminate at waypoints RIIVR and SEAVU. The proposed RIIVR and SEAVU STARs will terminate approximately 15 NM from the airport. The STARs remain laterally deconflicted until inside of the Precision Radar Monitor (PRM) areas. As these procedures turn to join their respective final approach courses, vertical separation will be maintained until the aircraft are established on a charted approach and are under precision monitor control. Current operations dictate that the Runways 25L/R approaches are 1,000 feet higher than the Runways 24L/R approaches. The proposed RNAV STARs will reverse this altitude configuration, as Runways 24L/R approaches incorporate a longer flight distance to the runway threshold than Runways 25L/R.
  - These STARs will include runway transitions to all runways, enabling the seamless transition of aircraft between Runways 24L/R and Runways 25L/R at LAX, which will facilitate the ability to balance the runway demands.
  - The introduction of the dual independent final design in these STARs will reduce the need for extensive delay vectoring caused by sequencing to a single dependent feed.
- Benefits
  - Analysis indicates that significant vertical savings are realized on both proposed procedures when considering current usage.
  - Since the proposed STARs essentially overlay current paths, no measurable lateral gain is achieved.
  - Projected annual savings for the RIIVR and SEAVU STARs are estimated in Tables 16 and 17. These savings do not include any associated reduction in delay vectoring due to the dual independent arrival concept.

Table 16. Proposed LAX RIIVR STAR Annual Benefits (Profile and Filed Mile Changes Only)

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	$558K	$1.30M
	Cost to Carry	$76K	$150K
Total Estimated Annual Fuel Savings (Dollars)		$634K	$1.4M
Total Estimated Annual Fuel Savings (Gallons)		216K	496K
Total Estimated Annual Carbon Savings (Metric Tons)		2.2K	5K

Table 17. Proposed LAX SEAVU STAR Annual Benefits (Profile and Filed Mile Changes Only)

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	$496K	$1.32M
	Cost to Carry	$120K	$202K
Total Estimated Annual Fuel Savings (Dollars)		$616K	$1.53M
Total Estimated Annual Fuel Savings (Gallons)		210K	521K
Total Estimated Annual Carbon Savings (Metric Tons)		2.1K	5.2K

- Modeling the airspace constraint
  – It is assumed that allowing dual independent arrivals into LAX would mitigate the need for MIT restrictions and reduce delay vectoring close to the airport.
  – To estimate the possible annual delay savings associated with the proposed dual independent arrivals, a TAAM model was developed to simulate the flows with an average day[2] of traffic both with and without the current procedural constraint.
    - In Figure 33, the white line indicates the western termination point of the modeled area. Procedural constraints were measured for aircraft crossing this white line from the east with and without constraints currently required by today's procedures.
    - To model current traffic patterns, one minute of separation was required between all RIIVR or SEAVU aircraft crossing this line. This is comparable to 5.6 MIT at 280 knots Indicated Air Speed (IAS). Dual independent arrivals were then simulated without the one-minute constraint in place.

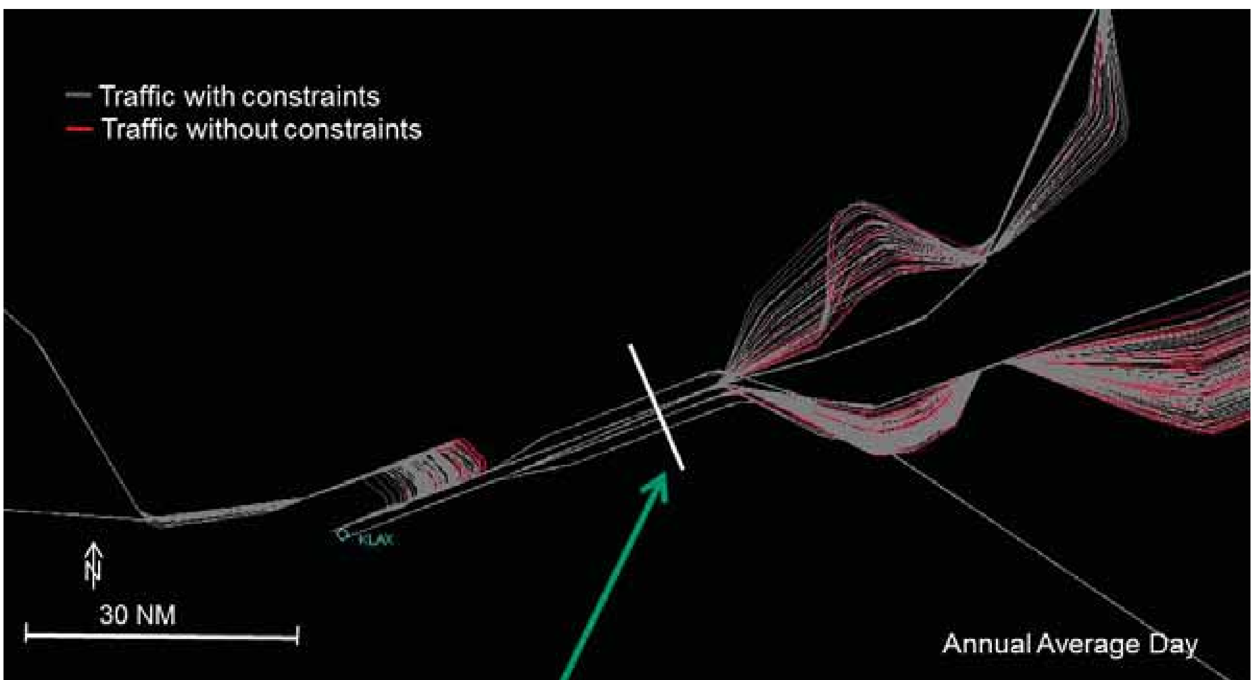


Figure 33. TAAM-Modeled Vectoring Patterns on RIIVR and SEAVU, With and Without Airspace Constraint

2 Calendar year 2010 data was used to estimate the traffic for an average day at LAX.

- The delay metrics associated with having to require one minute of separation between all RIIVR/SEAVU aircraft is approximately 20 to 25 seconds of delay time per aircraft. This translates into a total delay time of approximately five hours per day. Using the FAA's current aircraft direct operating cost (ADOC) value of $36 per minute, the potential savings realized by the proposed RIIVR and SEAVU STARs is estimated at $4 million, as shown in Table 18.

Table 18. Proposed LAX RIIVR and SEAVU STARs Annual Benefits (Delay Vectoring Mitigation)

	With constraints	Without constraints
Delay (minutes per flight)	1.4	1.0
Delay (minutes per day)	1,136	839
Airborne Aircraft Direct Operating Cost (ADOC) per minute	$36	
Annualized delay benefit	$3.99M	

- This model also measures the effect single flow constraints have on peak throughput into LAX. On the simulated day, the maximum throughput per hour was 68 aircraft; with the introduction of dual independent arrivals, the throughput could be as high as 72 aircraft per hour.

4.3.1.2 LAX OLDEE Arrival

The OLDEE STAR accounts for approximately 2% of all LAX jet arrivals.

- Issues
  - The OLDEE STAR is a conventional procedure relying upon ground based navigation.
  - There are inefficient lateral and vertical paths.
  - Arrivals are typically offloaded from the OLDEE onto the VISTA STAR.
  - SCT and ZLA would like the OLDEE to merge with the SEAVU and have runway transitions.

- Recommendations
  – The proposed replacement for the OLDEE STAR is designed as a PBN procedure that closely follows the arrival tracks as currently flown; see Figure 34.
  – The proposed procedure will mimic the current OLDEE STAR from JLI to SEAVU, at which point it merges with the RIIVR and SEAVU proposed by the OST as shown in Figure 35. This will allow flexibility in accommodating multiple runway assignments.
  – It is expected that these changes to the OLDEE will result in increased usage of this RNAV procedure.

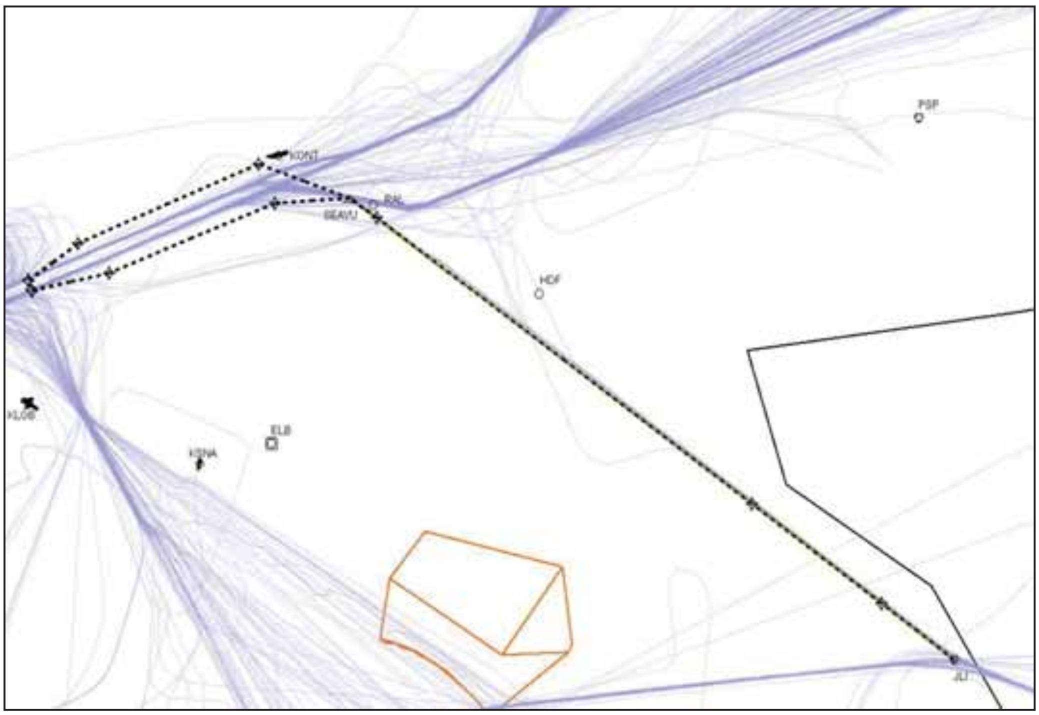


Figure 34. Proposed LAX OLDEE STAR

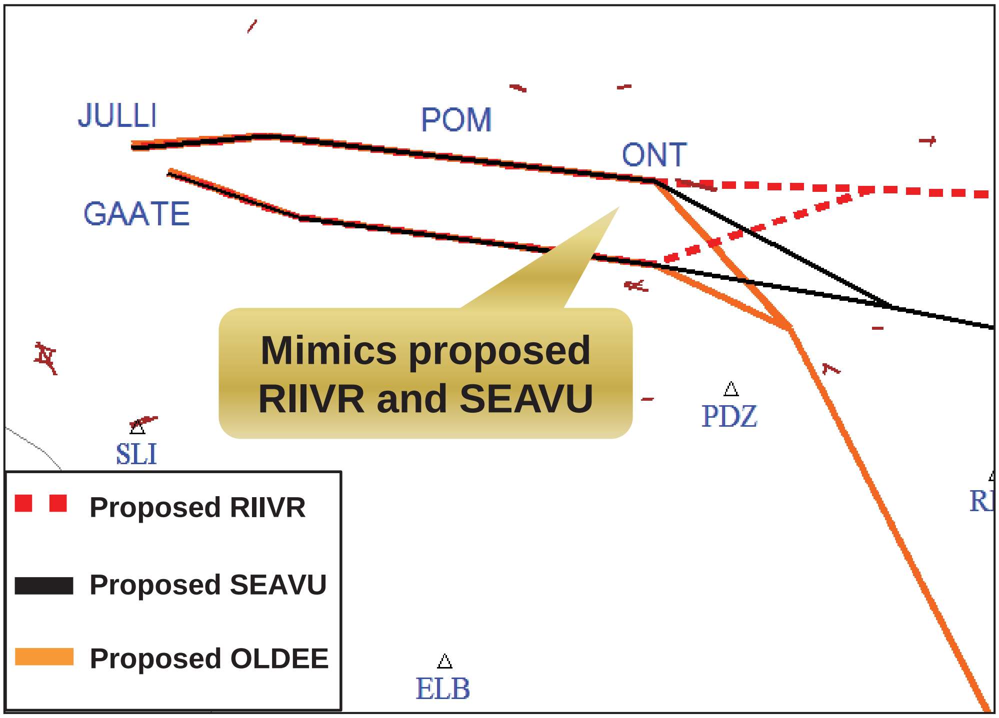


Figure 35. Proposed LAX OLDEE, RIIVR, and SEAVU STARs

- Benefits
  - Projected annual savings for the OLDEE STAR are estimated in Table 19. The vertical savings expected for this procedure are significant considering its minimal usage. Since the proposed STAR overlays current paths, no measurable lateral gain is achieved.

Table 19. Proposed LAX OLDEE STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	$207K	$584K
	Cost to Carry	$21K	$58K
Total Estimated Annual Fuel Savings (Dollars)		$228K	$642K
Total Estimated Annual Fuel Savings (Gallons)		78K	220K
Total Estimated Annual Carbon Savings (Metric Tons)		780	2.2K

4.3.1.3 LAX VISTA Arrival

The VISTA STAR accounts for approximately 4% of all LAX jet arrivals.

- Issues
  - The VISTA STAR is a conventional procedure relying upon ground based navigation.
  - The lateral path of the published procedure is currently not flown as depicted on the arrival. Most traffic utilizing this procedure is shortcut direct to either the MADOW intersection or SLI once the traffic is laterally clear of R2503B. Additionally, there are significant level-offs, including one at 12,000 feet.
  - The current VISTA is utilized as an offload STAR during peak traffic demand on the RIIVR and SEAVU arrivals.

- Recommendations
  - The proposed replacement for the VISTA STAR is designed as a PBN procedure as shown in Figure 36.
  - The lateral path of the proposed RNAV STAR closely mimics current arrival tracks and will provide more direct routing as well as a predictable, repeatable path.
  - Arrival windows were used in the vicinity of OCN to procedurally deconflict the arrival from R2503 and to significantly mitigate level-offs.
  - Per SCT request, a holding pattern will be developed at MADOW during the D&I process.

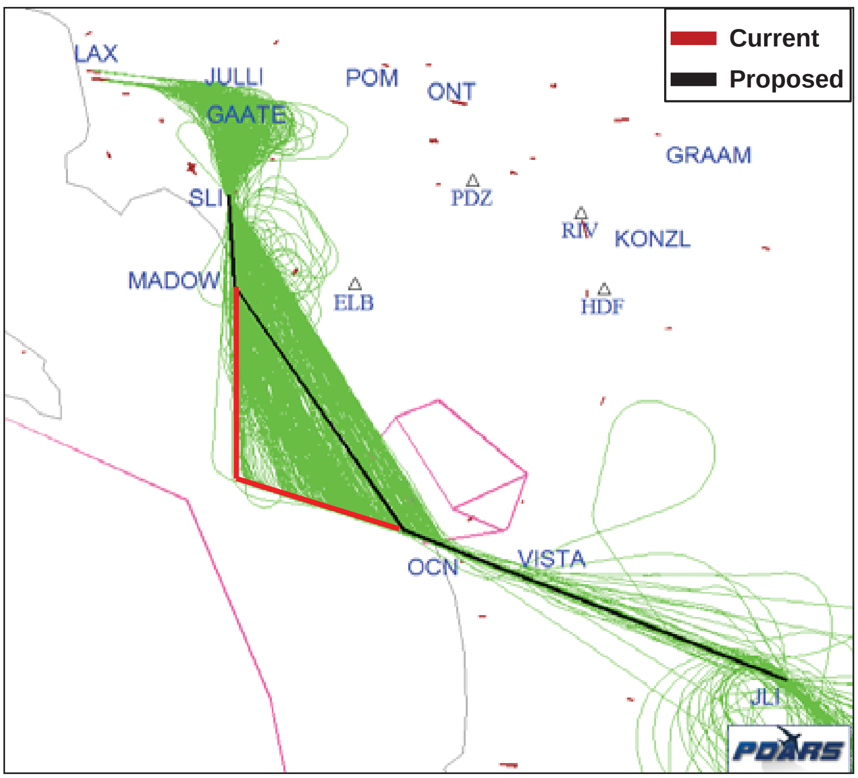


Figure 36. Current and Proposed LAX VISTA STAR

- Benefits
  - Projected annual savings for the VISTA STAR are estimated in Table 20. The vertical savings expected for this procedure are significant considering its minimal usage.

Table 20. Proposed LAX VISTA STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	$464K	$1.43M
	Cost to Carry	$86K	$183K
Total Estimated Annual Fuel Savings (Dollars)		$550K	$1.61M
Total Estimated Annual Fuel Savings (Gallons)		189K	552K
Total Estimated Annual Carbon Savings (Metric Tons)		1.9K	5.5K

4.3.1.4 LAX KEACH Arrival

The LAX KEACH STAR is an RNAV procedure that is designed to replace the existing LAX SADDE STAR. The KEACH is expected to be published in July 2012. The KEACH as currently designed is an RNAV overlay of the western part of the SADDE STAR, and since it is scheduled to be operational within the Southern California OAPM timeframe, the OST elected to study this future procedure as a baseline as opposed to the current SADDE STAR. The KEACH will account for 6% of LAX arrival traffic.

- Issues
  - This proposed arrival does not address the increased use of R2519 and conflicts with departure traffic in the VTU area.
  - The OST identified no gain in efficiency between the KEACH and the SADDE and expects no change in operations due to its implementation.
  - The OST identified long level-offs in current tracks filed on this flow.

- Recommendations
  - The lateral path of the OST's proposed RNAV KEACH STAR mimics current arrival tracks, which will provide more direct routing and will define a predictable, repeatable path as shown in Figure 37.
  - The OST's proposed KEACH procedure will have optimized lateral and vertical profiles that will successfully mitigate level-offs seen in current flight tracks.
  - R2519 separation is assured by the incorporation of a waypoint fix abeam.
  - Routing was developed to leverage the opportunity for an ELKEY transition when restricted airspace is inactive.

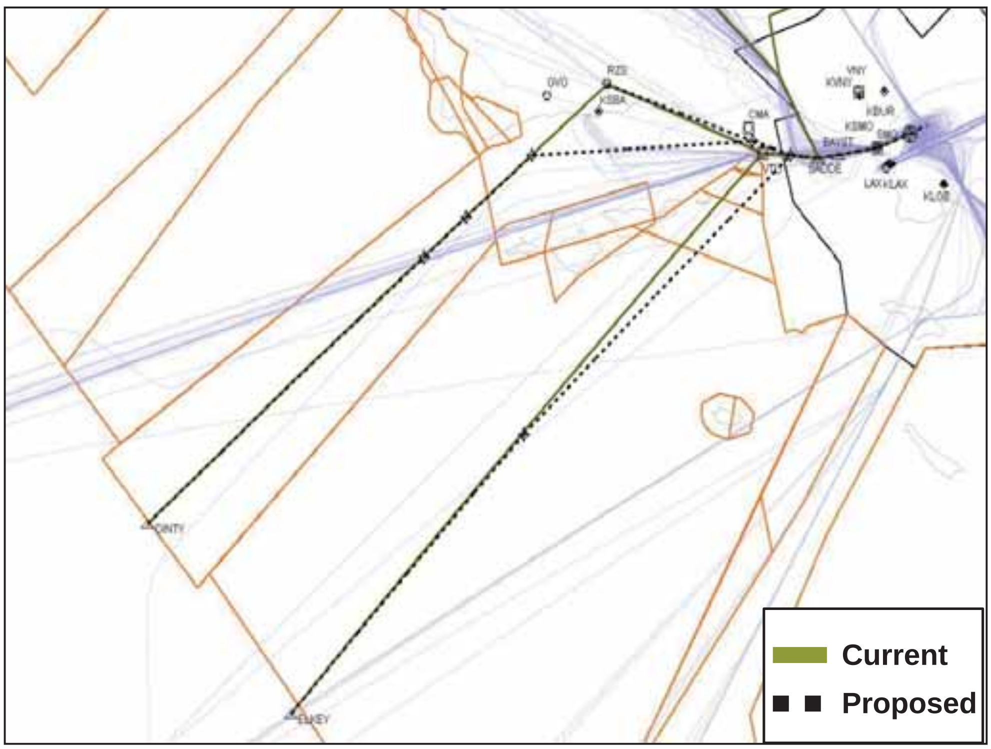


Figure 37. Current and Proposed LAX KEACH STAR

- Benefits
  - Table 21 shows the annual savings of the OST's proposed KEACH compared to flight tracks flying the SADDE arrival.

Table 21. Proposed LAX KEACH STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$166K	
	Profile	$543K	$1.59M
	Cost to Carry	$71K	$176K
Total Estimated Annual Fuel Savings (Dollars)		$780K	$1.93M
Total Estimated Annual Fuel Savings (Gallons)		267K	662K
Total Estimated Annual Carbon Savings (Metric Tons)		2.7K	6.6K

4.3.1.5 LAX SYMON Arrival

The LAX SYMON STAR is an RNAV procedure that is designed to replace the existing LAX SADDE STAR. The SYMON is expected to be published in July 2012. The SYMON as currently designed is an RNAV overlay of the northern part of the SADDE STAR, and since it is scheduled to be operational within the Southern California OAPM timeframe, the OST elected to study this future procedure as a baseline as opposed to the current SADDE STAR. The SYMON will account for 26% of LAX arrival traffic.

- Issues
  - The OST has identified significant level-offs on the current tracks filed on this arrival due to conflicts with FIM area traffic and LAX departure traffic. Conflicts were also identified with the CASTA and GMN traffic, causing long level-offs. This arrival also procedurally shares lateral and vertical airspace with BUR, VNY, LGB, and SNA arrival traffic, which adversely affects the efficiency of all flows in this area.

- This arrival has been identified by facilities and stakeholders as complex, requiring several transmissions and inputs to control/fly. This is due in part to the congestion in the FIM area.

- Recommendations
  - The lateral path of the OST's proposed RNAV STAR, as shown in Figure 38, mimics the current arrival tracks, and defines a predictable, repeatable path.
  - The OST elected not to laterally change the soon-to-be published procedure. Arrival windows were incorporated at waypoints on the OST's proposed SYMON STAR to reduce level-offs. The OST acknowledges that there may still be a level-off at 10,000 feet in the vicinity of the BAYST intersection.
  - The OST has proposed segregation of this arrival from BUR, VNY, LGB, and SNA traffic by shifting these flows to the west, deconflicting SYMON arrivals from all these flows.

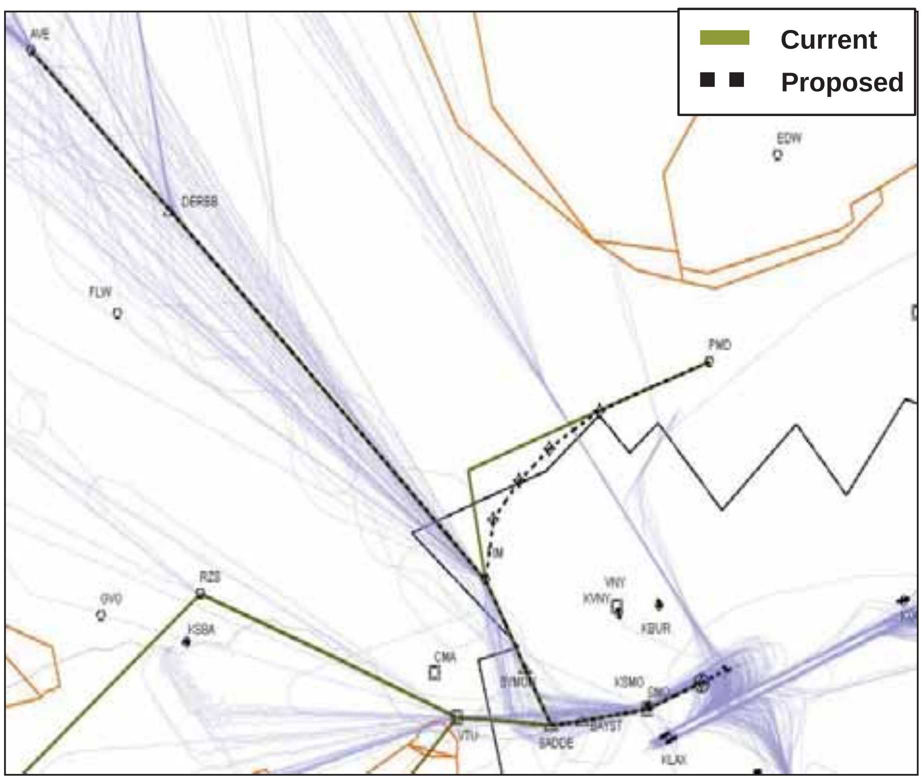


Figure 38. Current and Proposed LAX SYMON STAR

- Benefits
  - Since this arrival is an RNAV overlay of the northern part of the SADDE arrival, vertical savings were derived relative to current SADDE STAR traffic. Projected annual savings for the SYMON STAR are estimated in Table 22.

Table 22. Proposed LAX SYMON STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	$1.82M	$5.27M
	Cost to Carry	$182K	$527K
Total Estimated Annual Fuel Savings (Dollars)		$2.00M	$5.80M
Total Estimated Annual Fuel Savings (Gallons)		685K	1.99M
Total Estimated Annual Carbon Savings (Metric Tons)		6.9K	19.9K

4.3.1.6 LAX BUFIE Arrival

The BUFIE accounts for approximately 2% of all LAX jet arrivals.

- Issues
  - The BUFIE today consists of a conventional procedure relying on ground based navigation.
  - There are inefficient lateral and vertical paths on this procedure. There is a level-off of approximately 24 NM at 12,000 feet, 75 NM away from LAX.
  - A confliction with the SNA CHANL SID in the vicinity of SXC was identified by the FAA as an issue.
  - The lack of accessibility to use the current BUFIE procedure was noted by the stakeholders. Due to design inefficiencies, currently ZLA consistently reroutes traffic from the BUFIE to the current SADDE STAR adding track miles.

- Recommendations
  - Altitude windows are used to enhance efficiency on the arrival and to reduce level-offs. The GOATZ level-off is eliminated due to the creation of an OPD.
  - Procedural deconfliction from the CHANL departure traffic is accomplished with waypoint restrictions on each procedure.
  - The lateral path of the proposed STAR adjusts this arrival to the north of SXC, which will provide routing that will define a predictable, repeatable path as shown in Figure 39.

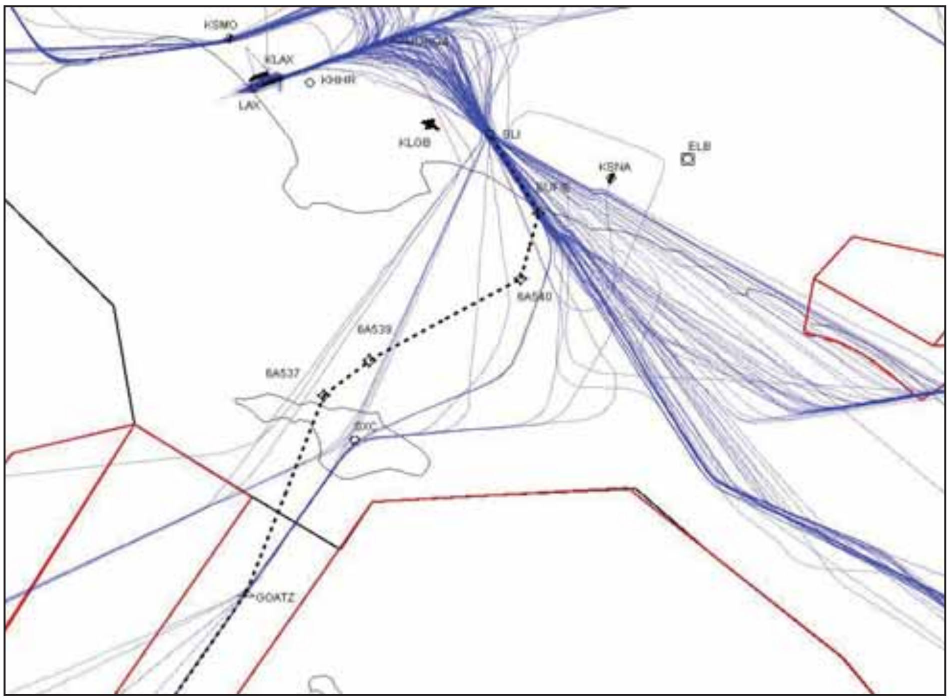


Figure 39. Proposed LAX BUFIE STAR

- Benefits
  - This proposal will have optimized lateral and vertical profiles with significant savings associated with fuel burn reductions due to the removal of level-offs.
  - Projected annual savings for the BUFIE STAR are estimated in Table 23.

Table 23. Proposed LAX BUFIE STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$82K	
	Profile	$607K	$1.85M
	Cost to Carry	$79K	$203K
Total Estimated Annual Fuel Savings (Dollars)		$768K	$2.14M
Total Estimated Annual Fuel Savings (Gallons)		261K	730K
Total Estimated Annual Carbon Savings (Metric Tons)		2.6K	7.3K

4.3.1.7 LAX KIMMO Arrival

- Issues
  - The KIMMO STAR is a conventional turboprop procedure relying upon ground based navigation.
  - The arrival currently has inefficient lateral paths, and actual flight tracks do not follow the current arrival procedure.
    - There is currently a dogleg on the EHF transition that proceeds to AMONT intersection, but aircraft are typically routed direct to the LHS VOR.

- Recommendations
  - As shown in Figure 40, the proposed replacement for the KIMMO STAR is designed as a PBN procedure for turboprops.
  - The proposed KIMMO will have OPD benefits and lateral paths.
  - The OST removed the EHF-AMONT dogleg and replaced it with a route from EHF direct LHS to mimic current flows, resulting in reduced filed miles. The dogleg at the end of the procedure was removed as aircraft rarely flew over the PURMS intersection after DARTS.

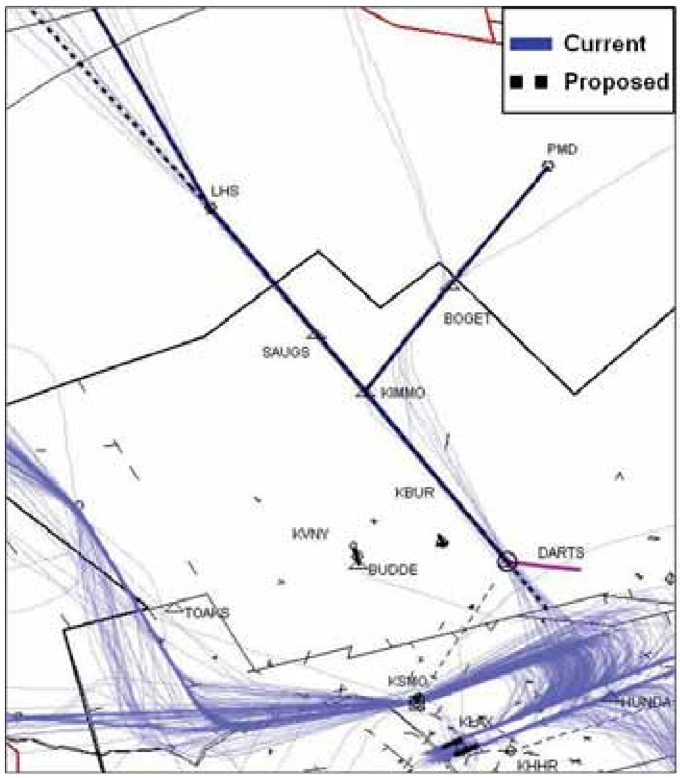


Figure 40. Current and Proposed LAX KIMMO STAR

- Benefits
  - With an improved vertical profile and a repeatable, predictable RNAV path, this procedure will enhance efficiencies for turboprop arrivals to LAX.
  - Due to low traffic counts, no modeling was done for this procedure.

4.3.1.8 LAX BASET and HOUND Arrivals

- Issues
  - The current BASET and REDEYE STARs are conventional procedures relying on ground based navigation.
  - These procedures are used for east traffic or midnight operations only and are not aligned with west configurations.
  - The current procedures do not accommodate independent flows.
  - There are currently inefficient vertical and lateral paths on these procedures.
- Recommendations
  - The proposed replacements for the BASET and REDEYE (HOUND) as shown in Figure 41 are designed as PBN procedures, with OPD benefits and optimized lateral paths.
  - The procedures mimic the RIIVR and SEAVU STARs, which have been modified into dual, independent flows, with the caveat that the altitudes will be higher to accommodate the longer downwinds.

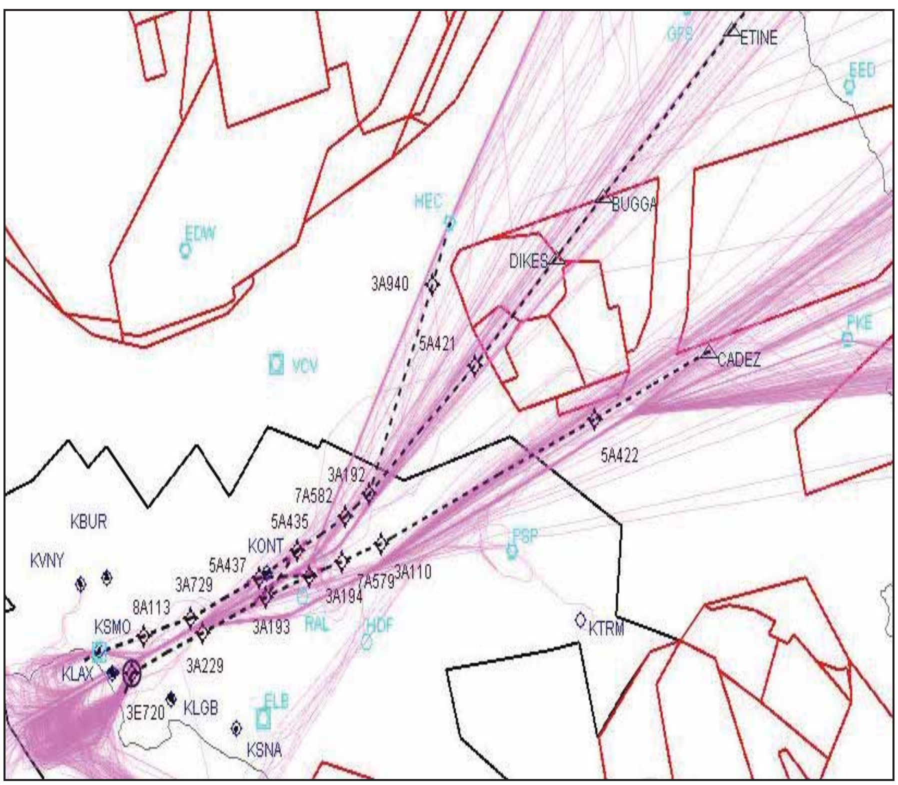


Figure 41. Proposed LAX BASET and HOUND STARs

- Benefits
  - Due to low traffic counts, no modeling was done for this procedure.

4.3.1.9 LAX MOOR Arrival

- Issues
  - The MOOR arrival is a conventional procedure relying upon ground based navigation.
  - The MOOR is an east flow procedure that is lightly used and contains inefficient vertical and lateral paths.
- Recommendations
  - As shown in Figure 42, the proposed replacement for the MOOR STAR is designed as a PBN procedure with OPD benefits.
  - By deconflicting the LAX flows from the BUR, VNY, LGB, and SNA flows, the MOOR arrivals will not have to compete with other procedures for the airspace over FIM.
  - The new RZS transition provides a significant decrease in filed flight miles. The proposed MOOR eliminates the long en route transition through the control extension.

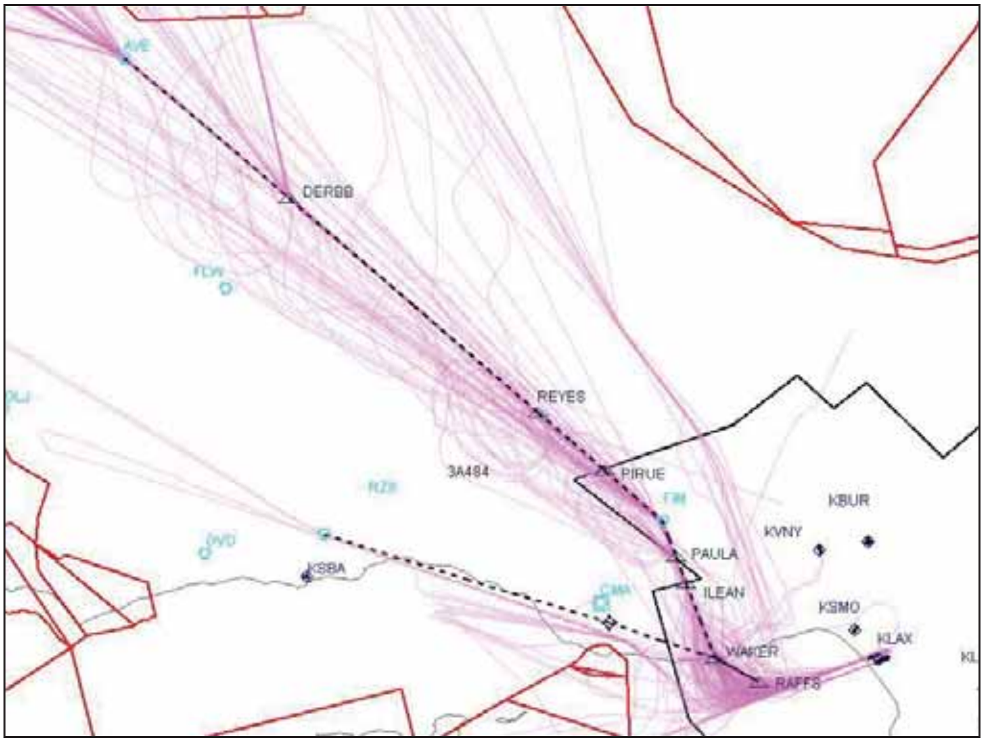


Figure 42. Proposed LAX MOOR STAR

- Benefits
  - Due to low traffic counts, no modeling was done for this procedure.

4.3.1.10 LAX FICKY Arrival

- Issues
  - A request was made for a new east flow procedure for overnight oceanic operations.

- Recommendations
  - The proposed FICKY (see Figure 43) is designed as a PBN procedure with OPD benefits.
  - This procedure merges with current existing approach procedures.

Figure 43. Proposed LAX FICKY STAR

- Benefits
  - This is a new procedure with no baseline; therefore, no modeling was done.

4.3.2 SAN Arrivals

This section describes the operational issues, recommendations, and expected benefits the OST has identified for arrivals to SAN.

4.3.2.1 SAN BAYVU Arrival

The BAYVU will account for 39% of all SAN jet arrival traffic.

- Issues
  - Inefficient lateral paths exist as aircraft are forced over the LAX VOR due to traffic congestion.
  - ZLA indicated a need for an OTISS transition that would lie northeast of the LAX VOR.
- Recommendations
  - The proposed BAYVU is designed as a PBN procedure with OPD benefits.
  - An OTISS transition was designed to mimic the current arrival tracks. It defines a predictable, repeatable path, and alleviates much of the congestion over LAX (see Figure 44).

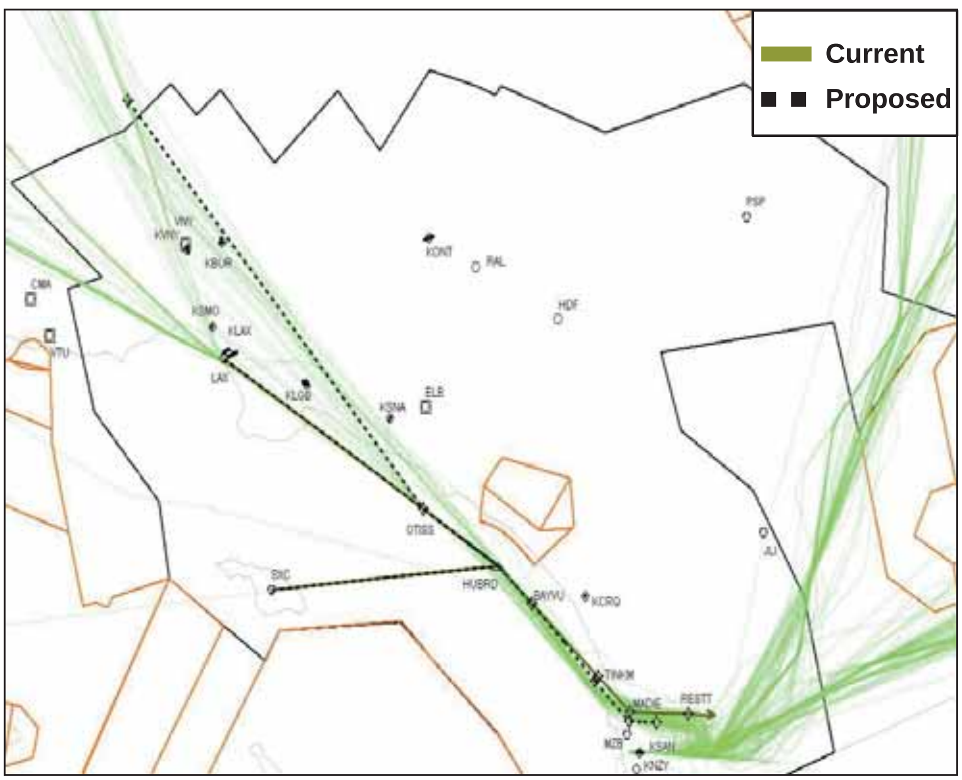


Figure 44. Current and Proposed SAN BAYVU STAR

- Benefits
  – Projected annual savings for the SAN BAYVU STAR are estimated in Table 24.

Table 24. Proposed SAN BAYVU STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile		
	Cost to Carry	$30K	
Total Estimated Annual Fuel Savings (Dollars)		$30K	
Total Estimated Annual Fuel Savings (Gallons)		9K	
Total Estimated Annual Carbon Savings (Metric Tons)		90	

4.3.2.2 SAN LYNDI Arrival

The LYNDI will account for 39% of all SAN jet arrival traffic.

- Issues
  – The IPL flow on the LYNDI arrival often conflicts with eastbound departures.

- Recommendations
  - In order to mitigate conflicts on the IPL flow of the LYNDI arrival, an offload route was built from BZA to the north as shown in Figure 45.

Figure 45. Proposed SAN LYNDI STAR

- Benefits
  - Due to little change in the proposed procedure compared to the current operation, the LYNDI was not modeled.

4.3.3 LGB and SNA Arrivals

This section describes the operational issues, recommendations, and expected benefits the OST has identified for arrivals to LGB and SNA.

4.3.3.1 LGB and SNA KEFFR Arrival

Approximately 54% of SNA jet arrivals and 49% of LGB jet arrivals use the conventional KAYOH STAR. The KEFFR STAR will be an RNAV procedure that serves the same flows as the KAYOH; it is expected to be published in February 2012.

- Issues
  - The soon to be published KEFFR arrival has inefficient vertical and lateral paths.

  – The altitude restriction at BANDS intersection is overly restrictive as aircraft are currently forced down below LAX arrival flows.

- Recommendations
  – The proposed KEFFR STAR is designed as a PBN procedure with OPD benefits.
  – The OST proposed KEFFR optimizes the HEC transition, shortening the lateral path and providing a more direct routing via LUCER to HUMPS.
  – The JOLAR transition procedurally deconflicts the KEFFR from the LAX and ONT arrivals.
  – The current and proposed KEFFR procedures as well as the current KAYOH are shown in Figure 46.

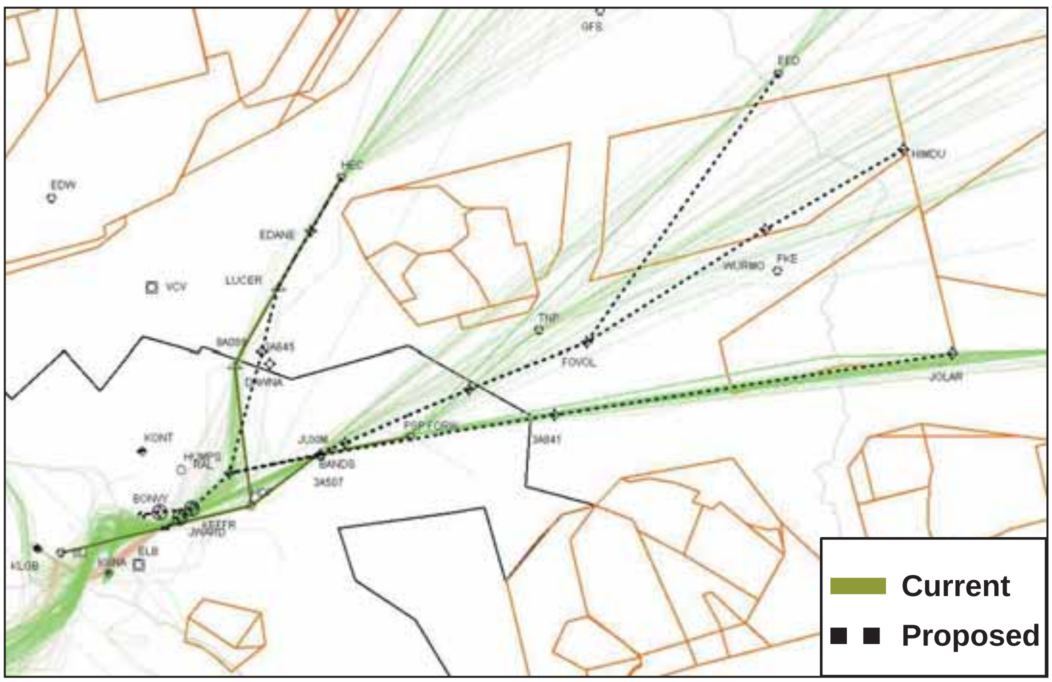


Figure 46. Current LGB and SNA KAYOH STAR and Proposed LGB and SNA KEFFR STAR

- Benefits
  - Projected annual savings for the KEFFR STAR are estimated in Table 25.

Table 25. Proposed LGB and SNA KEFFR STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$29K	
	Profile	$406K	$1.08M
	Cost to Carry	$26K	$67K
Total Estimated Annual Fuel Savings (Dollars)		$461K	$1.18M
Total Estimated Annual Fuel Savings (Gallons)		156K	402K
Total Estimated Annual Carbon Savings (Metric Tons)		1.6K	4K

4.3.3.2 LGB and SNA QMARK Arrival

Approximately 33% of SNA jet arrivals and 36% of LGB jet arrivals use the conventional TANDY STAR. The QMARK STAR will be an RNAV procedure that serves the same flows as the TANDY; it is expected to be published in July 2012.

- Issues
  - The TANDY STAR is a conventional procedure relying on ground based navigation.
  - The soon to be published QMARK arrival has inefficient vertical and lateral paths.
  - This arrival also procedurally shares lateral and vertical airspace with BUR, VNY, and LAX arrival traffic, which adversely affects the efficiency of all FIM flows.

- Recommendations
  - The OST proposed QMARK arrival is designed as a PBN procedure with OPD benefits.
  - The OST procedurally deconflicted the QMARK from the LAX SYMON arrival by shifting the route to the west.
  - The QMARK arrival removes extra filed track miles that relate to a dogleg to SXC.
  - LGB RNP approach transitions are also tied into the QMARK arrival.
  - The current and proposed procedures are shown in Figure 47.

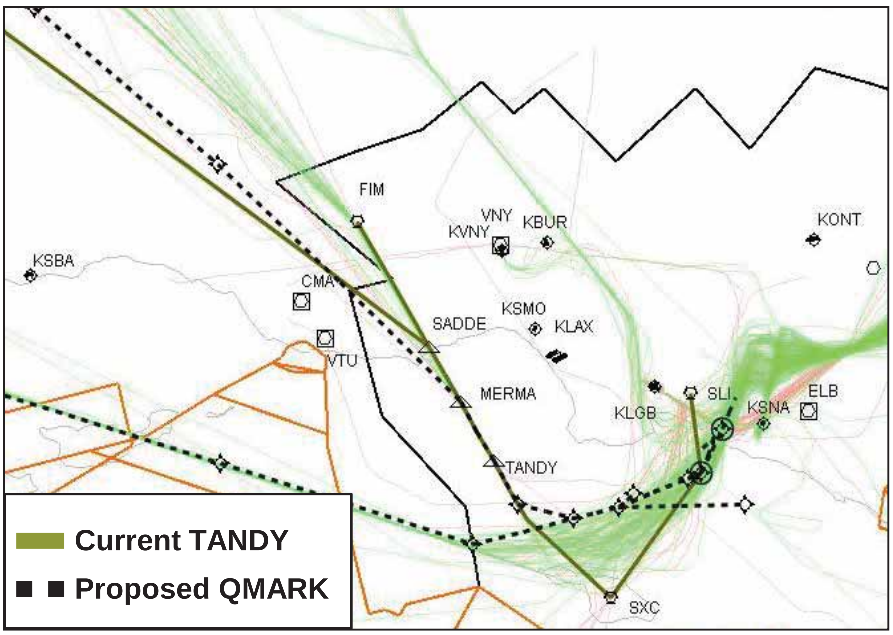


Figure 47. Current LGB and SNA TANDY STAR and Proposed LGB and SNA QMARK STAR

- Benefits
  - Projected annual savings for the QMARK STAR are estimated in Table 26.

Table 26. Proposed LGB and SNA QMARK STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$190K	
	Profile	$437K	$1.27M
	Cost to Carry	$77K	$127K
Total Estimated Annual Fuel Savings (Dollars)		$705K	$1.58M
Total Estimated Annual Fuel Savings (Gallons)		239K	540K
Total Estimated Annual Carbon Savings (Metric Tons)		2.4K	5.4K

4.3.4 ONT Arrivals

This section describes the operational issues, recommendations, and expected benefits the OST has identified for arrivals to ONT.

4.3.4.1 ONT SETER Arrival

The SETER accounts for approximately 29% of all ONT jet arrivals.

- Issues
  - The SETER STAR is a conventional procedure relying on ground based navigation.
  - The current SETER STAR has an altitude restriction at 14,000 feet at the BANDS intersection that results in level-offs. This restriction causes aircraft to be higher than optimal during their approach.
  - There are currently inefficient vertical and lateral paths on these procedures.

- Recommendations
  - The proposed replacement for the SETER STAR is designed as a PBN procedure with OPD benefits.
  - The proposed SETER STAR would mimic current lateral flight tracks as shown in Figure 48.
  - The proposed SETER STAR will utilize vertical windows to reduce level-offs while allowing aircraft to fly a more optimal profile. Vertical profiles to ONT, LGB/SNA and LAX are shown in Figure 49.
  - Flights from the northeast are descended to cross below LAX arrivals and join laterally with LGB and SNA KEFFR arrivals while remaining vertically deconflicted.
  - An unused JLI transition was removed.

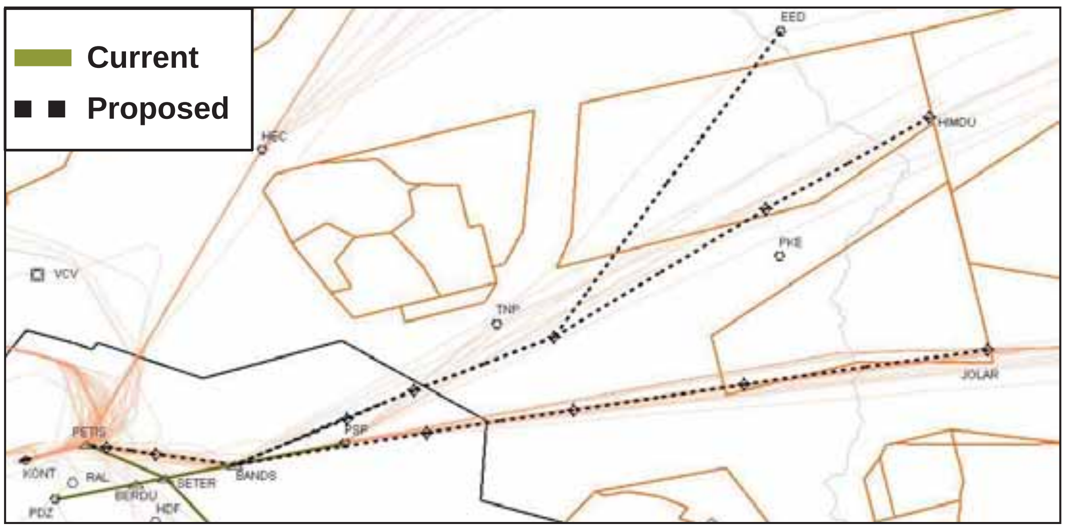


Figure 48. Current and Proposed ONT SETER STAR

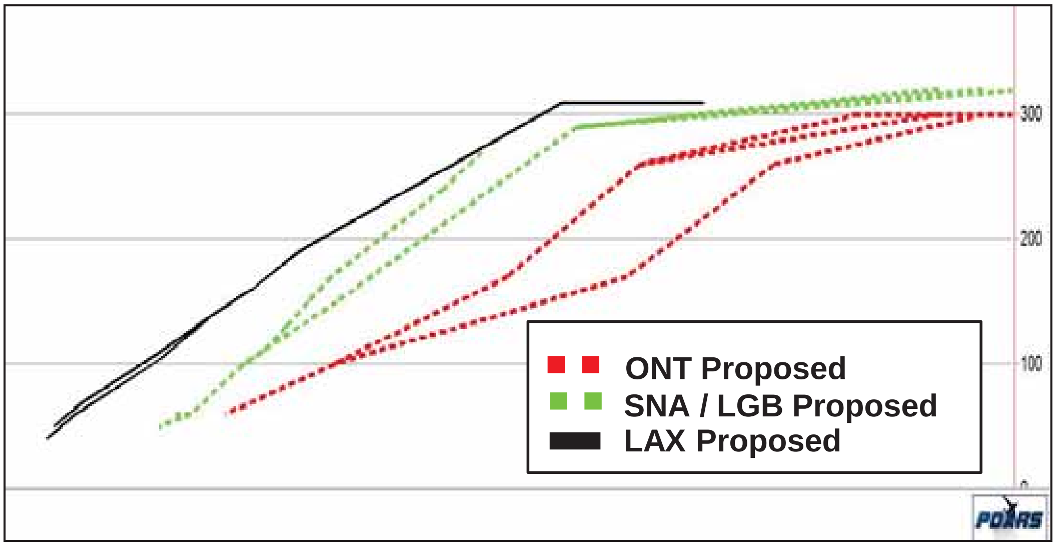


Figure 49. Proposed ONT, LGB/SNA, and LAX Vertical Paths

- Benefits
  - Projected annual savings for the SETER STAR are estimated in Table 27.

Table 27. Proposed ONT SETER STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	$169K	$508K
	Cost to Carry	$10K	$30K
Total Estimated Annual Fuel Savings (Dollars)		$179K	$538K
Total Estimated Annual Fuel Savings (Gallons)		62K	185K
Total Estimated Annual Carbon Savings (Metric Tons)		620	1.9K

4.3.4.2 ONT ZIGGY Arrival

The ZIGGY accounts for approximately 22% of all ONT jet arrivals.

- Issues
  - The ZIGGY STAR is a conventional procedure relying on ground based navigation.
  - Currently the ZIGGY STAR has inefficient speed restrictions at MAJEK and DAWNA.
  - Inefficient vertical paths have arrival aircraft descending at a steeper than optimal rate.
- Recommendations
  - The proposed replacement for the ZIGGY STAR is designed as a PBN procedure with OPD benefits as shown in Figure 50.
  - Northeast arrivals over HEC are deconflicted from the LGB and SNA KEFFR flows at DAWNA intersection.
  - Terrain issues to the north limit the possibility for creating an optimal procedure.

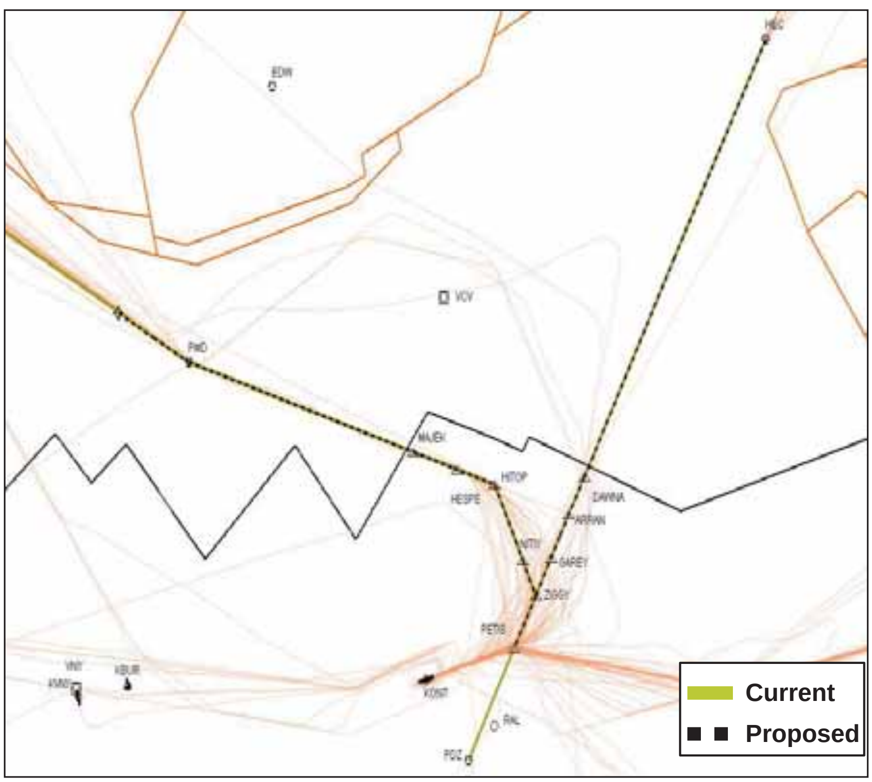


Figure 50. Current and Proposed ONT ZIGGY STAR

- Benefits
  – Projected annual savings for the ZIGGY STAR are estimated in Table 28.

Table 28. Proposed ONT ZIGGY STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	N/A	
	Profile	$108K	$277K
	Cost to Carry	$6K	$17K
Total Estimated Annual Fuel Savings (Dollars)		$114K	$294K
Total Estimated Annual Fuel Savings (Gallons)		39K	100K
Total Estimated Annual Carbon Savings (Metric Tons)		390	1K

4.3.4.3 ONT New BLKMN Arrival

- Issues
  – There is currently no arrival procedure to ONT from the west. Aircraft today are routed north over PMD via the ZIGGY STAR resulting in excessive track miles, fuel burn, and carbon emissions.

- Recommendations
  - The proposed BLKMN STAR, shown in Figure 51, is designed as a PBN procedure with OPD benefits.
  - The proposed BLKMN STAR will mimic the proposed BUFIE STAR to BUFIE intersection then continue north to a new fix where it will terminate.

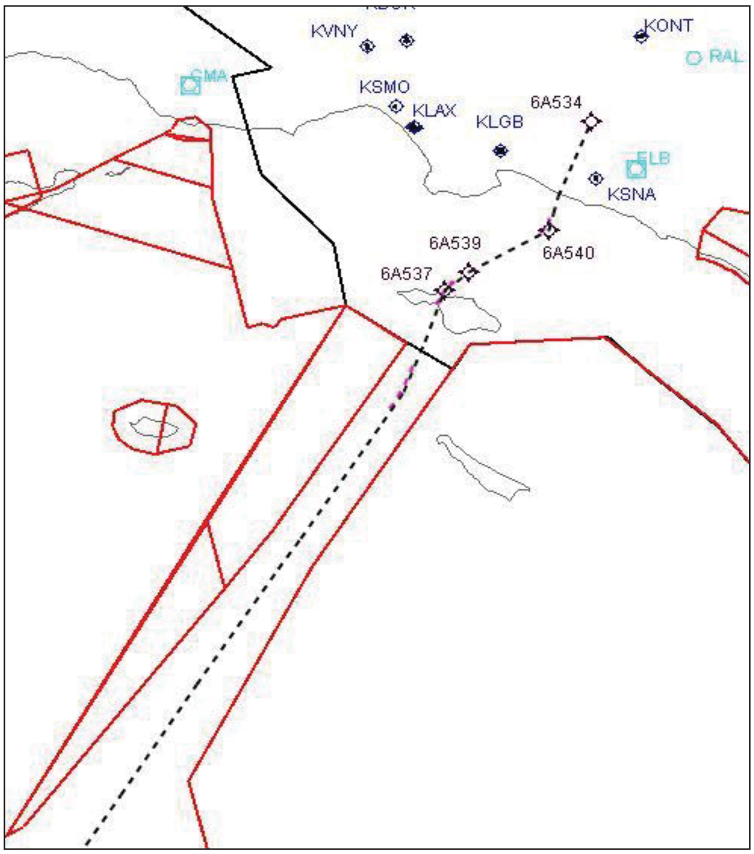


Figure 51. Current and Proposed ONT BLKMN STAR

- Benefits
  - This is a new procedure with no baseline; therefore, no modeling was done.

4.3.5 BUR and VNY Arrivals

This section describes the operational issues, recommendations, and expected benefits the OST has identified for arrivals to BUR and VNY.

4.3.5.1 BUR and VNY JANNY Arrival

The JANNY accounts for approximately 44% of all BUR jet arrivals and 42% of all VNY jet arrivals.

- Issues
  - The current JANNY STAR conflicts with LAX, VNY, and BUR departures that fly east over DAG.
  - There is high traffic congestion over PMD with arrival, departure, and overflight flows.
- Recommendations
  - The proposed JANNY STAR would shift the initial fix northeast of DAG reducing conflicts and allowing for OPD benefits as shown in Figure 52.
  - Airport transitions were added to both BUR and VNY.

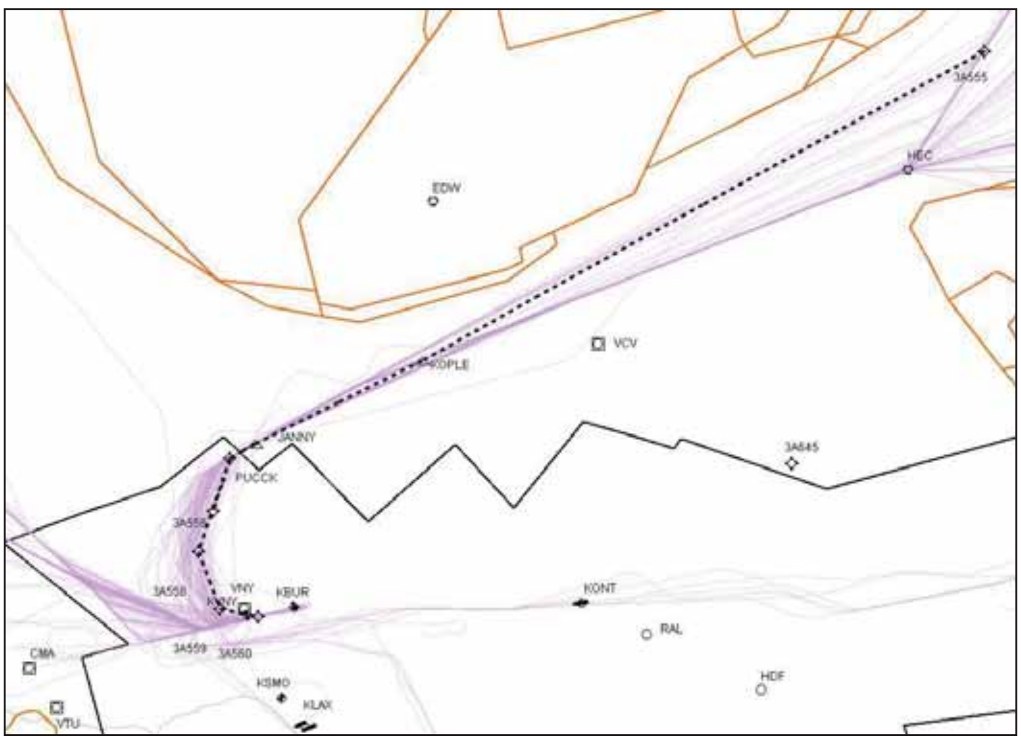


Figure 52. Current and Proposed BUR and VNY JANNY STAR

- Benefits
  - Terrain issues and military airspace limited the amount of savings and procedural deconfliction that could be achieved over PMD.
  - Projected annual savings for the JANNY STAR are estimated in Table 29. These savings are for BUR traffic only as VNY was not modeled.

Table 29. Proposed BUR JANNY STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$123K	
	Profile	$245K	$739K
	Cost to Carry	$22K	$52K
Total Estimated Annual Fuel Savings (Dollars)		$390K	$914K
Total Estimated Annual Fuel Savings (Gallons)		133K	312K
Total Estimated Annual Carbon Savings (Metric Tons)		1.3K	3K

4.3.5.2 BUR CANYN Arrival

The CANYN accounts for approximately 45% of all BUR jet arrivals.

- Issues
  - Currently flights utilize the CEEME STAR, which is a conventional procedure relying on ground based navigation.
  - The current CEEME STAR has altitude restrictions which result in level-offs.
  - Arriving flights into the Los Angeles Basin are stacked from AVE to FIM.
  - There are excessive speed restrictions at the DERBB intersection due to heavy traffic congestion.

- Recommendations
  - The proposed replacement for the CEEME STAR, shown in Figure 53, is designed as a PBN procedure with OPD benefits.
  - The proposed CANYN arrival would offset BUR arrivals to the west and procedurally deconflict them from the LAX SYMON arrivals while reducing level-offs.
  - Excessive restrictions at DERBB would be alleviated by offsetting the route to the west.

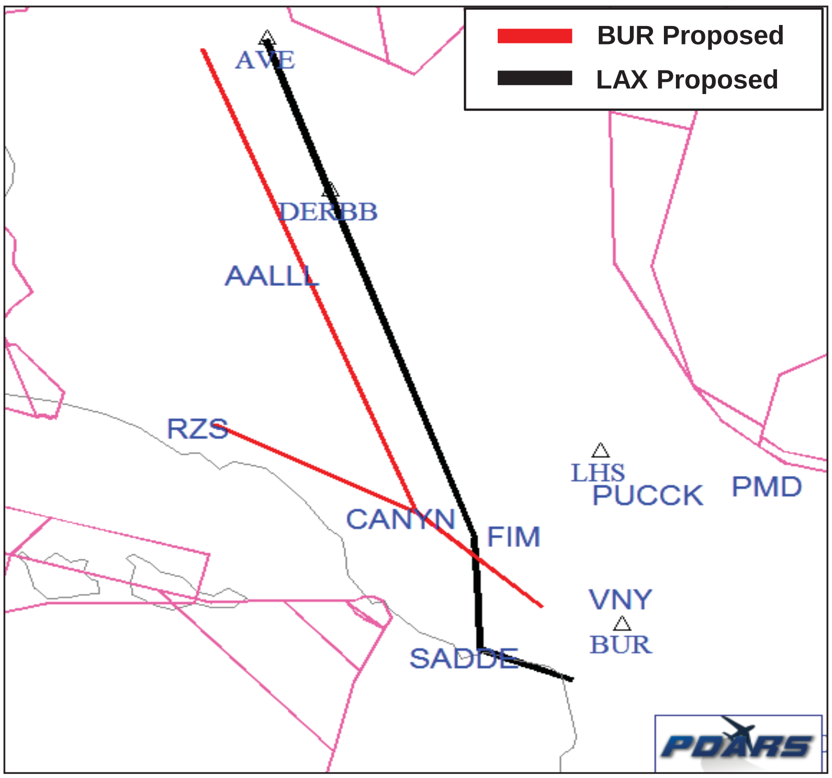


Figure 53. Proposed BUR and LAX STARs from the North

- Benefits
  - Projected annual savings for the CANYN STAR are estimated in Table 30. The CANYN arrivals will see significant profile improvements on the proposed procedure. However, to deconflict the CANYN from LAX arrivals, additional track distance was necessary. The deconfliction from LAX arrivals will reduce delay for both flows. This impact could not be modeled or estimated at this time by the OST.

Table 30. Proposed BUR CANYN STAR Annual Benefits

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	($123K)	
	Profile	$82K	$245K
	Cost to Carry	($12K)	($3K)
Total Estimated Annual Fuel Savings (Dollars)		($53K)	$119K
Total Estimated Annual Fuel Savings (Gallons)		(16K)	42K
Total Estimated Annual Carbon Savings (Metric Tons)		(160)	4K

4.3.5.3 VNY AALLL Arrival

Current flights utilize the FERN5 STAR and account for approximately 42% of VNY jet arrivals.

- Issues
  - The FERN5 STAR is a conventional procedure relying on ground based navigation.
  - The current FERN5 has inefficient vertical paths that result in level-offs.
  - The current procedure has conflictions in the FIM area with other Los Angeles Basin traffic.
  - This arrival also procedurally shares lateral and vertical airspace with BUR and LAX arrival traffic, which adversely affects the efficiency of all FIM flows.

- Recommendations
  - The proposed replacement for the FERN5 is designed as a PBN procedure with OPD benefits, as shown in Figure 54.
  - The proposed AALLL arrival would offset VNY arrivals to the west and procedurally deconflict them from LAX SYMON arrivals while reducing level-off and filed miles.
  - The procedure is designed for arrivals to Runways 16L/R. Excessive restrictions at DERBB would also be alleviated by offsetting flights to the west.

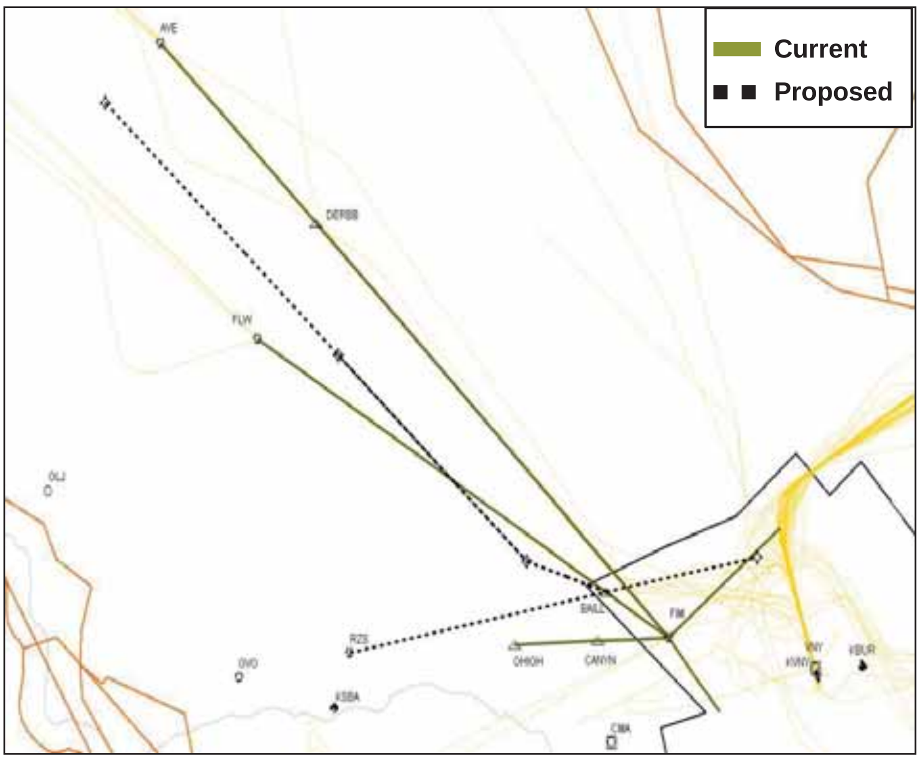


Figure 54. Current and Proposed VNY AALLL STAR

- Benefits
  - With improved profiles and segregated flows from the LAX arrival stream, this procedure will enhance safety and efficiency for arrivals to VNY.
  - As this was a procedure to a satellite airport, no modeling was done.

4.3.5.4 BUR, VNY, and SMO Small Prop Arrival

- Issues
  - There are inefficient vertical and lateral paths on the current procedure. Prop aircraft are typically forced to lower altitudes early due to conflictions with other Los Angeles area flows.
  - This arrival also procedurally shares lateral and vertical airspace with LAX arrival traffic, which adversely affects the efficiency of all FIM flows
- Recommendations
  - The proposed replacement, as shown in Figure 55, is designed as a PBN procedure.
  - This STAR would be procedurally deconflicted from the LAX SYMON arrivals and would offer airport transitions to BUR, VNY, and SMO with improved vertical profiles.
  - The procedure would take existing turboprop and small prop flights and mimic the proposed CANYN and AALL STARs into BUR and VNY.

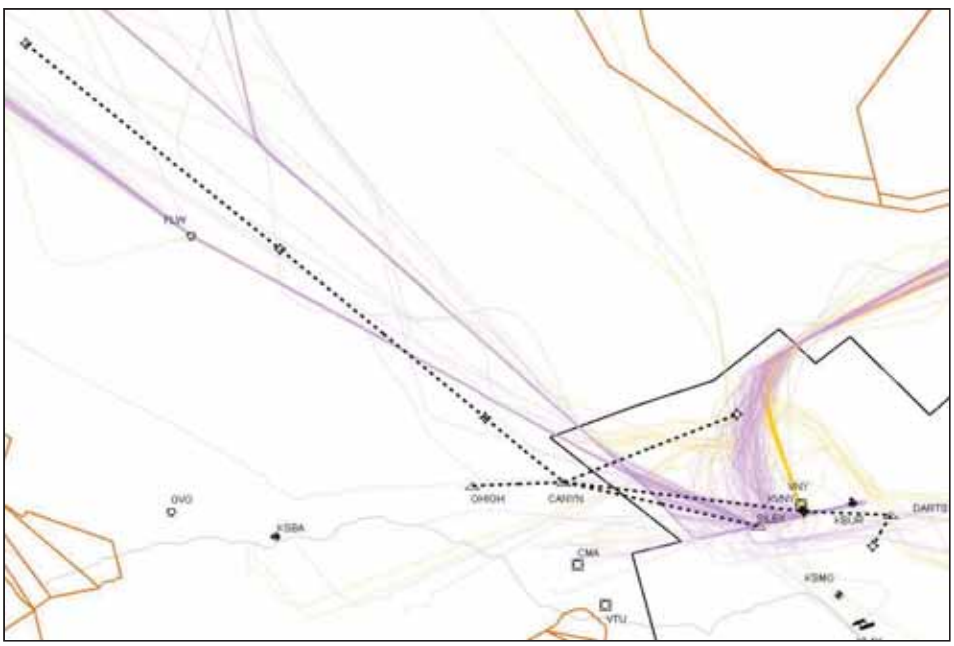


Figure 55. Proposed BUR, VNY, and SMO Small Prop STAR

- Benefits
  - With improved profiles and segregated flows from the LAX arrival stream, this procedure will enhance safety and efficiency for small props to BUR, VNY, and SMO.
  - Due to low traffic counts, no modeling was done for this procedure.

4.3.5.5 BUR, VNY, SMO, CMA, and OXR New East Arrival

- Issues
  - Due to the lack of a published route, SCT requested an arrival procedure from the PSP area for BUR, VNY, SMO, CMA, and OXR airports. Currently, arrivals are routed north to the DAG VOR, then join current STARs or are vectored in the vicinity of PSP.
- Recommendations
  - The OST developed an RNAV STAR that mimics the ONT SETER STAR to PETIS then terminates at a waypoint south of DARTS. The proposed route as shown in Figure 56 would significantly reduce flight track miles and allow for OPD benefits.

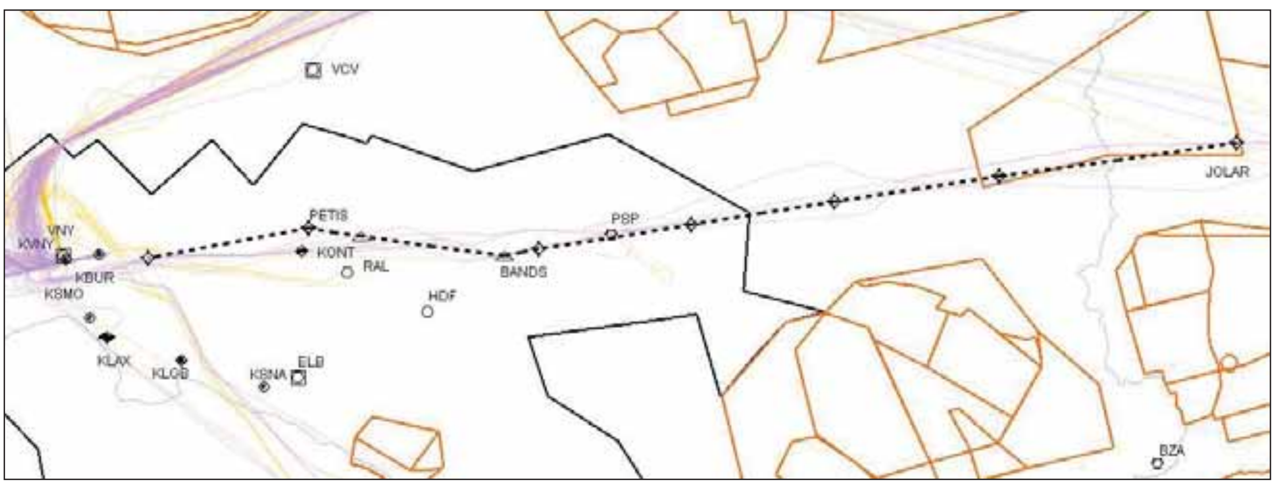


Figure 56. BUR, VNY, SMO, CMA, and OXR New East STAR

- Benefits
  - With improved profiles and a repeatable, predictable path separated from other Los Angeles Basin airports, this procedure will enhance efficiency for arrivals from the PSP area to the BUR, VNY, SMO, CMA, and OXR airports.
  - This is a new proposed procedure with no baseline; therefore no modeling was done.

4.3.6 Satellite Airport Arrivals

This section describes the operational issues, recommendations, and any derived benefits the OST has identified for satellite airport arrivals.

4.3.6.1 NZY and SDM BARET Arrival

- Issues
  - The San Diego area at SCT requested a modified BARET STAR for SDM and NZY airports. The current procedure conflicts with the LYNDI STAR to SAN.
  - The BARET STAR is a conventional procedure relying upon ground based navigation.
  - There are currently inefficient vertical and lateral paths on this procedure.
- Recommendations
  - The proposed BARET, shown in Figure 57, is designed as a PBN procedure with OPD benefits.
  - This arrival is an independent procedure for NZY and SDM. It mimics the SAN LYNDI STAR arrival from the northeast until SALTN and is then segregated east of the LYNDI. From IPL, the proposed procedure overlays V317 to remain south of the LYNDI.

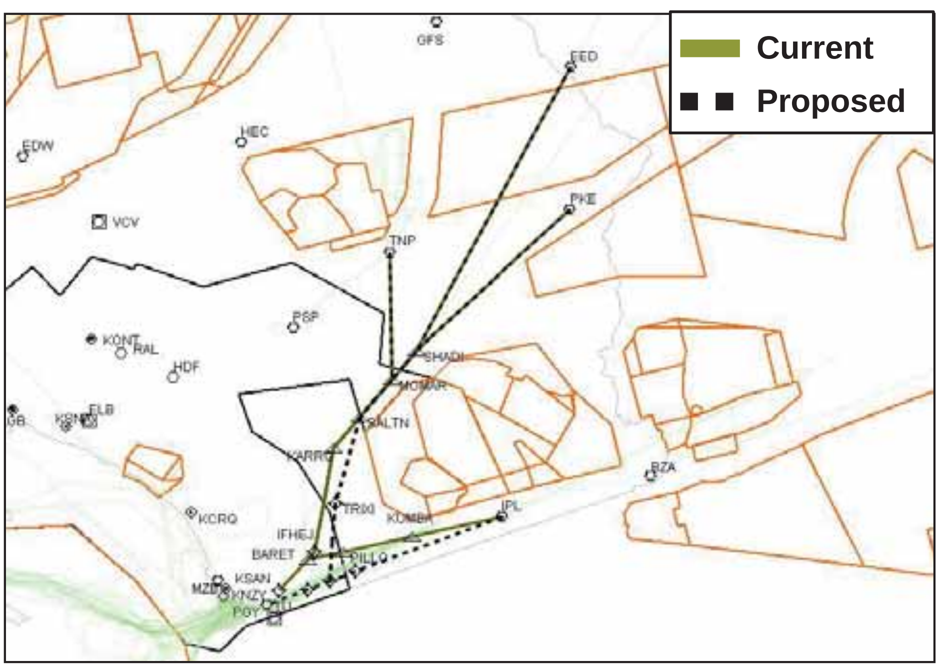


Figure 57. Current and Proposed NZY and SDM BARET STAR

- Benefits
  - With improved profiles and a repeatable, predictable RNAV path deconflicted from the primary SAN east arrival flow, this procedure will enhance safety and efficiency for arrivals to SDM and NZY airports.
  - Due to low traffic counts, no modeling was done.

4.3.6.2 CRQ FODDR Arrival

- Issues
  - There are inefficient vertical and lateral paths on the current procedure and actual flight tracks do not overfly the current procedure.
  - The current CRQ FODDR STAR conflicts with several other major Southern California flows in the vicinity of EHF.
- Recommendations
  - The proposed FODDR is designed as a PBN procedure with OPD benefits.
  - The proposed procedure was moved west of the current route to deconflict from the EHF flows, as shown in Figure 58.

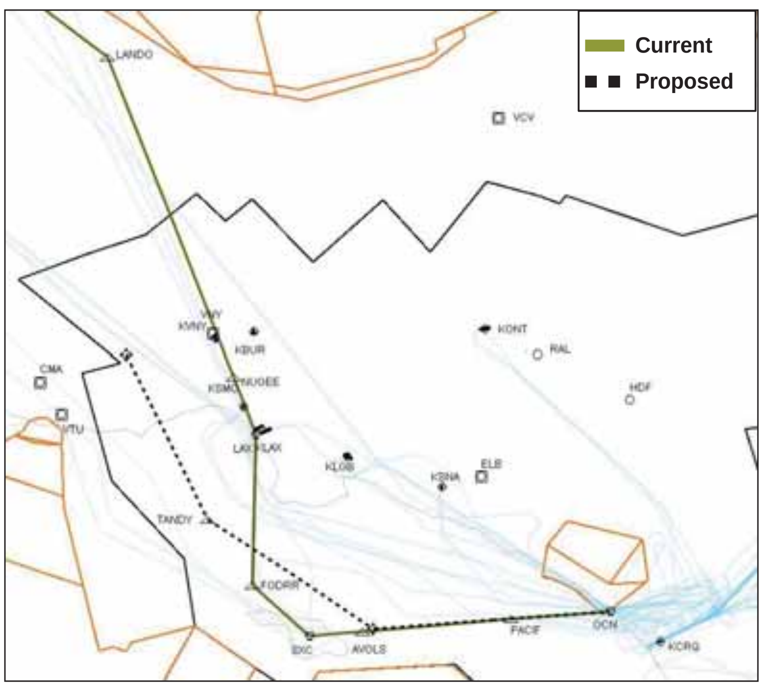


Figure 58. Current and Proposed CRQ FODDR STAR

- Benefits
  - Improving the vertical profile of the FODDR and relocating the route west to segregate from other Southern California flows will enhance safety and efficiency for arrivals to CRQ.
  - Due to low traffic counts, no modeling was done.

4.3.6.3 SBA KWANG Arrival

- Issues
  - Currently there is no published STAR to SBA. ZLA requested a route for SBA arrivals from the PMD area.
- Recommendations
  - The proposed KWANG, shown in Figure 59, is designed as a PBN procedure with OPD benefits.
  - The STAR begins over PMD and terminates at the beginning of the approach transition.

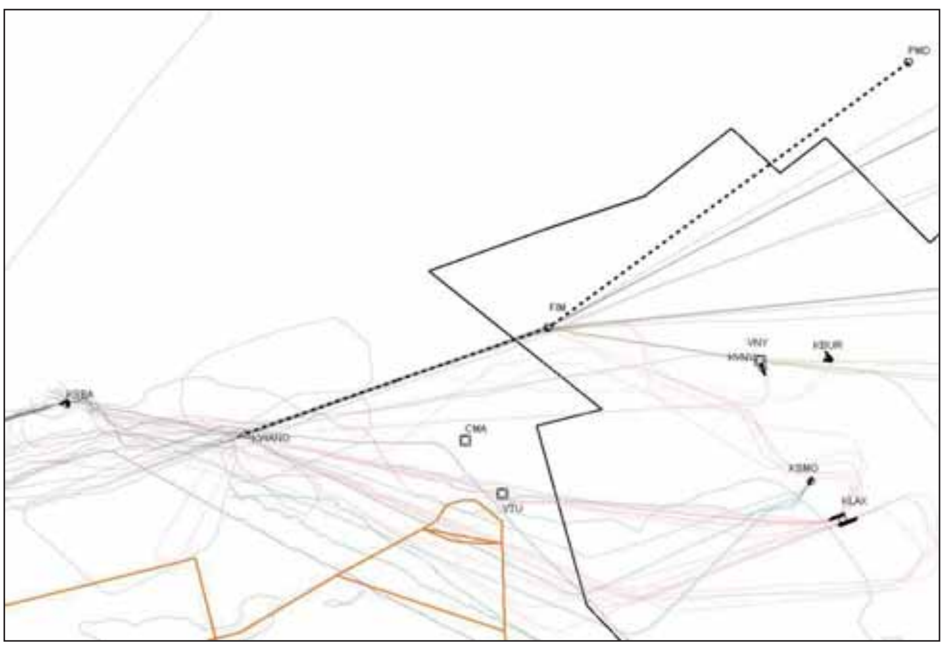


Figure 59. Proposed SBA KWANG STAR

- Benefits
  - This is a new proposed procedure with no baseline; therefore, no modeling was done.

4.3.6.4 CMA, OXR, and NTD New GUERA and NLMAN Arrivals

- Issues
  - Currently the route through ZLA's airspace from over PMD to CMA, OXR, and NTD is complicated and relies upon conventional radials, DMEs, and fixes.
  - Frequency congestion was identified as a concern by the ZLA sectors that work the traffic through this area. Standardized routing was requested to alleviate this congestion.
- Recommendations
  - The OST developed a PBN STAR for props to OXR, CMA, and NTD (GUERA) and a PBN STAR to NTD for jet aircraft (NLMAN) as shown in Figure 60.
  - These procedures will reduce ATC workload by creating a standardized route, reducing frequency congestion, and taking advantage of automation to produce preferential arrival routes.

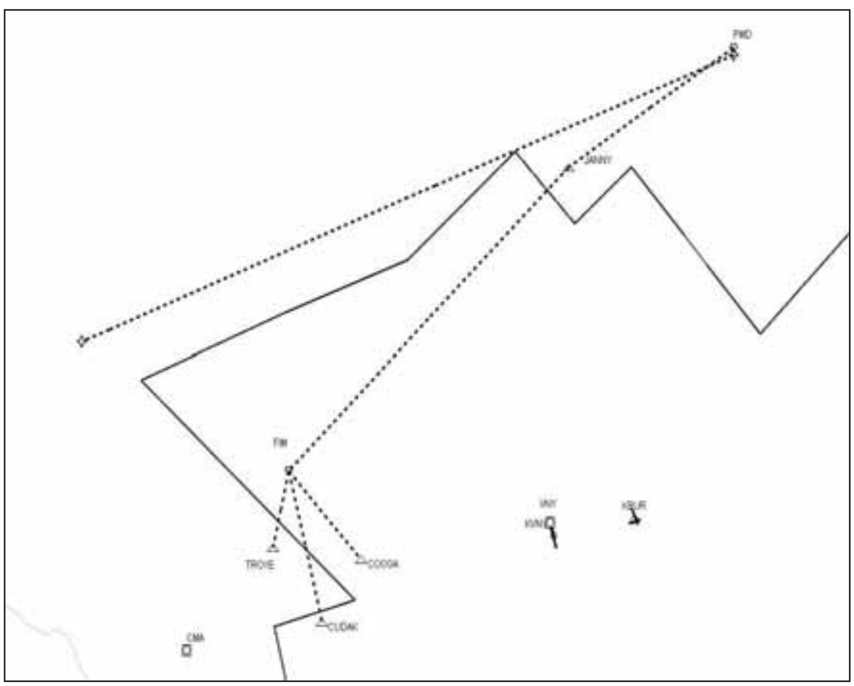


Figure 60. Proposed CMA, OXR, and NTD New GUERA and NLMAN STARs

- Benefits
  - This is a new proposed procedure with no baseline; therefore, no modeling was done.

4.3.7 Summary of Southern California Arrival Benefits

In general, the issues associated with the current arrivals to Southern California were related to inefficient lateral and vertical paths, unused en route transitions, and a lack of dual independent arrivals to Runways 24L/R and 25L/R at LAX. To address these concerns, the Southern California OST focused on PBN solutions. The OST conceptual proposals for arrivals included the following:

- RNAV STARs with OPDs
- Removal of unused en route transitions and development of runway transitions
- Dual independent arrivals to Runways 24L/R and 25L/R at LAX incorporated into a redesign of the RIVVR, SEAVU, and OLDEE STARs
- More efficient lateral paths created by removing doglegs and adjusting terminal entry points.

The OST recognizes that these new procedures may require Letter of Agreements (LOAs) and Standard Operating Procedure (SOP) changes in order to facilitate OPDs.

Table 31shows the total arrival fuel burn benefits for the Southern California proposals as described throughout Section 4.3.

Table 31. Total Annual Fuel Burn Benefits for Southern California Arrivals

		Low	High
Estimated Annual Fuel Savings (Dollars)	Distance	$467K	
	Profile	$6.14M	$17.47M
	Cost To Carry	$794K	$1.82M
Total Estimated Annual Fuel Savings (Dollars)		$7.40M	$19.76M
Total Estimated Annual Fuel Savings (Gallons)		2.52M	6.76M
Total Estimated Annual Carbon Savings (Metric Tons)		25K	68K

4.4 Other Southern California Issues

4.4.1 SMO/LAX Interactions

- Issues
  - Current SMO procedures inhibit independent operations with LAX departures. Limiting factors include runway configurations and the proximity of the airports (4 NM).
  - Excessive ground delays occur at SMO due to LAX departure demand. LAX operations are also adversely affected since Runways 24L/R departures are held until the SMO departures are separated from the LAX departure paths. Similarly, SMO departures from Runway 21 must be held until LAX departures are separated from the SMO departure areas.
  - Interactions between SMO and LAX also create complex ATC coordination. Three facilities are involved in the coordination of a SMO departure, as LAX ATCT, SMO ATCT, and SCT are all involved in the release process. If SMO procedures were deconflicted from LAX departures, verbal coordination between facilities could be minimized.
- Recommendations
  - The OST and SCT developed PBN procedures to and from SMO that would deconflict the flows from Runways 06L/R and 24L/R at LAX.

4.4.1.1 Runway 03 RNAV Approach Concept

- Recommendations
  - The OST developed an RNAV straight in approach to SMO Runway 03 as shown Figure 61.
  - The RNAV approach is designed to maintain vertical deconfliction from the LAX Runway 07 final approach course.
  - The courses of the RNAV approach to SMO Runway 03 and the Runway 06 approach to LAX will diverge by more than the minimum separation requirement of 15 degrees after crossing the LAX final.

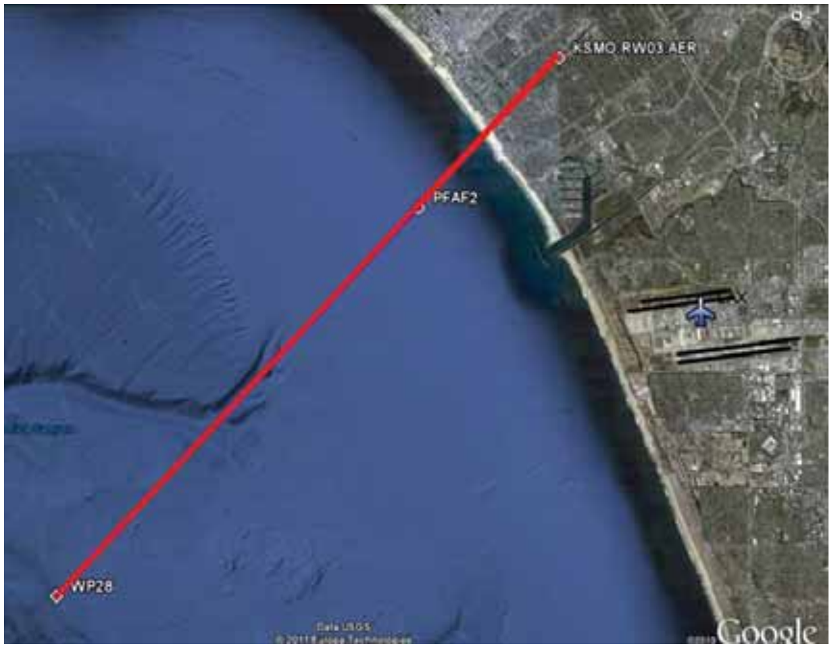


Figure 61. Proposed SMO Runway 03 RNAV Approach

- Benefits
  - This approach enables greater independent operations.
  - A straight-in RNAV Runway 03 approach creates a previously unavailable option.

4.4.1.2 Runway 03 RNAV SID

- Recommendations
  - The OST modified the original EDDYO SID design that SCT had developed for Runway 03. Multiple transitions were added to mimic current traffic paths.
  - The proposed SMO Runway 03 SID procedure is shown in Figure 62.

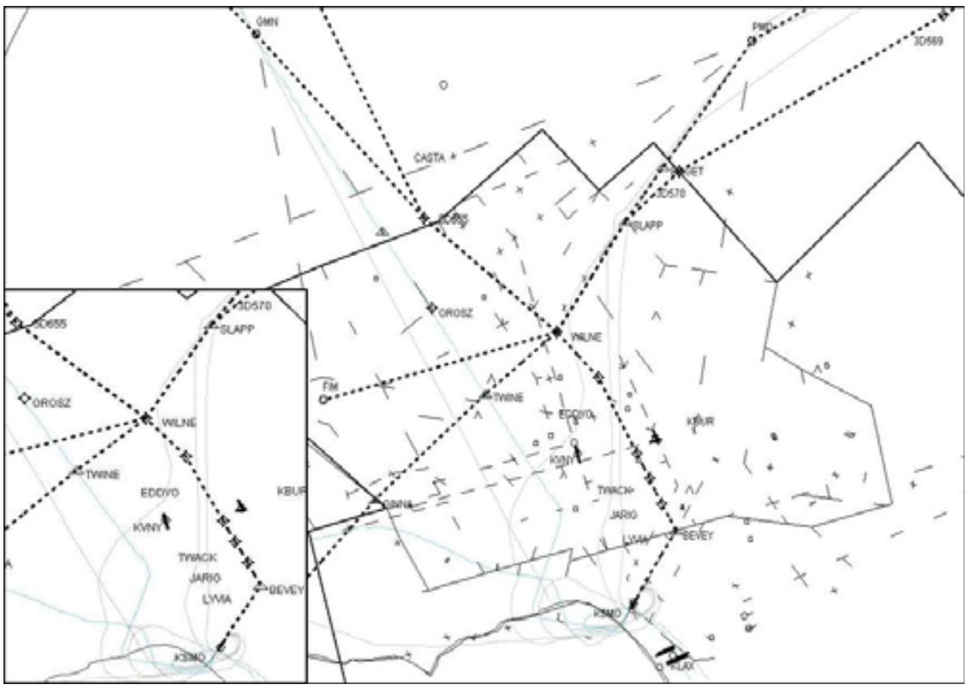


Figure 62. Proposed SMO Runway 03 RNAV SID

4.4.1.3 Runway 21 RNAV Approach Concept

- Recommendations
  - The OST developed a straight-in RNAV approach to Runway 21, as shown in Figure 63.
  - The missed approach procedure will mimic the proposed RNAV SID off SMO Runway 21. RNAV criteria will be used to procedurally deconflict from LAX Runways 24L/R departures.

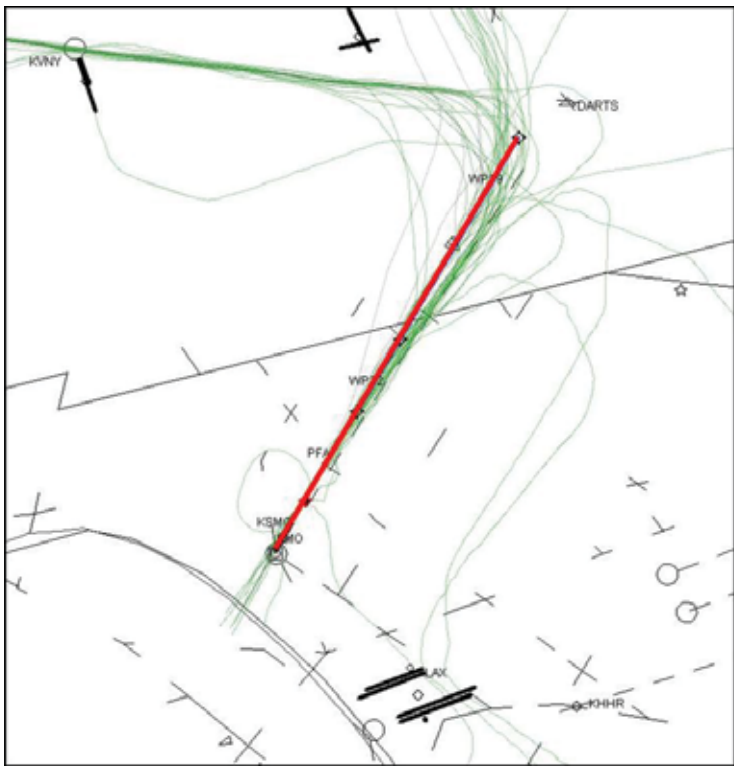


Figure 63. Proposed SMO Runway 21 RNAV Approach

4.4.1.4 Runway 21 RNAV SID

- Recommendations
  - The OST designed an RNAV SID with multiple transitions as shown in Figure 64 that is procedurally deconflicted from LAX Runways 24L/R departures.
  - The proposed SMO Runway 21 SID is procedurally deconflicted from LAX departures by approximately 3.25 miles, which meets minimum separation requirements.

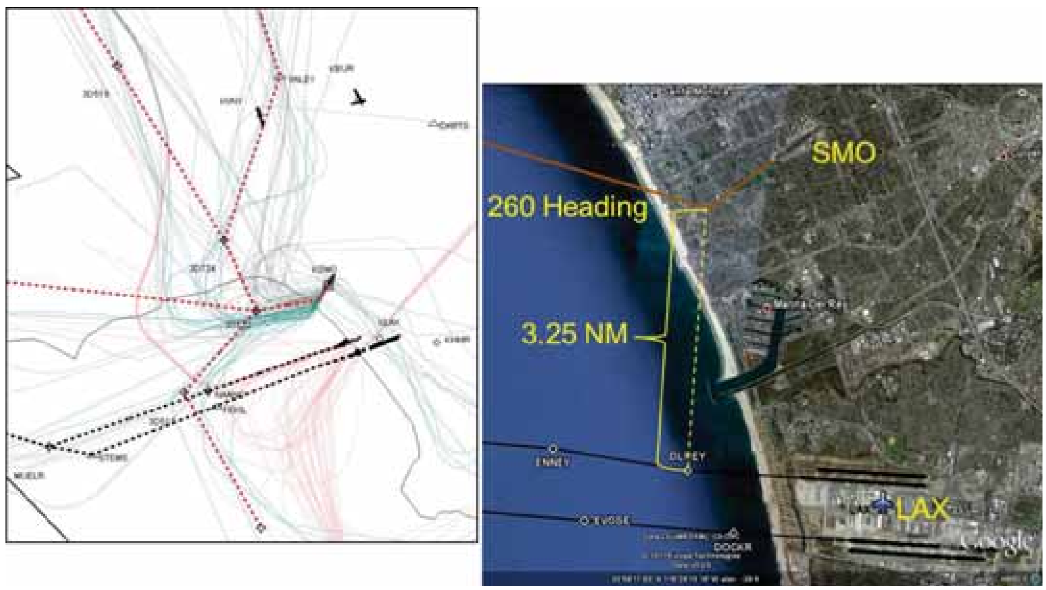


Figure 64. Proposed SMO Runway 03 RNAV Approach

- Benefits
  - The deconfliction of the SMO and LAX procedures will result in reduced vectoring, improved fuel planning, reduced departure and arrival delays, and minimized interfacility coordination.
  - The new procedures will allow for simultaneous operations at both airports with the sole constraint being limitations to the 270 degree heading that is used for prop aircraft from LAX Runways 24L/R.

– CAASD completed a study in 2009 estimating the delay impacts of SMO/LAX interactions[3]. This report details fuel and operating costs associated with delays at SMO and LAX interactions between LAX Runways 24L/R and SMO Runway 21. The delay estimates were recently updated to reflect current fuel costs. The updated delay savings due to deconflicted procedures are detailed below.

  - Analysis Assumptions
    - Only jets will use the new SID
    - 96% of jet operations RNAV capable
    - 20 IFR jet departures per day
    - Average SMO IFR delay for release for jets: 5.4 min/departure
    - 2 LAX departures delayed for each SMO departure
    - First departure delayed 2-3 minutes
    - Second departure delayed 1-1.5 minutes
    - 60% of SMO IFR departures impact LAX departures
  - Annual cost savings associated with new SMO SID for fuel savings alone (not including other ADOC)
    - LAX impact: $110,000 – $160,000
    - SMO impact: $100,000
    - Total: $210,000 – $260,000

4.4.2 T-Routes

- Issues
  - Facilities and stakeholders identified concerns with the current Victor route system within SCT airspace, specifically, that the existing routings limit throughput and conflict with high volume procedures.
  - The lack of flexibility inherent with legacy Victor airway design limits opportunities to take advantage of routings that could produce system benefits.
- Recommendations
  - As a result of specific requests through the outreach process, three T-Routes were designed by the OST.

[3] Canales, R., et al., September 2009, *Identification and Evaluation of Airspace Issues Affecting the Southern California and Denver Metropolitan Areas*, MTR090313, The MITRE Corporation, McLean, VA.

4.4.2.1 V186 T-Route

- Issues
  - BUR and VNY departure traffic was identified as conflicting with V186 traffic, causing excessive vectoring and level-offs.
- Recommendations
  - An RNAV T-Route was developed to deconflict V186 traffic from BUR and VNY departures as shown in Figure 65. The T-Route was moved south of present day V186 to allow for this segregation.
  - This T-Route is 2.6 NM longer than the present day V186 from FIM to PURMS. Efficiency and safety enhancements realized by development of this T-Route justify the longer route, as the BUR and VNY area has been identified as an area experiencing high levels of Traffic Collision and Avoidance System (TCAS) resolution advisories.

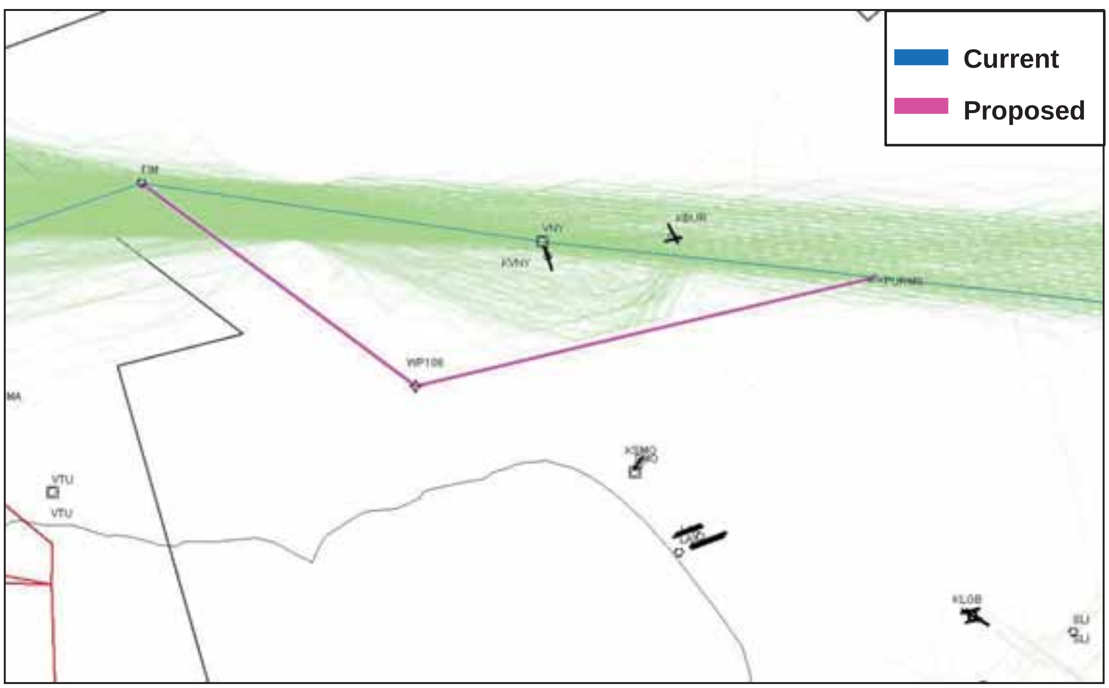


Figure 65. Current V186 and Proposed T-Route

4.4.2.2 V66 T-Route

- Issues
  - SAN arrival traffic was identified conflicting with V66 traffic, causing excessive vectoring and level-offs.
- Recommendations
  - An RNAV T-Route was developed to deconflict V66 traffic from SAN arrivals, as shown in Figure 66. The T-Route was moved north of present day V66 to allow for this segregation.
  - This T-Route is 3.3 NM longer than the present day V66 route from MZB to IPL. Efficiency and safety enhancements realized by deconflicting this traffic from SAN LYNDI arrival flows justify the longer route.

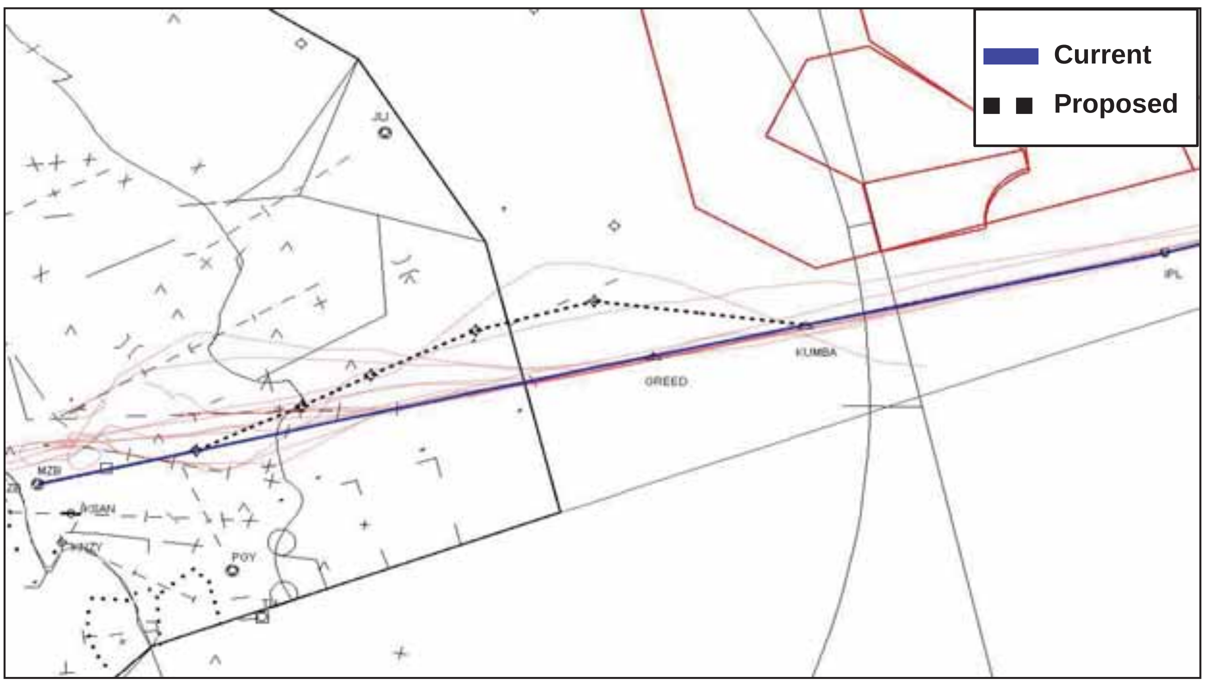


Figure 66. Current V66 and Proposed T-Route

4.4.2.3 Los Angeles Basin to LAS T-Route

- Issues
  - Stakeholders expressed a desire for an RNAV T-Route to the LAS area rather than the currently assigned V394/V363/V442 routings.
- Recommendations
  - An RNAV T-Route was developed from POXKU to APLES (see Figure 67). This T-Route may conflict with ONT and LAX flows, which will require further evaluation before final implementation.
  - The proposed T-Route compared to the V363 and V394 routing saves 3.6 NM. This route as compared to the V442 routing saves 3.2 NM. Standardized routing will increase efficiency and provide a reliable RNAV route out of the Southern California area to LAS.
  - The Southern California D&I team should validate that this proposed T-Route would not conflicted with routings associated with the LAS Optimization Project.

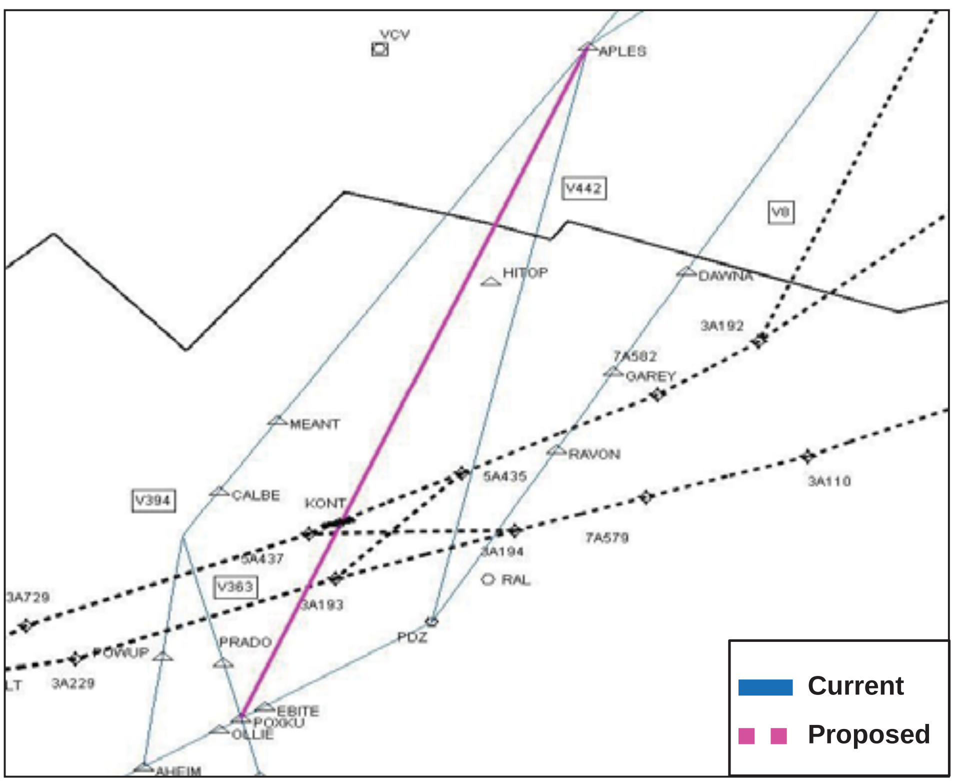


Figure 67. Current LAS Routing and Proposed T-Route

4.4.3 RNP Approaches

One issue that stakeholders identified was that at many Southern California airports, there are long downwinds and runway transitions that require extra flying miles and unnecessary fuel loading. To help address this issue, the OST developed conceptual RNP AR approaches to runways at these identified airports for stabilized and efficient approach operations.

The RNP AR approach transitions are connected to the proposed RNAV STARs where available to ensure maximum efficiency, both laterally and vertically.

During the D&I process, additional RNP AR approaches may be considered for other runways or airports.

Although there are indeed many benefits to be realized using RNP AR approaches (i.e., optimum profiles, cost to carry, efficient flight paths in IFR conditions etc.), quantifying these benefits is very difficult and the OST opted not to calculate benefits that were not supported by accepted data.

4.4.3.1 RNP Approaches into LAX

The OST designed an RNP approach that seamlessly connects to the SYMON and KEACH STARs, which both have an altitude restriction of 7,000 feet at SMO (see Figure 68).

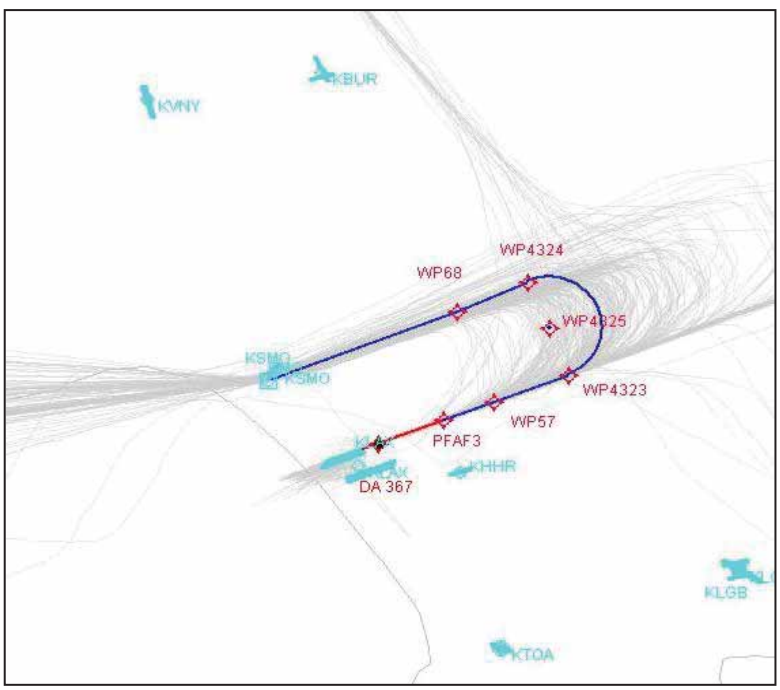


Figure 68. RNP AR Approach to Runway 24R at LAX

4.4.3.2 RNP Approaches into LGB

The OST designed an RNP Runway 30 approach with two approach transitions connecting to the QMARK and KEFFR STARs. Both approach transitions closely follow the historic flight paths into LGB (see Figure 69).

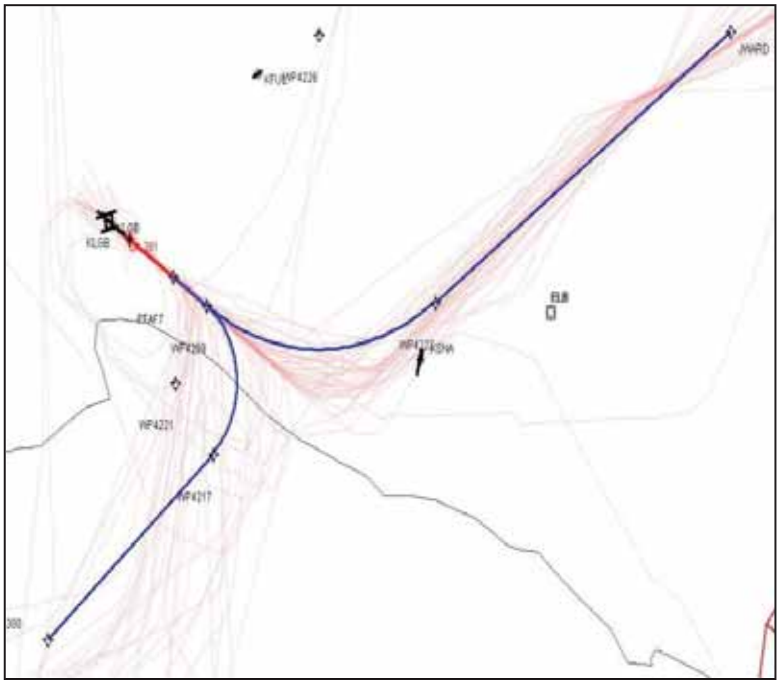


Figure 69. RNP AR Approach to Runway 30 at LGB

4.4.3.3 RNP Approaches into BUR

An RNP Runway 15 approach was designed with transitions connecting to the JANNY, CANYN, and PETIS STARs. Both approach transitions closely follow the historic flight paths into BUR (see Figure 70).

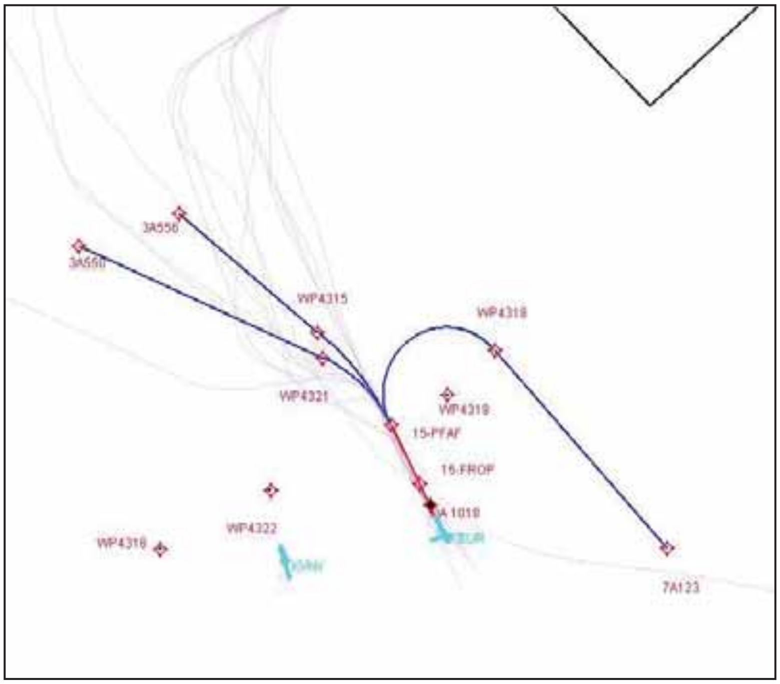


Figure 70. RNP AR Approach to Runway 15 at BUR

4.4.3.4 RNP Approaches into SAN

The OST designed an RNP Runway 27 approach with transitions connecting to the BAYVU and LYNDI STARs. Both approach transitions closely follow the historic flight paths into SAN (see Figure 71).

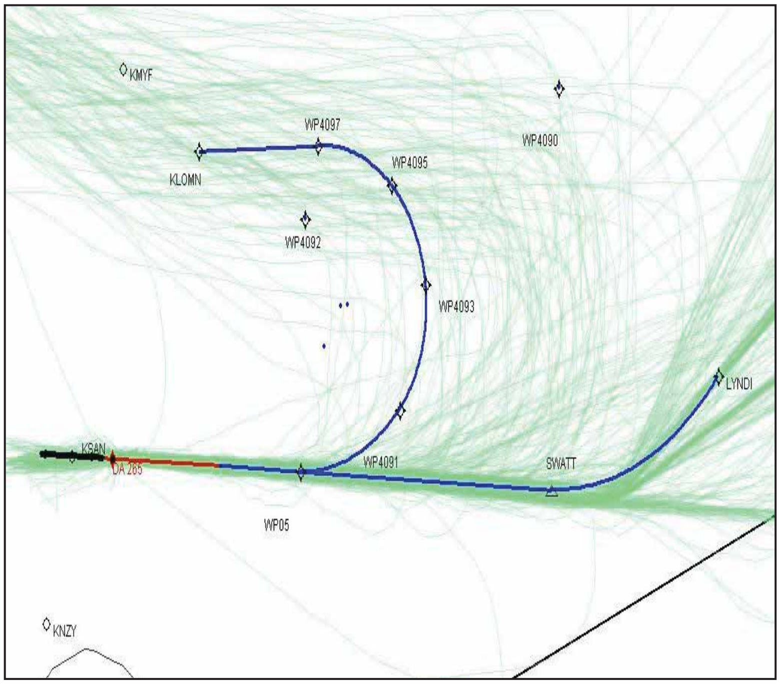


Figure 71. RNP AR Approach to Runway 27 at SAN

4.4.3.5 RNP Approaches into VNY

An RNP Runway 16R approach was designed with transitions connecting to the AALLL, JANNY, and the proposed East STARs. Both approach transitions closely follow the historic flight paths into VNY (see Figure 72).

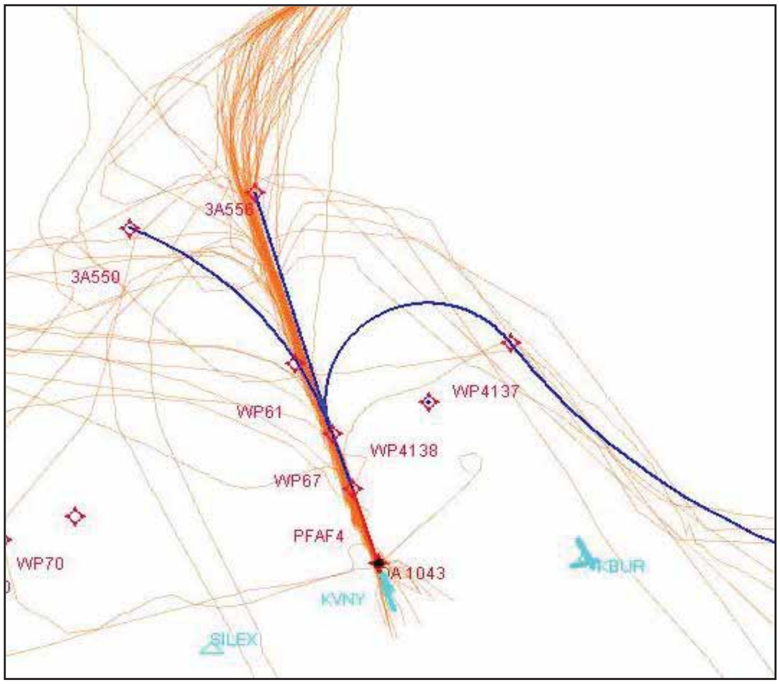


Figure 72. RNP AR Approach to Runway 16 at VNY

4.4.3.6 RNP Approaches into UDD

Stakeholders requested that the OST analyze the possibility of designing RNP approaches into UDD. The terrain surrounding UDD adds challenges to the ability to design RNPs from each direction.

The OST was able to design two RNPs using historic flight paths as a basis for the lateral tracks to Runways 10 and 28 (see Figure 73).

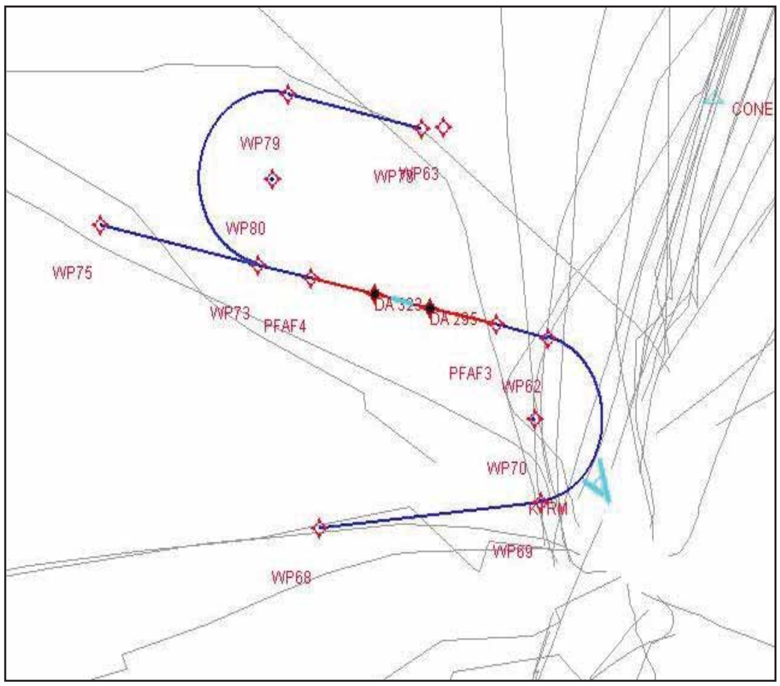


Figure 73. RNP AR Approach to Runways 10 and 28 at UDD

4.4.3.7 RNP Approaches into TRM

Stakeholders requested the OST to analyze the possibility of designing RNP approaches into TRM. The terrain surrounding TRM adds challenges to the ability to design RNPs from each direction.

The OST was able to design two RNPs using historic flight paths as a basis for the lateral tracks to Runways 17 and 35 (see Figure 74).

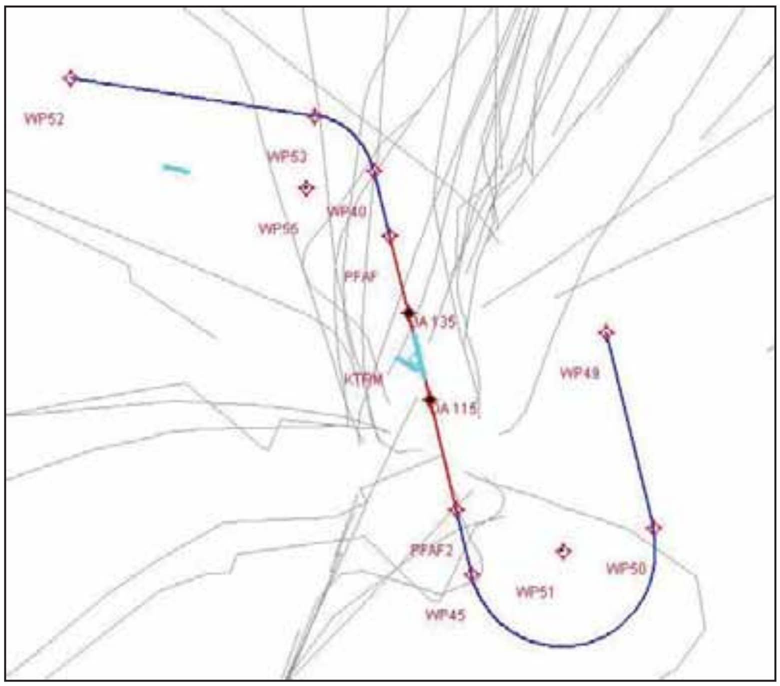


Figure 74. RNP AR Approach to Runways 17 and 35 at TRM

4.5 Southern California OAPM Issues Not Addressed or Requiring Additional Input

The Southern California OST identified and characterized a range of problems and developed a number of conceptual solutions; however, some issues require additional coordination and input and could not be addressed within the time constraints of the OST process. These issues may be explored further during the D&I process. Other issues were simply beyond the scope of OAPM, and should be considered outside this process.

4.5.1 Issues for Consideration during Design and Implementation

There were issues identified that are designated for further consideration during the D&I phase of the Southern California OAPM process. These issues were identified and recorded and are summarized below:

- Conventional procedures may require development at various airports throughout the Southern California Metroplex to accommodate those aircraft that are not RNAV/RNP equipped.
- Certain airspace sectors and facility boundaries may need to be modified to incorporate the new PBN procedures. A list of those sectors identified can be found in Appendix B at the end of this document.
- Additional east flow transitions need to be added to the LAX VTU SID.
- The SNA IRVINE SID is currently a conventional procedure with long level segments in the vicinity of SXC. A PBN procedure should be designed for more repeatable and predictable flight tracks, thereby reducing level-offs.
- The ANAHM SID is currently a conventional procedure with unused transitions and inefficient vertical and lateral paths. A PBN procedure should be designed for more repeatable and predictable flight tracks.
- The facilities have requested that the CASTA SID be used without the current time restrictions. The CASTA and LOOP SIDs are unused between the hours of 2100-0700 local. More in-depth analysis will be required to make an accurate decision on the possibility of extended use.
- Holding patterns need to be developed in the D&I process.
- The OST recommends replacing the proposed FIXIT with an RNAV VTU SID. Further analysis will be required during the final design portion of the project.
- The PSP STARs (SBONO/CLOWD) are not completely tied into the RNP approaches. An ending altitude is required, but will need to be determined when actual procedures are in the final design stages.
- More work is required in determining where to implement RNP approaches at satellite airports.
  - Notional RNP approaches have been developed for facility consideration and are included in the TARGETS package.
- More work is required in determining where new or improved T-Routes are needed in SCT's airspace.
  - Although the OST did make some T-Route proposals, these were specifically requested by facilities and stakeholders.

4.5.2 Issues Outside of the Scope of OAPM

Additional issues were identified that were beyond the scope of the Southern California OST and have been recorded for further consideration outside of the OAPM process. The out-of-scope issues identified and recorded are summarized below:

- RNAV visual approaches
  - RNAV visual approaches are generally created by an individual airline or group.
- PSP operations revert to ZLA overnight
  - Lack of radar coverage in the area makes this hard to achieve; however, with the implementation of Fusion the OST feels this could be considered in the future.
- Extended service volume (ESV) for ONT ILS
  - This is a conventional approach and steps to extend the ILS ESV lie with the Western Service Center.
- Reverse flows over GMN
  - Although it would be beneficial to reverse the arrival and departure flows over the GMN area, this project would involve four large facilities (SCT, ZLA, NCT, ZOA) requiring long term planning and extensive environmental work.
- Class B, Class C, TRSA
  - Airspace changes requiring rulemaking do not fit within the OAPM timeline.
- NTD airspace transfer
  - Facilitating this airspace transfer is outside of the OAPM scope.

4.5.3 Limits of Design Process

The limitations placed on proposed designs by criteria for PBN procedures were brought up as an issue by facilities, stakeholders, and OST team members. The primary issue encountered is that the criteria for PBN procedures are overly restrictive, particularly for high-performing aircraft in use throughout the NAS today.

One example of this criteria issue is the POGGI SID off SAN. The current POGGI cannot pass a criteria check without a speed restriction of 230 knots or less over JETTI and LOWMA. However, both facilities and stakeholders pointed out that this restriction is canceled by ATC for many, if not most, aircraft on the procedure, because it is unnecessary: aircraft can fly the procedure well without the restriction.

Changes in criteria are well beyond the scope of the OST and indeed the OAPM process altogether; however, these types of criteria issues limit the scope of the PBN solutions and likely guarantee some controller intervention on PBN procedures, thus negating some of the expected benefits of the PBN procedures.

5 Summary of Benefits

5.1 Qualitative Benefits

5.1.1 Near-Term Impacts

The benefits of the PBN procedures proposed by the OST include the following:

- Reduced phraseology, frequency congestion, and pilot workload:

  Reduced phraseology due to PBN will reduce the number of transmissions needed to accomplish required restrictions by combining multiple clearances into a single transmission. Prior studies have demonstrated transmission reductions on the order of 18% to 34% with 85% RNAV equipage,[4] and the OST believes it is reasonable to expect a similar level of savings. Reduced transmissions will translate into less frequency congestion which could potentially reduce "hear back/read back" errors. In addition, the consolidation of clearances associated with an RNAV procedure reduces pilot workload, which allows for more "heads-up" time and allows the crew to focus on high-workload situations.

- Repeatable, predictable flight paths and accurate fuel planning:

  The introduction of PBN ensures lateral flight path accuracy. The predictable flight paths help assure procedurally deconflicted traffic flows and allow airlines to more accurately plan for a consistent flight path. It also allows users to more accurately predict the amount of fuel required for a procedure.

- Enhanced lateral and vertical flight paths: Optimized climbs and descents and shorter lateral paths reduce the number and length of level-offs and total distance flown, thereby reducing fuel burn and carbon emissions. Altitude windows can vertically separate traffic flows and allow for industry-standard glide paths.

5.1.2 Long-Term Impacts to Industry

Implementation of these proposed procedures will have long-term effects for industry.

- Flight planning

  OAPM proposed procedures will result in reduced mileage and fuel burn in the long-term, particularly as more metroplexes are optimized. In the near-term, more direct paths that are not dependent on ground-based navigational aids, plus optimized flight profiles, will lead to reduced fuel burn only within an optimized metroplex. Reduced fuel loading will also allow for a reduction in cost to carry.

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4 Sprong, K., et al., June 2006, "Benefits Estimation of RNAV SIDs and STARs at Atlanta," F083-B06-020, (briefing), The MITRE Corporation, McLean, VA.

- Timetable

  Shortened, more efficient routes will necessitate timetable adjustments, particularly as more metroplexes are optimized. This will potentially benefit crew scheduling, connecting information, time on gates, ramp scheduling, etc.

5.2 Quantitative Benefits

The quantified benefits of the Southern California OST recommendations are broken down into annual fuel savings in dollars, annual fuel savings in gallons, and annual carbon emissions reductions in metric tons. The primary benefit drivers are reduced miles flown and improved vertical profiles. The Southern California OST found that current track data indicated aircraft were already flying efficient lateral paths, and therefore much of the benefits result from improved vertical profiles.

Table 32 breaks down the benefits for Southern California. These numbers were derived by comparing currently flown track miles, published procedure miles, and vertical profiles to proposed PBN procedure track miles and vertical profiles. First, it is fully expected that ATC will continue to offer shorter routings and remove climb restrictions, when feasible, further increasing operator benefits. The benefits analysis assumes aircraft will fly the specific lateral and vertical RNAV procedures.

Table 32. Total Annual Fuel Benefits Associated with Distance, Profile, and Filed Mile Changes

	Low	High
Estimated Annual Fuel Savings: SIDs and STARs (Dollars)	$9.94M	$22.68M
Estimated Annual Fuel Savings: SIDs and STARs (Gallons)	3.36M	7.72M
Estimated Annual Carbon Savings: SIDs and STARs (Metric Tons)	34K	77K

Table 33 breaks down the benefits for the RIIVR and SEAVU associated with creating LAX dual independent arrivals.

Table 33. Total Annual ADOC Benefits for Proposed RIIVR and SEAVU STARs

Estimated Annual ADOC Savings: LAX Dual Independent Finals	$3.99M

Table 34 breaks down the benefits of proposed procedures developed to mitigate the delays associated with the operational interactions between LAX and SMO airports.

Table 34. Total Annual Fuel Benefits Associated with LAX and SMO Interactions

Estimated Annual Fuel Savings: SMO / LAX Interactions	$200K	$260K

Table 35 breaks down the comprehensive benefits of all modeling done for the Southern California Metroplex.

Table 35. Total Annual Benefits

Estimated Annual Savings: TOTAL	*$14.13M*	*$26.93M*

Appendix A Acronyms

Acronyms	
AAR	Airport Arrival Rate
ADOC	Aircraft Direct Operating Cost
AR	Authorization Required
ARTCC	Air Route Traffic Control Center
ASPM	Airport Specific Performance Metrics
ATALAB	Air Traffic Airspace Lab
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
BADA	Base of Aircraft Data
CAASD	Center for Advanced Aviation System Development
CATEX	Categorical Exclusion
CTC	Cost to Carry
CY	Calendar Year
D&I	Design and Implementation
DEP	Depart
EA	Environmental Assessment
EIS	Environmental Impact Statement
EQ	Equipment/Frequency Fail
ETMS	Enhanced Traffic Management System
EUROCONTROL	European Organization for the Safety of Air Navigation
FAA	Federal Aviation Administration
IAP	Instrument Approach Procedure
IAS	Indicated Air Speed
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
iTRAEC	Integrated Terminal Research, Analysis, and Evaluation Capabilities
L/R	Left/Right
LOA	Letter of Agreement
MIT	Miles-in-Trail
MSL	Mean Sea Level
NAS	National Airspace System
NAT	National Analysis Team
NAVAID	Navigational Aid

Acronyms	
NM	Nautical Mile/s
NOP	National Offload Program
NTML	National Traffic Management Log
OAPM	Optimization of Airspace and Procedure in the Metroplex
OPD	Optimized Profile Descent
OST	OAPM Study Team
PBN	Performance Based Navigation
PDARS	Performance Data Analysis and Reporting System
PRM	Precision Radar Monitor
RITA	Research and Innovative Technology Administration
RNAV	Area Navigation
RNP	Required Navigation Performance
ROM	Rough Order of Magnitude
RTCA	Radio Technical Commission for Aeronautics
SCT	Southern California TRACON
SEC	Specialized Expertise Cadre
SID	Standard Instrument Departure
SOP	Standard Operating Procedure
SRM	Safety Risk Management
STAR	Standard Terminal Arrival Route
SWAP	Severe Weather Avoidance Program
TAAM	Total Airport and Airspace Model
TARGETS	Terminal Area Route Generation Evaluation and Traffic Simulation
TCAS	Traffic Collision and Avoidance System
TMA	Traffic Management Advisor
TMI	Traffic Management Initiatives
TRACON	Terminal Radar Approach Control
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnidirectional Range
WX	Weather
ZLA	Los Angeles Air Route Traffic Control Center

Appendix B Sectors Needing Evaluation

Airport	Procedure	SCT Sectors Needing Evaluation	ZLA Sectors Needing Evaluation
LAX	KARVR	MANHATTAN, NEWPORT	12, 21, 23
LGB	NELLY	DEL REY area	4, 18
LGB	SENIC	*N/A*	12, 21, 22
SNA	CHANL	DEL REY area	18, 21, 22
BUR	VNY9	BURBANK area	*N/A*
ONT	POM	ONTARIO area	*N/A*
ONT	PRADO	HEMET	12, 18
LAX	RIIVR	*N/A*	37, 39
LAX	SEAVU	*N/A*	37, 39
LAX	KEACH	ZUMA	*N/A*
LAX	BUFIE	COAST area	21, 22
LAX	MOOR	ZUMA	*N/A*
SAN	BAYVU	*N/A*	27, 30
SNA/LGB	QMARK	*N/A*	13, 14
BUR/VNY	JANNY	*N/A*	E10
BUR	CANYN	BURBANK area, PT. MUGU	13, 14
VNY	AALLL	BURBANK area, PT. MUGU	13, 14

Appendix C PBN Toolbox

Sample PBN Toolbox Options
Adding an arrival route
Adding a departure route
Extend departure routes
Build in procedural separation between routes
Reduce route conflicts between airports
Changing airspace to accommodate a new runway
Adding a parallel arrival route (to a new runway)
Splitting a departure fix that serves more than one jet airway
Increased use of 3 NM separation
Increased use of terminal separation rules
Static realignment or reassignment of airspace
Adaptive realignment or reassignment of airspace
Improving sector boundaries (sector split, boundary move, new area of specialization)
Shifting aircraft routing (Avoiding re-routes, shorter routes)
Eliminating altitude restrictions
More efficient holding (design, usage and management)
Adding surveillance coverage
Adding en route access points or other waypoint changes (NRS)
Adding en route routes
Reduce restrictions due to Special Use Airspace
TMA initiatives

Southern California Association of Governments

Regional General Aviation Demand Forecast

Regional General Aviation Forecast

PHASE 1 TECHNICAL REPORT

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Disclaimer

1. Introduction

This report documents the results of the first phase of a two-phase study for the Southern California Association of Governments (SCAG) to prepare a regional general aviation demand forecast for the six-county Southern California region. The report reviews recent trends in the size and composition of the Southern California pilot community, the numbers of general aviation aircraft based in the region, and the numbers of general aviation and other aircraft operations at airports in the region, as well as prior studies that have examined changes in the size and composition of the pilot community and general aviation aircraft fleet. The report also reviews prior studies that have addressed techniques for forecasting future general aviation activity and presents the forecasting approach that has been used in the current study, as well as recent forecasts of general aviation activity by the Federal Aviation Administration. This is followed by a discussion of the analysis of likely future changes in the size and composition of the Southern California pilot community and the implications for future levels of general aviation activity, as well as changes in the general aviation fleet based at airports in the region. The report then describes the development of a set of alternative regional general aviation demand forecasts that take these factors into consideration and provide a range of potential future changes in the size of the Southern California pilot community, based aircraft fleet, and resulting levels of general aviation activity. Finally the report summarizes the conclusions from the current phase of the project and discusses the work to be undertaken in the remainder of the study.

The Southern California Airport System

The airport system serving the six counties of the Southern California region currently comprises 44 public use general aviation airports, nine air carrier airports, one of which is a joint use military airfield, and two airports that currently serve or recently served regional airline flights, often referred to as commuter airports, all of which accommodate general aviation operations. In addition there is one military airfield, Palmdale Regional Airport/U.S. Air Force Plant 42 that formerly allowed joint-use civilian operations and currently allows general aviation operations with prior permission, and a number of smaller private-use airports. Several of the smaller public-use airports are privately owned. One of these airports, Roy Williams Airport in the town of Joshua Tree recently closed and is currently for sale. Another airport, Rialto

Municipal Airport, is planned to be closed at some point in the future but is currently open. The 54 airports currently open for public-use general aviation activity represent the largest general aviation airport system of any metropolitan region in the United States (and in fact the world), both in terms of airports and the number of general aviation aircraft operations.

The locations of the airports that comprise the Southern California public-use airport system are shown in Figure 1-1, with the definition of the airport identifier codes for each airport assigned by the Federal Aviation Administration shown in the map given in Table 1-1. The airports have been classified into four categories based on the size of the largest aircraft that they can typically accommodate. Of the nine air carrier airports and Palmdale Regional Airport, all of which have runway facilities that can accommodate large commercial aircraft, six currently have scheduled airline service:

- Bob Hope Airport, Burbank (BUR)
- John Wayne Orange County Airport (SNA)
- Long Beach Airport (LGB)
- Los Angeles International Airport (LAX)
- Ontario International Airport (ONT)
- Palm Spring International Airport (PSP)

Of the other three airports capable of handling air carrier activity, San Bernardino International Airport (SBD), and Southern California Logistics Airport (VCV) currently handle a small amount of nonscheduled air cargo flights, as well as some general aviation activity. March Inland Port operates under a joint use agreement with March Air Reserve Base (RIV) and currently has no based general aviation aircraft apart from aircraft belonging to the March Field Aero Club and aircraft kept at the March Field Air Museum, located on the airfield. Other general aviation use of the airfield requires prior permission. The integrated air express operator DHL formerly maintained a sorting hub at the airport and generated a moderate volume of air cargo aircraft operations.

Of the two commuter airports, Imperial County Airport currently has regional airline service by United Express between the airport and LAX. Oxnard Airport also had service to LAX by United Express until June of 2010, when the service was discontinued. The airport currently only serves general aviation activity although the County of Ventura, which owns the airport, is hoping to attract regional airline service in the future.

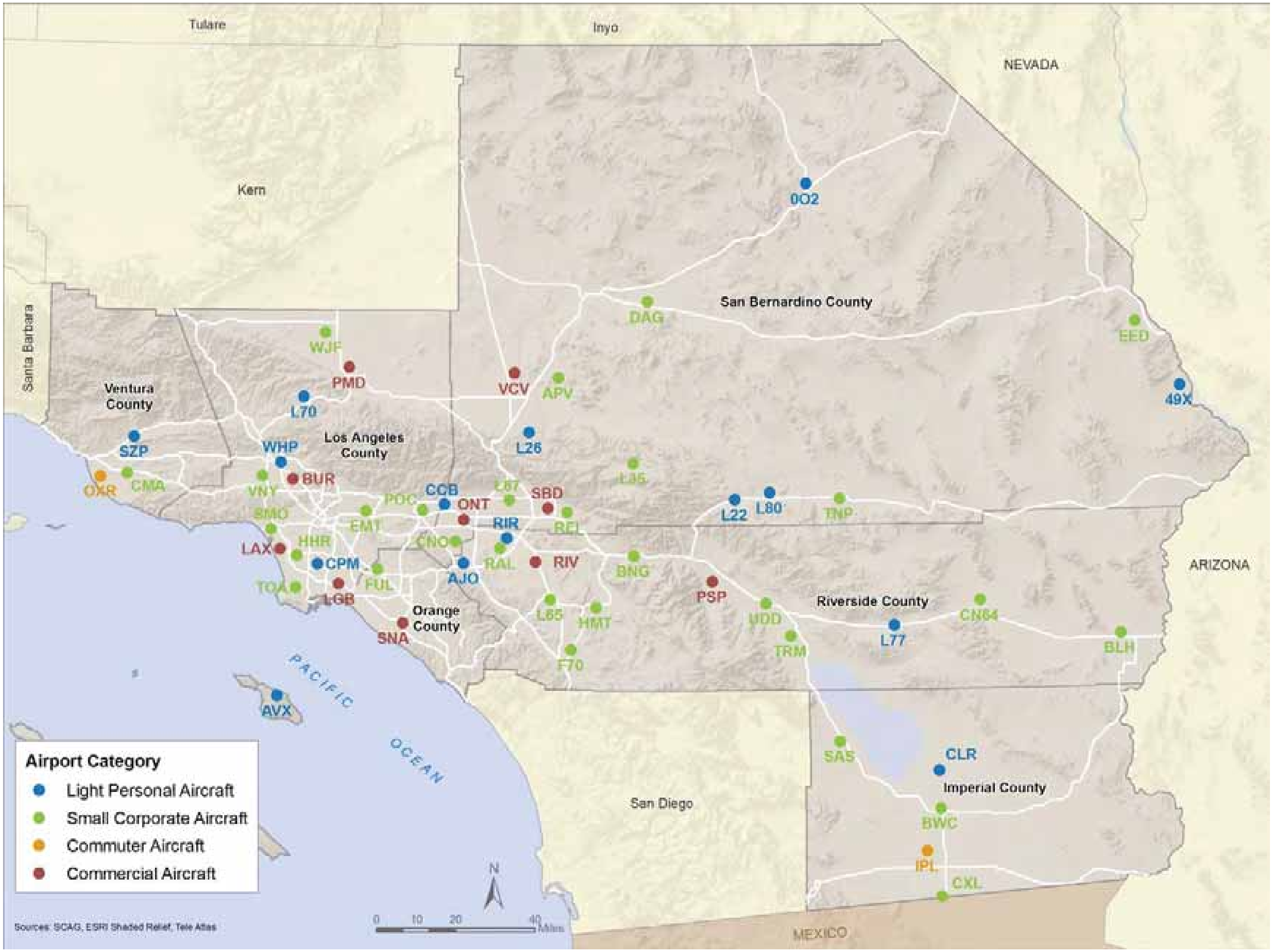


Figure 1-1. Southern California Airport System

Table 1-1. Airport Identifier Codes

Identifier	Airport	Identifier	Airport
0O2	Baker Airport	L70	Agua Dulce Airpark
49X	Chemehuevi Valley Airport	L77	Chiriaco Summit Airport
AJO	Corona Municipal Airport	L80	Roy Williams Airport, Joshua Tree
APV	Apple Valley Airport	LAX	Los Angeles International Airport
AVX	Catalina Airport	LGB	Long Beach Airport
BLH	Blythe Airport	ONT	Ontario International Airport
BNG	Banning Municipal Airport	OXR	Oxnard Airport
BUR	Bob Hope Airport, Burbank	POC	Brackett Field, La Verne
BWC	Brawley Municipal Airport	PMD	Palmdale Regional Airport
CCB	Cable Airport	PSP	Palm Springs International Airport
CLR	Cliff Hatfield Memorial Airport, Calipatria	RAL	Riverside Municipal Airport
CLX	Calexico International Airport	REI	Redlands Municipal Airport
CMA	Camarillo Airport	RIR	FlaBob Airport, Riverside
CN64	Desert Center Airport, Palm Desert	RIV	March Air Reserve Base (March Inland Port)
CNO	Chino Airport	SAS	Salton Sea Airport
CPM	Compton/Woodley Airport	SBD	Sam Bernardino International Airport
DAG	Barstow-Daggett Airport	SMO	Santa Monica Airport
EED	Needles Airport	SNA	John Wayne Orange County Airport
EMT	El Monte Airport	SZP	Santa Paula Airport
F70	French Valley Airport	TNP	Twenty Nine Palms Airport
FUL	Fullerton Municipal Airport	TOA	Zamperini Field, Torrance
HHR	Hawthorne Municipal Airport	TRM	Jacqueline Cochran Regional Airport, Thermal
HMT	Hemet-Ryan Airport	UDD	Bermuda Dunes Airport
IPL	Imperial County Airport	VCV	Southern California Logistics Airport, Victorville
L22	Yucca Valley Airport	VNY	Van Nuys Airport
L26	Hesperia Airport	WHP	Whiteman Airport, Pacoima
L35	Big Bear City Airport	WJF	General William J. Fox Airfield, Lancaster
L65	Perris Valley Airport		
L67	Rialto Municipal Airport		

Composition of General Aviation Activity

General aviation (GA) flight activity comprises a wide range of different types of flying including:

- Flight training
- Personal and recreational flying
- Business and corporate flying
- On-demand charter flying
- Aerial work, including observation, firefighting, agricultural spraying and other purposes

Historically, flight training has accounted for a large proportion of the aircraft operations at smaller airports due to the large number of takeoffs and landings involved in learning to fly. However, with the recent decline in the number of active student pilots, this segment of general aviation activity has become a smaller proportion of overall activity. At the same time, the introduction of new business models for corporate and business aviation, including fractional ownership and purchase of blocks of flight time from on-demand air charter operators such as Netjets, as well as the availability of smaller, less expensive jet aircraft, has resulted in business and corporate flying becoming a growing share of general aviation activity.

For the purposes of the regional general aviation demand forecast, the general aviation sector is considered to also include on-demand flight activity operated under Federal Aviation Regulations (FAR) Part 135, commonly referred to as air taxi operations, since these operations also use general aviation airports and for many purposes are often virtually indistinguishable from true general aviation operations, operating under FAR Part 91. The difference between the two types of operations is whether the operations are being performed “for hire.” Thus if a corporation owns its own aircraft and employs the pilots, the aircraft would operate under Part 91, whereas if it charters an aircraft from an air taxi charter company, the aircraft would operate under Part 135. The introduction of fractional ownership has complicated this situation, but for statistical purposes the Federal Aviation Administration (FAA) counts such operations as part of general aviation. Unless indicated otherwise, the term “general aviation” in this working paper includes Part 135 operations.

Data on the range of activities that fall within the general aviation sector is available from the most recent FAA General Aviation and Part 135 Activity Survey, which covers operations in the United States in 2009, as shown in Table 1-2. This survey classifies GA and Part 135 activity into 14 different purposes, which clearly show the wide range of activities covered by the GA sector.

Table 1-2. General Aviation and Part 135 Activity – United States 2009

Category of Aircraft Use	Primary Use Active Aircraft	Actual Use Hours Flown (000)	Actual Use Percent	Avg Hours Flown (see note)
General Aviation				
Personal	152,272	8,540	35.9%	56.1
Business	22,445	2,532	10.7%	112.8
Corporate	10,498	2,444	10.3%	232.8
Instructional	14,130	3,440	14.5%	243.4
Aerial application	3,161	960	4.0%	303.9
Aerial observation	5,288	1,211	5.1%	229.0
Aerial other	849	162	0.7%	190.7
External load	157	88	0.4%	562.3
Other work	1,177	222	0.9%	188.5
Sightseeing	849	119	0.5%	139.8
Air medical	486	174	0.7%	358.0
Other	4,005	970	4.1%	242.3
Total GA	**215,317**	**20,862**	**87.8%**	**96.9**
On Demand FAR Part 135				
Air taxi	6,992	2,198	9.2%	314.3
Air tours	367	223	0.9%	608.2
Air medical	1,200	480	2.0%	399.6
Total Part 135	**8,559**	**2,901**	**12.2%**	**338.9**
Total GA & Part 135	**223,876**	**23,763**	**100.0%**	**106.1**

Source: FAA, *General Aviation and Part 135 Activity Survey – Calendar Year 2009*, Washington, DC, April 2011.

Note: Assumes all actual hours flown are by aircraft for which the purpose is the primary use. In reality many aircraft are used for multiple purposes.

The full definitions of each of the activity purposes shown in Table 1-2 are given in Appendix A.

The largest single type of activity is personal flying, which accounts for about 36% of all flight hours, followed by instructional activities, which account for about 15% of all flight hours. Operations under Part 135 account for about 12% of all flight hours, of which the largest proportion is air taxi operations, with air medical flights under Part 135 accounting for about 2% of all flight hours. Business and corporate flying under Part 91 together account for about 21% of all flight hours, divided approximately equally between the two purposes, which the FAA defines as follows:

- **Business Transportation:** Individual or group use for, or in the furtherance of, a business *without* a paid flight crew
- **Corporate/Executive Transportation:** Individual or group business transportation *with* a paid flight crew (includes fractional ownership)

Table 1-2 also shows the average number of hours flown per year by aircraft used for the different purposes. Because a given aircraft may be used for multiple purposes, this average may be somewhat misleading and is not strictly the average flight hours for aircraft primarily used for each purpose, but assumes that the flight hours for each purpose are all flown by the aircraft for which that purpose is the primary use. However, to the extent that many aircraft are in fact used mainly for a single purpose, this gives an indication of the differences in average use across the different purposes. Aircraft primarily used for personal flying have the lowest average utilization of 56 flight hours per year, while aircraft used primarily for air tours have the highest average utilization of about 608 flight hours per year, although this may be somewhat overstated since there are relatively few aircraft used primarily for air tours and many of the actual flight hours reported for air tours are likely performed by aircraft used primarily for other purposes. In general, aircraft used primarily for Part 135 operations are utilized for about 339 flight hours per year on average.

Aircraft used primarily for instructional flying have an average utilization of about 243 flight hours per year, while those used primarily for corporate transportation have an average utilization of about 233 flight hours per year. It may be worth noting that these utilization rates are considerably less than one hour per day. Clearly there is a wide range of utilization rates across the fleet, since many aircraft in these categories are far more heavily used than this. Aircraft primarily used for business transportation have an average utilization of only 113 flight hours per year although this may be somewhat understated since this category involves flying without a paid crew. In most cases this means flight operations by the owner of the aircraft, who most likely also uses the aircraft for personal flying. Thus the average utilization of aircraft used primarily for personal flying is probably overstated, since some of the actual flight hours for personal flying are performed in aircraft used primarily for business flying. Of course, the reverse is also true, with some business flying being performed in aircraft used primarily for personal flying. Whether these effects cancel each other out is unclear.

In any case, an average utilization of only 56 flight hours per year represents about one flight hour per week. As with business flying, there is clearly a wide range of utilization rates across the fleet, with some aircraft being used very infrequently.

While these are national average utilization rates, it is likely that the pattern of aircraft utilization in the Southern California region is not significantly different. As part of the current study an effort will be undertaken to obtain more specific data from the FAA covering aircraft in the Southern California region to see how their utilization may differ from that for the United States in total.

Recent Trends in the Southern California Pilot Community

In addition to the composition and utilization of the general aviation aircraft fleet, the other major factor that needs to be considered in developing forecasts of future aviation activity is the size and composition of the pilot community. Table 1-3 shows the recent trend in the number of active pilots in the six-county SCAG region by type of pilot certificate, from airmen registration data obtained from the FAA. The distinctions between the various types of pilot certificate are discussed further below, but the names of the different types of certificate are generally self-explanatory.

Active pilots are defined as airmen holding a pilot certificate and a valid medical certificate where required (student pilots only require a medical certificate for solo flight, glider and balloon pilots do not require a medical certificate, and sport pilots do not require a medical certificate if they hold a valid driver's license). It can be seen from Table 1-3 that there has been a slow decline in the total number of active pilots in the region over the past nine years, although an apparent increase in the number of student pilots, particularly since 2006 (however this appears to be an artifact of changes to the validity of student pilot certificates in July 2008) . The implications of this for the future pilot community in the region are discussed further below.

Table 1-3. Recent Trend in the Southern California Pilot Community

	Active Pilots as of December 31		
Type of Pilot Certificate	2001	2006	2010
Student pilot	3,642	4,106	5,093
Private pilot	11,272	11,050	9,970
Commercial pilot	4,906	5,254	5,119
Airline transport pilot	4,926	4,604	4,439
Recreational or sport pilot	1	12	70
Rotorcraft or glider	1,263		
Total	**26,010**	**25,026**	**24,691**

Source: FAA, *Active Airmen Certificate Totals by Region, State, County*, Airmen Certification Branch, Oklahoma City, OK, Personal communication.

Notes: 1. Active airmen holding rotorcraft or glider certificates only were counted separately in 2001, but included in the other categories for 2006 and 2010.

2. The validity of student pilot certificates for pilots under 40 years of age was changed from 36 months to 60 months on July 1, 2010.

The distribution of the active pilots among the six counties in the region is shown in Table 1-4.

Table 1-4. Recent Trend in the Southern California Pilot Community by County

	Active Pilots as of December 31		
County	2001	2006	2010
Imperial County	258	197	183
Los Angeles County	11,584	10,842	10,878
Orange County	5,981	5,495	5,303
Riverside County	3,011	3,458	3,447
San Bernardino County	2,788	2,744	2,632
Ventura County	2,388	2,290	2,248
Total	**26,010**	**25,026**	**24,691**

Source: FAA, *Active Airmen Certificate Totals by Region, State, County*, Airmen Certification Branch, Oklahoma City, OK, Personal communication.

It can be seen that Los Angeles County accounts for a little less than half the active pilots in the region (44% in 2010), with Orange County having the second highest proportion (22% in

2010). Riverside County has the third highest proportion (14% in 2010), followed by San Bernardino County (11% in 2010) and Ventura County (9% in 2010). The number of active pilots has declined from 2001 to 2010 in all counties except Riverside County, where it increased from 2001 to 2006, but declined slightly from 2006 to 2010. Los Angeles County showed a slight increase in active pilots from 2006 to 2010.

Key Issues and Concerns

The future level of general aviation activity in the Southern California region will depend on a large number of factors that cannot be known with any certainty, and the further into the future the activity is being forecast the less certain these factors are likely to become. The more critical factors include:

- The price and availability of aviation fuel, particularly how much longer leaded aviation gasoline (avgas) will be available.
- Future trends in the percentage of the population that decide to learn to fly, the proportion of student pilots that complete their flight training and obtain a private pilot certificate, how long they remain an active pilot, and how much flying they do while they are still active.
- The future demand for professional pilots, particularly airline pilots, since this has a major influence on how many people decide to pursue flying as a career.
- The long-term prospects for economic growth in the light of rising Federal and State deficits, a major trade imbalance, rising energy costs and the eventual need to address global warming, an aging population, and increasing costs of health care, since this affects corporate profits and individual disposable income, both of which will influence aircraft ownership and use, as well as how many people can afford to learn to fly or remain active.
- Persistent concerns and opposition by some surrounding communities to GA activities at local airports. These concerns arise primarily from aircraft noise, particularly from jet aircraft, a perceived health risk from aircraft emissions and aviation fuel, and the risk of accidents from aircraft over-flights. Some local municipalities have placed or attempted to place restrictions on flight

operations and have also requested risk assessment studies to determine ways to address these issues. The future demand for general aviation activity in the region and particularly how it is distributed among the airports in the region could be influenced by these concerns, to the extent that they affect the type and level of operations that can occur at various airports, or result in airports being closed.

- The airspace utilization in Southern California is also a consideration in the light of the conflict that sometimes exists between commercial and GA operations in parts of the SCAG region. The introduction of the FAA's Next Generation air traffic control system may also have an impact on how air traffic operates at many GA airports. The extent to which these factors could influence future general aviation demand in the region will require discussion with the FAA and SCAG staff to identify the constraints and opportunities for greater flexibility in the new air traffic control system.

While some insight into these issues may be obtained from an analysis of recent trends in general aviation activity, it is far from clear whether general aviation activity will recover from its recent decline as the economy continues to recover and if so, at what rate. Although it is likely that business and corporate flying will resume their growth as the economy recovers, changing recreational preferences and shifts in the distribution of household incomes could limit the number of people who decide to take up flying. This effect may be compounded by public concerns about global warming and the perception that general aviation flying consumes a large amount of fuel in relation to the distance flown. This may translate into a reduced number of people deciding to take up flying, as well as political pressure to limit the amount of general aviation flying or require general aviation users to purchase carbon offsets.

Structure of this Report

The remainder of this report consists of six chapters. The following chapter reviews the literature on forecasting general aviation activity and presents the forecast methodology adopted for the current study. Chapter 3 describes the most recent forecasts of general aviation activity at both the national and airport level developed by the FAA and presents a regional forecast of GA activity in Southern California developed from those forecasts, as well as reviews recent trends in based aircraft and aircraft operations by GA and other components of flight activity in the Southern California region. The following chapter reviews previous studies of the composition of the U.S. pilot community, presents findings from a survey of California pilots and aircraft owners that was conducted as part of the current study, and describes the pilot cohort analysis that forms the core of the planned forecast approach. Chapter 5 then discusses the development of the alternative forecasts of active pilots for the Southern California region using the planned approach and associated levels of general aviation activity. The following chapter describes the corresponding forecasts of based aircraft developed in this phase of the study and resulting implications for future levels of aircraft operations. Finally, Chapter 7 presents the conclusions from the findings of current phase of the project and discusses the work to be undertaken in the remainder of the study.

2. Forecast Methodology

This planned forecast methodology to be used in preparing the Regional General Aviation Demand Forecast for the Southern California region is based on the recognition that the general aviation sector comprises a range of different activities that are each influenced by different factors. Therefore, the development of the forecasts will be based on a detailed understanding and analysis of the way in which these factors determine the growth (or decline) of each type of activity, as well as the interrelationships between them.

Literature Review on Forecasting General Aviation Activity

In spite of the large number of general aviation airports in the United States and the recurring need to prepare forecasts of future general aviation activity as part of studies to update airport master plans, prepare statewide and regional airport system plans, and for other purposes, development of improved techniques for forecasting general aviation activity have received surprisingly little attention in the airport planning literature. None the less, a review of relevant recent literature was undertaken to identify prior studies addressing changes in the composition and activity levels of the pilot community and dynamics of the general aviation fleet, as well as forecasting approaches for general aviation activity more generally.

One of the earliest reviews of forecasting methodology for general aviation was undertaken by Gosling & Cao (1994) as part of a larger study of aviation forecasting techniques performed for the California Department of Transportation. A more recent report prepared for the FAA Office of Aviation Policy and Plans (GRA, 2001a) presented a summary of different methods for forecasting aviation activity by airport, including general aviation activity. However, the descriptions of the techniques are very general and some of the techniques are fairly simplistic (although widely used). The report mentions cohort analysis, although the term is used in a different sense from that used in the planned forecast approach described in this working paper, and a better term would have been market segmentation analysis. The following year a Transportation Research E-Circular (TRB, 2002) presented a survey of aviation demand forecasting methodologies, including those for general aviation. This included a description of a model for estimating general aviation operations at non-towered airports, discussed further below, and forecasting techniques for business jet and rotorcraft deliveries and fleet size. Although these techniques involve assessments of the demand for business jet or rotorcraft flying, the approaches to these assessments are only described in very broad terms due to the proprietary nature of the analysis. The description of one approach mentioned that a given year's production of business jets is generally fully retired from the aircraft fleet in about 40 years, with about 50% of the year's production retired from the fleet in about 33 years.

A subsequent synthesis report prepared for the Airport Cooperative Research Program (Spitz & Golaszewski, 2007) updated the information in the earlier report for the FAA Office of Aviation Policy and Plans, although the description of airport activity forecasting methods is no more detailed and does not explicitly address general aviation activity apart from a reference to the earlier study that developed a model for estimating general aviation operations at non-towered airports.

General Industry Trends

The FAA and various industry organizations supporting general aviation produce annual statistical reports that examine changes in the general aviation sector over time. The FAA produces an annual summary of U.S. civil airmen statistics and an annual activity survey of general aviation and Part 135 (on-demand commercial operations) aircraft, as well as forecasts of future levels of pilot population and general aviation activity, which include time series data for past years. These FAA data are discussed in more detail in the section on Data Requirements and Sources below.

Summaries of industry trends are published by the Aircraft Owners and Pilots Association (AOPA, 2011), the General Aviation Manufacturers Association (GAMA, 2011), and the National Business Aviation Association (NBAA, 2011). While much of the data presented in these statistical reports is derived from FAA sources, it is typically presented in a more user-friendly format and combines the information from multiple sources into a single document. The GAMA *General Aviation Statistical Databook & Industry Outlook* provides data on general aviation shipments that is not available from other sources, while the NBAA *Business Aviation Fact Book* presents information on uses of business aircraft that is derived from surveys performed by the NBAA.

Pilot Population and Aircraft Fleet Composition

A number of studies have examined changes in the characteristics of the pilot population over time, although these have most commonly addressed the influence of pilot characteristics on accident risk (e.g. Li, Baker, *et al.*, 2003; Rebok, Qiang, *et al.*, 2009). A study in the early 1970s (Booze, 1972) examined pilot attrition by age and a more recent study (Rogers, Véronneau, *et al.*, 2009) examined changes in the pilot population over time from 1983 to 2005 in order to examine the effect of changes in the regulations that raised the age limit for pilots to perform the duties of pilot or co-pilot of a commercial passenger or cargo aircraft with ten or more passenger seats or 7,500 payload-pounds of cargo capacity from age 60 to 65. The latter study showed that the average age of pilots has been steadily increasing, and with it the average number of flight hours experience.

A study in the mid-1970s (Rocks, 1976) examined the pattern of attrition of the general aviation aircraft fleet, but this issue does not appear to have been subject to more recent study, apart from analysis undertaken for the 1994 San Francisco Bay Area Regional Airport System Plan (MTC, 1994), discussed further below.

General Aviation Forecasting Studies

A study performed for the FAA and published in 2001 developed a model for estimating general aviation operations at non-towered airports (i.e. those without a control tower) (GRA, 2001b). However, because the model is based on data from a combination of towered and non-towered airports, it is equally applicable to smaller towered GA airports. The study assessed a number of alternative model formulations, but found that the best fit to the observed data was given by the following relationship:

$$\begin{aligned}\text{OPS} = {} & -571 + 355 * \text{BA} - 0.46 * \text{BA}^2 - 40{,}510 * \%\text{in100mi} + 3{,}795 * \text{VITFSnum} \\ & + 0.001 * \text{Pop100} - 8{,}587 * \text{WACAORAK} + 24{,}102 * \text{Pop25/100} \\ & + 13{,}674 * \text{TOWDUM}\end{aligned}$$

where

where	OPS	=	Annual general aviation operations
	BA	=	Based aircraft
	%in100mi	=	Airport's percentage of all based aircraft within 100 miles
	VITFSnum	=	Number of Part 141 certificated flight schools at airport
	Pop100	=	Population within 100 miles of airport
	WACAORAK	=	Airport in CA, OR, WA, AK (1 = yes, 0 = no)
	Pop25/100	=	Ratio of population within 25 miles of airport to population within 100 miles
	TOWDUM	=	Control tower at airport (1 = yes, 0 = no)

The estimated model coefficients show that a towered airport would have more GA operations that a non-towered airport, other things being equal, as expected (although the causality may flow the other way, in that busier airports are more likely to have towers than less busy airports). Since the number of based aircraft is included in the model, the population in the surrounding area presumably accounts primarily for operations by visiting aircraft. Even so, there is likely to be a high degree of correlation between population of the surrounding area and the number of based aircraft. The model does not explicitly distinguish between local and itinerant operations, although the number of flight schools at the airport will clearly influence the number of local operations.

As part of a study for the National Aeronautics and Space Administration to explore the potential demand for a conceptual Small Aircraft Transportation System (SATS) based on advanced technology general aviation aircraft, researchers at Virginia Tech university developed a sophisticated modeling system termed the Transportation Systems Analysis Model (TSAM) (Trani, Baik, *et al.*, 2003; Baik, Ashiabor & Trani, 2006; Ashiabor, Baik & Trani, 2007; Baik, Trani, *et al.*, 2008). This modeling system predicts passenger flows between counties in the U.S. and then performs a mode choice analysis that assigns the passenger flows to commercial airlines, air taxi, or automobile travel. Because the modeling system does not distinguish between true air taxi and general aviation more broadly, the model can be considered as predicting passenger flows by general aviation. Indeed the authors refer to this mode as general aviation in some of their papers. The modeling system includes an airport choice model that assigns the GA passenger trips to airports and estimates the resulting number of aircraft operations, divided into single-engine propeller, multi-engine propeller and turbojet aircraft.

About the same time, Rohacs (2006) was formulating a modeling framework to analyze the potential for advanced small aircraft flights in Europe. However, the model appears designed to predict system level values, rather than airport- or region-specific activity, and details of the implementation of the model are rather vague.

As part of preparing a Regional General Aviation and Heliport System Plan, the North Central Texas Council of Governments (the metropolitan planning organization for the Dallas/Fort Worth region) is in the process of developing a regional demand forecasting process that is broadly similar in scope to the planned approach for the current study. The proposed analysis approach for the NCTCOG study is documented in a white paper (NCTCOG, 2009) that describes three levels of analysis: regional demand, allocation of regional demand to counties, and allocation of county demand to airports, as illustrated in Figure 2-1. However, the details of how this analysis approach will be implemented do not appear to have been fully worked out yet.

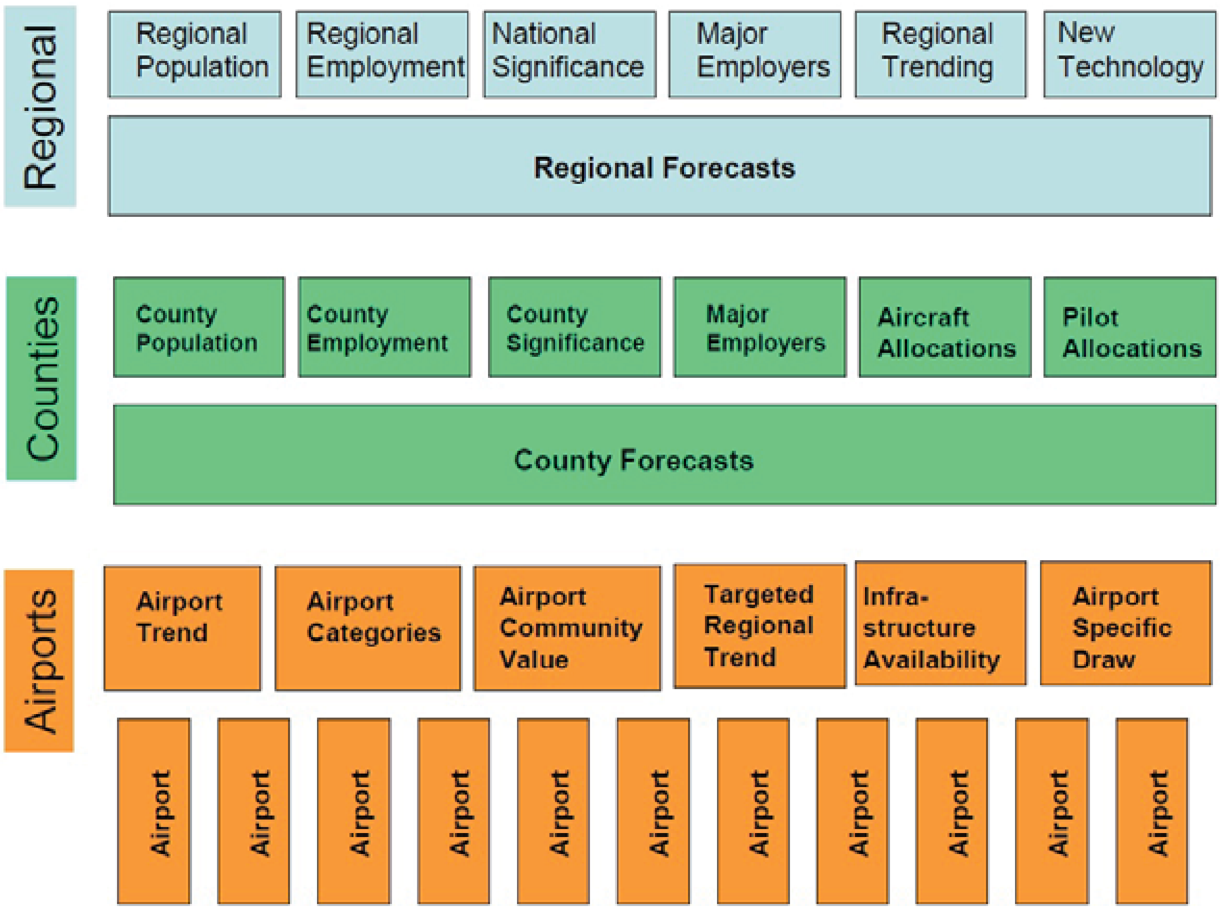


Figure 2-1. Proposed Forecasting Approach for North Central Texas Region

Planned Approach to Forecasting Regional General Aviation Activity

The future demand for general aviation activity in the Southern California region will obviously depend on the size and composition of the pilot community, as well as the amount of flying done by the various categories of pilots. Pilots begin their flying career as student pilots. Some never progress beyond this stage but others gain their private pilot certificate and continue flying as private pilots. For many pilots the private pilot certificate may be the most advanced certificate they ever obtain, but others progress to hold commercial pilot or airline transport pilot certificates, where the commercial pilot certificate is a required step to obtaining an airline transport pilot (ATP) certificate. Generally, those pilots progressing to holding commercial pilot or ATP certificates intend to seek employment as a pilot or flight instructor, although some pilots obtain their commercial pilot certificate for the satisfaction of achieving a higher level of certification without any intention of using their pilot certification for gainful employment.

Future Composition of the Pilot Community and Level of Flying Activity

Of course, as pilots gain flying experience and progress through the various levels of certification, they are also getting older. Therefore one can study the composition of the pilot community using techniques from demographic cohort analysis. Pilots take up flying at some point in their lives, progress through various certificates, and eventually cease flying. From data on the distribution of the age of pilots when they first take up flying and the time it takes them to reach the highest level of certification they achieve, projections of the future composition of the pilot community can be made based on assumptions about future levels of new pilot starts as a percentage of the population in the relevant age ranges.

Future levels of general aviation activity will depend not only on the number of pilots with each type of certificate but the amount of flying that these pilots do. This varies by the type of certificate held and the age of the pilot. It is also likely that the average number of hours flown per year by pilots with a given type of certificate and a given age will also change over time in response to general economic factors and the cost of flying, as well as such factors as restrictions on the use of airspace or changes in pilot certification requirements. In the case of business aviation and corporate flying, as distinct from flight training and personal flying, the level of flight activity is less a function of the number of pilots than the demand for this type of flying, which is largely determined by the state of the economy and the cost of owning and operating aircraft, which in turn is affected by such factors as the cost of aviation fuel, interest rates, and corporate tax rules. Indeed, the demand for professional pilots, and hence the amount of flying by those pilots, is determined by the level of business and corporate flying, rather than the other way round.

It should be clear from this discussion that the future size of the pilot community in the Southern California region and the amount of flying done by those pilots depends on many factors that cannot be known with any certainty. Developing a general aviation demand forecast based on a single set of highly conjectural assumptions is of limited value for aviation planning purposes and is almost certain to be wrong. What is much more useful is an assessment of the range within which future values of general aviation activity might lie and the likelihood that the values might exceed various levels. In short, rather than a single point forecast, what is needed is an assessment of the projected probability distribution of the forecast values. The development of such probability distributions is commonly referred to as risk analysis, and commercial computer simulation software exists to perform the necessary calculations to estimate the probability distributions (strictly these are likelihood distributions rather than probability distributions, but the distinction is not important for this study and therefore the more commonly understood term will be used). Although initially the regional general aviation demand forecast for 2035 will be developed using a simpler approach based on defining a range of input assumptions reflecting low, baseline and high demand growth assumptions, the analysis approach will be designed so that future work could extend this to the use of a more formal risk analysis approach.

Future Based Aircraft Fleet

The second major consideration in developing a regional general aviation demand forecast is projecting the future number of aircraft based at airports in the region. While the number of aircraft is obviously influenced by the level of flying activity, this is not a simple relationship. Aircraft do not disappear when the level of flying reduces nor do new aircraft suddenly appear when the level of flying increases. Rather, the aircraft fleet evolves in an analogous way to the pilot community. New aircraft are purchased or imported into the region, while other aircraft are exported from the region or older aircraft are scrapped. The level of utilization of a given aircraft also changes as the aircraft gets older, since this is generally associated with higher maintenance costs and poorer fuel efficiency. When the level of flying increases, it can be expected that new aircraft purchases and imported aircraft will tend to exceed the number of aircraft exported or scrapped and the total fleet will grow. Conversely, if the level of flying decreases, underutilized or unused aircraft will be retired from the fleet at a higher rate than new aircraft will be added and the total fleet will decline. However, the average levels of aircraft utilization will also change with changing levels of flying activity, and so the changes in the aircraft fleet will tend to lag behind the changes in flight activity. Furthermore these changes will not be uniform across the fleet, but will vary with the age and type of the aircraft.

Cohort analysis can also be applied to projecting changes in the aircraft fleet in a similar way to the analysis of the pilot community discussed above. As aircraft get older, their average level of utilization declines and they become more likely to be retired from the fleet by being exported or scrapped, unless they become so old that they become of historic interest or attractive to collectors and get restored to flying condition. However, this is a special case that typically only affects a few aircraft. It should also be noted that some aircraft are lost each year to flying accidents, although the improvement in general aviation safety has reduced this effect in recent years.

Projecting Future Levels of Airport Activity

Once the size and composition of the future aircraft fleet based in the region has been forecast, it is necessary to project the allocation of this fleet to airports in order to forecast the number of based aircraft and associated activity levels at each airport in the region. The decision by an aircraft owner of where to base the aircraft depends on a number of factors, including the proximity of alternative airports to the owner's residence or place of business, the facilities and services available at each airport, including whether the runway is long enough to accommodate the aircraft, and the availability and cost of hangar or tie-down space. Apart from the proximity of alternative airports, the other factors can change in the future, and indeed a major objective of the aviation system planning process is to determine future needs for such changes. Therefore the aircraft allocation process should be based on a formal model of the airport choice process by aircraft owners, referred to in the remainder of this working paper as the based-aircraft choice model.

Such a model can be estimated from existing data on the location of aircraft owners in the region and the airport where they base their aircraft and would be structured as a standard disaggregate behavioral choice model, analogous to a travel mode choice model in surface transportation planning. A common form for such a model is the multinomial logit model, which can incorporate utility functions for each airport that include variables describing the facilities and services available at each airport. This allows the based aircraft allocation process to be responsive to potential changes at each airport, as well as changes in the distribution of aircraft owners throughout the region due to changes in the regional distribution of the population and the locations of users of business or corporate aviation, as well as changes in the composition of the pilot community and the use of business or corporate aviation.

This use of a formal model to establish a logical and consistent basis for allocating the projected future regional based aircraft fleet to airports is necessary for several reasons. Perhaps the most important is to provide a means to study the effect of changing facilities and services at regional airports on the distribution of based aircraft. The second is that a large proportion of the aircraft fleet in 2035 (25 years hence) will be owned by different people from the current fleet and the locational distribution of those people is likely to be different from the current distribution of aircraft owners. Thirdly, to the extent that the demand for hangar or tie-down space at certain airports may exceed the available facilities, it can be expected that hangar space or tie-down rental rates will rise to balance demand with capacity and this will also affect the allocation. Finally, the allocation of regional based aircraft demand to airports is likely to be politically sensitive, particularly if some airports are forecast to experience increased numbers of based aircraft and levels of activity while others are forecast to experience a reduction in based aircraft and activity. It is therefore important that the allocation process is transparent and can be justified on the basis of empirical experience and agreed assumptions.

It should be recognized that just as forecasts of future levels of regional activity are subject to a wide range of uncertainties, so any process to allocate that activity to specific airports is also subject to similar, or even greater, uncertainties. There is no crystal ball that can predict what will happen at a given airport. Rather, the purpose of developing demand allocation models is to suggest what might happen under various assumptions and provide a tool to explore how changing those assumptions could change the resulting forecast activity levels at different airports.

Analysis Framework

The analysis approach to be used in developing the regional general aviation demand forecasts comprises a number of separate but interrelated components shown in Figure 2-2. These components distinguish between personal flight activity by individual pilots and owners of personal aircraft on the one hand and flight activity by corporately owned aircraft on the other, where the corporate aircraft fleet includes aircraft owned by government agencies, educational institutions, nonprofit organizations, and similar organizations that typically employ professional pilots to operate the aircraft.

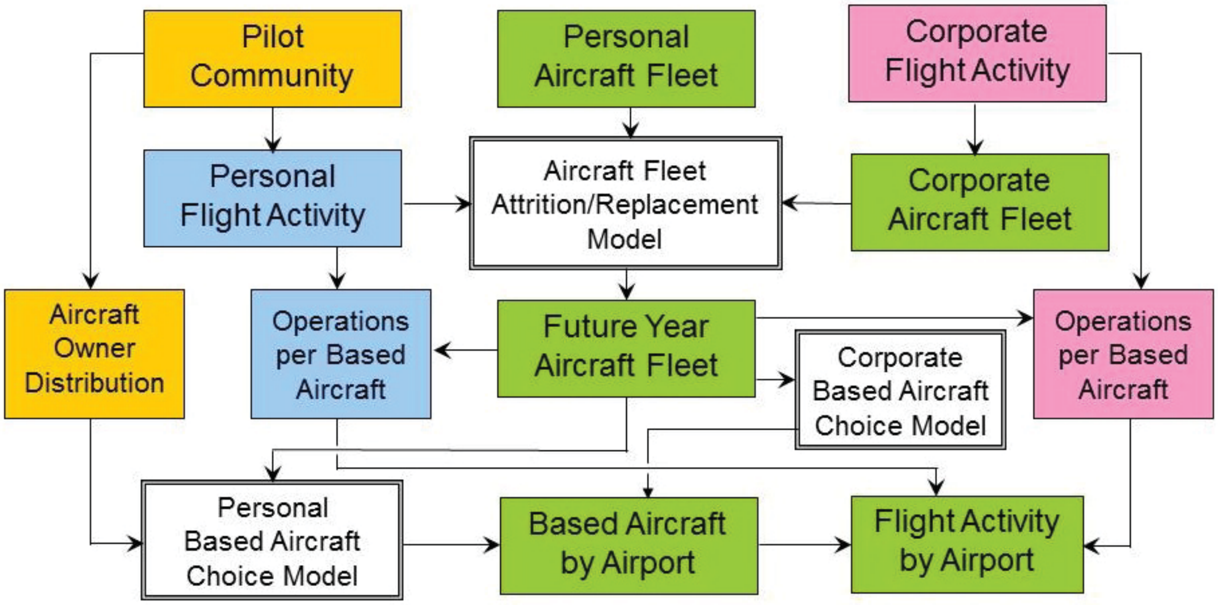


Figure 2-2. Demand Forecast Analysis Approach

The analysis framework shown in Figure 2-2 distinguishes between the composition and location of the pilot community and owners of personal aircraft (highlighted in yellow), the associated personal flight activity (highlighted in blue), business and corporate flight activity (highlighted in pink), and the composition and activity of the aircraft fleet (highlighted in green). Flight training is treated as a category of personal flight activity, since it is largely determined by the composition of the pilot community. Aerial work is treated as a category of corporate flight activity, since it is performed for corporate or governmental entities by professional pilots. The figure shows three key analytical modules, the aircraft fleet attrition and replacement model, the personal based-aircraft airport choice model, and the corporate based-aircraft airport choice model.

Figure 2-2 also shows that the number of operations per based aircraft is derived in the analysis from the forecast level of flight activity and the size and composition of the aircraft fleet, rather than being an input assumption. This avoids the difficulty inherent in basing general aviation activity forecasts on assumed future levels of operations per based aircraft, which are likely to vary with the composition of the pilot community, changes in the levels of flight activity by different categories of pilot, and changes in aircraft fleet, making estimates of future changes in the number of operations per based aircraft extremely challenging without undertaking the type of detailed analysis shown in Figure 2-2.

Each of the other analysis components shown in color in Figure 2-2 utilize various analytical techniques to generate the projected future values of regional general aviation activity that form the inputs to the other components of the analytical framework. These components and their associated analytical techniques are described in the following sections.

Pilot Community Cohort Analysis

The future pilot community module utilizes a cohort analysis to forecast the future size and composition of the pilot community, and the associated level of flight activity. This projects the change in the number of pilots holding different levels of pilot certificate over time in five-year age cohorts, as pilots grow older and transition from student pilot to private pilot, from private pilot to commercial pilot, and from commercial pilot to airline transport pilot (ATP), or become inactive and drop out of the active pilot population. Obviously, not all pilots progress to a higher level of certificate, particularly to ATP. Some student pilots never complete their training and obtain a private pilot certificate.

The number of pilots in each age range holding each type of certificate in a given year is given by the following relationships:

$$N_{s,a,y} = N_{s,a-5,y-5} * (1 - A_{s,a,y} - T_{sp,a,y}) + E_{s,a-5,y-5}$$

$$N_{p,a,y} = N_{p,a-5,y-5} * (1 - A_{p,a,y} - T_{pc,a,y}) + N_{s,a-5,y-5} * T_{sp,a,y}$$

$$N_{c,a,y} = N_{c,a-5,y-5} * (1 - A_{c,a,y} - T_{ct,a,y}) + N_{p,a-5,y-5} * T_{pc,a,y}$$

$$N_{t,a,y} = N_{t,a-5,y-5} * (1 - A_{t,a,y}) + N_{c,a-5,y-5} * T_{ct,a,y}$$

where $N_{s,a,y}$ = the number of student pilots in age group *a* in year *y*

$N_{p,a,y}$ = the number of private pilots in age group *a* in year *y*

$N_{c,a,y}$ = the number of commercial pilots in age group *a* in year *y*

$N_{t,a,y}$ = the number of airline transport pilots in age group *a* in year *y*

$E_{s,a,y}$ = the number of new student pilot starts in age group *a* over the five-year period starting in year *y*

$A_{s,a,y}$ = The net attrition rate of student pilots in age group *a* in the five-year period ending in year *y*

$A_{p,a,y}$ = The net attrition rate of private pilots in age group *a* in the five-year period ending in year y

$A_{c,a,y}$ = The net attrition rate of commercial pilots in age group *a* in the five-year period ending in year *y*

$A_{t,a,y}$ = The net attrition rate of airline transport pilots in age group *a* in the five-year period ending in year *y*

$T_{sp,a,y}$ = The transition rate of student pilots in age group *a* to private pilots in the five-year period ending in year *y*

$T_{pc,a,y}$ = The transition rate of private pilots in age group *a* to commercial pilots in the five-year period ending in year *y*

$T_{ct,a,y}$ = The transition rate of commercial pilots in age group *a* to airline transport pilots in the five-year period ending in year *y*

The net attrition rates for a given age group include those pilots moving out of the region (positive) and into the region (negative), as well as those pilots who become inactive. The definition of an inactive pilot requires some care, because pilots do not report their actual flying in a given year, only when they apply for a new medical certificate. In the case of private pilots under age 40, a medical certificate is valid for five years. A pilot holding a valid medical certificate is considered to be active, even if in fact that pilot has done no flying for several years. While the medical certificates for commercial and airline transport pilots have shorter validity periods, pilots can exercise the privileges of a lower class of medical certificate for the period that that class of medical certificate would have been valid. Thus an airline transport pilot with an expired first-class medical certificate (which is valid for 6 months for pilots age 40 and over) can continue to fly as a private pilot for the period that a third-class medical certificate would have been valid.

It is of course quite likely that some pilots make the transition through more than one certificate level in a five-year period. For example, a student pilot may gain both the private pilot certificate and commercial pilot certificate within five years. This is covered by the combination of the attrition rate and transition rate. Such a pilot would be included in the transition rate from student to private pilot and the transition rate from private pilot to commercial pilot, but also in the attrition rate for private pilots, in order to ensure the correct number of private pilots at the end of the five-year period. It would also be possible to account for multiple transitions in a five-year period in the above formulae, but given the limitations of the data and the granularity of the analysis (five-year increments), such a refinement does not appear to be worth making.

The foregoing analysis does not consider pilots holding recreational and sport pilot certificates. Given the relatively small number of pilots in these categories, the type of cohort analysis discussed above would not be supported by the data, nor would it make much difference to the resulting estimate of the size of the pilot population. Instead, these pilot categories can be included by a separate analysis based on the current trend in the number of such pilot certificates issued.

The above equations allow for pilot attrition and transition rates to vary over time. While the available data on the composition of the pilot community may not allow a detailed analysis of how these rates have varied in the past, allowing these rates to vary in the cohort analysis provides a way to reflect projected changes from current rates in the future, as discussed below in the section on Key Assumptions.

Once the number of pilots in each age group with a given level of pilot certificate has been calculated, the total number of flight hours per year performed by those pilots can be calculated from the average number of flight hours per pilot for a pilot in that age and certificate category. Estimates of the average number of flight hours per year for pilots in a given age group and certificate category can be derived from the number of flight hours reported by pilots when they renew their medical certificates or from pilot surveys, as discussed further below in the section on Data Requirements and Sources.

In the case of airline transport pilots, their reported flight hours include all types of flying, the majority of which is likely to be airline flying. Indeed many airline pilots may not do any GA flying at all. Since they do not report flight hours for GA flying separately, it will be necessary to estimate the proportion of their flight hours spent in GA flying from pilot survey data or other sources.

Aircraft Owner Distribution

The current geographic distribution of aircraft owners in the region can be determined from the aircraft ownership data maintained by the County Assessors. These data provide the registered address of the aircraft owner, allowing the distribution of aircraft owners by zip code to be determined. In the case of some corporately owned aircraft, the registered address may be outside the region, such as a corporate head office. In these cases, it will be necessary to determine the location of the local office of the aircraft owner, which in some cases may be the airport where the aircraft is based.

As the composition of the aircraft fleet ownership changes over time, the distribution of the aircraft owners may change, reflecting the geographic locations of new owners and relocation of existing owners. An ownership distribution model will be developed from the current ownership pattern that predicts the proportion of the regional aircraft owners located in each zip code area. Separate models will need to be developed for personally owned aircraft and corporately owned aircraft. In the case of personally-owned aircraft, the distribution of owner locations is likely to be most influenced by the number of high-income households in a zip code area, but the influence of other variables will be explored as part of the model estimation.

The geographic distribution of owners of corporately-owned aircraft is likely to reflect the distribution of the types of businesses owning aircraft. As a general rule larger firms are more likely to own aircraft, so employment by different industry sectors may be the most appropriate explanatory variables. Exploratory analysis will be performed to identify those sectors that account for the greatest proportion of aircraft ownership and to select the most appropriate explanatory variables to predict the distribution of aircraft owners. This may require some compromise between the extent to which a given variable accounts for the current distribution of aircraft owners and the availability of forecasts of that variable for future years.

Personal Flight Activity

The number of flight hours by different categories of pilot certificate has been discussed above. In order to translate these estimates into forecasts of personal flight activity, it is necessary to determine the proportion of flight hours devoted to personal flight activity (personal and recreational flying, flight training, and business flying by individual aircraft owners). This can be done based on an analysis of FAA survey data of annual general aviation flight hours by aircraft type (FAA, 2011c). Since there is generally only one pilot in an aircraft being used for most personal flying, there is a one-to-one correspondence between pilot hours and aircraft hours. The one exception to this is dual flight instruction, in which both the student pilot and the flight instructor will be counting the flight time. It will therefore be necessary to estimate the proportion of instructional flight time that is spent in dual instruction and the proportion where the student pilot is solo. In general, for most student pilots this is approximately equal over the course of their flight training.

The data on aircraft flight hours by purpose does not of course indicate the type of certificate held by the pilot, and while student and private pilots are precluded from serving as pilots for corporate flying and other flight activity where the flight crew is paid, pilots holding commercial and airline transport certificates can and do engage in personal flying. It will therefore be necessary to estimate the amount of compensated flying from the aircraft survey data for different use categories, and hence estimate the proportion of flight time by commercial and airline transport pilots that is spent in personal flight activity.

Corporate Flight Activity

In contrast to personal flight activity, the level of corporate flight activity is not determined by the size and composition of the regional pilot community but by the need for transportation or other aviation activity by the organizations generating the corporate flight activity, whether through the use of their own aircraft or by chartering aircraft operated by others. As shown by the various categories of aircraft use shown in Table 1-2 above and the descriptions of the different categories in Appendix A, corporate flight activity encompasses a wide range of flight purposes, including:

- Corporate/executive transportation
- Aerial application or observation
- Other aerial work and external load activity
- Sight-seeing under FAR Part 91
- Air medical services (under both FAR Part 91 and Part 135)
- Air taxi services
- Air tours.

Some activities under Other Work Use or Other use (e.g. aerial advertising, positioning flights, and proficiency flights) could also be most appropriately considered part of corporate flight activity. In the Southern California region, some categories of aircraft use, such as aerial application, external load, sightseeing and air tours, are likely to occur extremely infrequently relative to other categories and can be combined into a single category of Other use.

Since the aircraft involved in corporate flight activity are generally quite different from those used for personal flying, the estimates of flight hours for these purposes by different types of aircraft can be applied to the data on the composition of the Southern California based aircraft fleet to estimate the amount of corporate flying by that fleet.

Accounting for Fractional Ownership

The recent growth in fractional ownership plans requires an adjustment to the analysis approach. From an operational standpoint, fractional ownership is no different from an air taxi charter. It is only the way that the service is paid for that differs. However, because the user has purchased a share of the ownership of the aircraft rather than chartering the aircraft for a specific flight, this activity is counted as part of general aviation corporate flight activity rather than as a Part 135 air taxi flight. Because aircraft used in fractional ownership plans are likely to achieve higher utilization that those operated exclusively by the aircraft owner, adjustments to the average number of flight hours per aircraft are likely to be required, for both aircraft used in fractional ownership plans and those operated exclusively by the aircraft owners.

The FAA survey data of annual general aviation flight hours by aircraft type (FAA, 2011c) includes estimates of the annual hours flown in fractional ownership by aircraft type. These data can be used to estimate the proportion of corporate GA flying that should be classified as fractional ownership activity and used to adjust the average flight hours per aircraft assumed for aircraft used in fractional ownership. Unfortunately the published results of the FAA survey do not include an estimate of the number of aircraft involved in fractional ownership plans. Therefore this number will need to be estimated from other sources (e.g. J.P. Morgan's *Business Jet Monthly* newsletter (J.P. Morgan, 2011)).

Operations per Based Aircraft

The number of operations per based aircraft is a metric that is commonly used in forecasting general aviation activity at airports, primarily because it is easily calculated from aircraft operations counts and based aircraft counts, both of which are routinely collected or estimated at all airports. However, in the aggregate this measure fails to capture the effects of the widely different level of utilization of different types of aircraft used for different purposes.

It also assumes that the ratio of operations by visiting aircraft to those by based aircraft remains constant. If the composition of the aircraft fleet at a given airport or the level of activity by visiting aircraft relative to that of based aircraft changes over time, it can be expected that the number of operations per based aircraft will also change.

Therefore what is needed instead is a way to determine the number of operations by based aircraft as a function of the level of flight activity by the owners of those aircraft, which can then be combined with an estimate of the number of operations by visiting aircraft determined in a separate step. Given the number of flight hours for personal and corporate flight activity as discussed in the previous sections, these can be translated into aircraft operations based on estimates of the number of landings per flight hour and the proportion of those landings that occur at the airport where the aircraft is based. The average number of landings per flight hour for different aircraft types is available from FAA survey data of annual general aviation flight activity by aircraft type (FAA, 2011c). The average for each aircraft type covers all purposes for which that aircraft type is used, so some adjustments will be required to reflect the different uses of each type of aircraft. For example, flight training will generate far more landings per flight hour than recreational flying, although both flight purposes may use similar aircraft types.

These adjustments can be made on the basis of data for aircraft types that are typically not used extensively for flight training, although an attempt will be made to obtain more detailed data from the FAA general aviation activity survey to perform a more explicit analysis of these differences.

Estimates of the proportion of landings that are performed at the airport where the aircraft is based requires assumptions about the proportion of flight hours involved in local operations (those where the aircraft remains in the traffic pattern or returns to the airport without landing elsewhere), the average number of landings per flight hour for local operations compared to itinerant operations, and the average number of flight segments for an itinerant trip. This information can be obtained for a representative set of flights from surveys of airport users, such as the 1990 FAA *General Aviation Pilot and Aircraft Activity Survey* (Executive Resource Associates, 1991). Although this survey is now over 20 years old, the underlying patterns of general aviation activity are not anticipated to have changed all that much, although of course the total level of activity has.

Aircraft Fleet Attrition/Replacement Model

This model component is designed to predict the changes in the general aviation aircraft fleet based in the region over time in order to generate a projected future year (2035) aircraft fleet. The model considers the attrition of the current aircraft fleet as aircraft age and become uneconomical to maintain in airworthy condition or are lost due to accidents, together with replacement due to new aircraft purchases and net imports of aircraft to the region less exports of aircraft from the region. From the perspective of the regional based aircraft fleet, the only difference between new aircraft purchases and imports is the age of the new aircraft being added to the regional based aircraft fleet.

The model is based on a Markov process, in which the probability of an aircraft of type *i* and age *a* in the regional fleet in year *t* being lost to the fleet (whether through attrition or export) in year *t+1* is given by $P_i(a)$. As a practical matter, aircraft are grouped into a limited number of similar types (e.g. single-engine piston, multi-engine piston, etc.) in order to calculate the probabilities $P_i(a)$ from national aircraft fleet data. The total number of registered aircraft of a given type and age at the national level over time provides the probability of attrition, while the corresponding number of registered aircraft of a given type and age in the region, after adjusting for attrition, provides the probability of net export (exports less imports).

Since the analysis is only attempting to predict the size of the fleet by aircraft type, and not track individual aircraft, only net exports (or net imports) matter. There is a national market for used aircraft (indeed even an international market), so if a specific aircraft based in the Southern California region is sold to a purchaser outside the region but another aircraft of the same type that is based outside the region is purchased by a buyer in Southern California and moved to the region, there is no net change in the regional based aircraft fleet (although of course the location of the owners within the region has most likely changed).

Accounting for new aircraft purchases is complicated since the decision to purchase a new aircraft depends not only on the available fleet of used aircraft, but the overall demand for aircraft. Therefore, a separate sub-model will be developed based on recent trends in national data for new aircraft sales by type. Since someone choosing between purchasing a new aircraft and a used aircraft is only likely to consider relatively new used aircraft, the number of new aircraft added to the Southern California aircraft fleet in a given year will depend on the overall level of general aviation activity in the region and the size of the existing aircraft fleet that is relatively new (perhaps up to five years old). The exact age criterion is probably not all that important, although of course the relationship between the number of new aircraft purchased in a given year and the size of the existing fleet that is considered relatively new will vary with the age criterion used. An analysis of the age profile of aircraft in Southern California over recent years will be undertaken to identify the most suitable criterion.

Although the approach is based on an analysis of the composition of the registered aircraft fleet over time, there is no guarantee that the historical rates of attrition and new aircraft acquisition will persist in the future, particularly over a period as long as 25-years. Therefore the resulting attrition and acquisition rates will be reviewed with the Aviation Technical Advisory Committee and adjusted as necessary to reflect Committee input on factors that appear likely to modify those rates in the future.

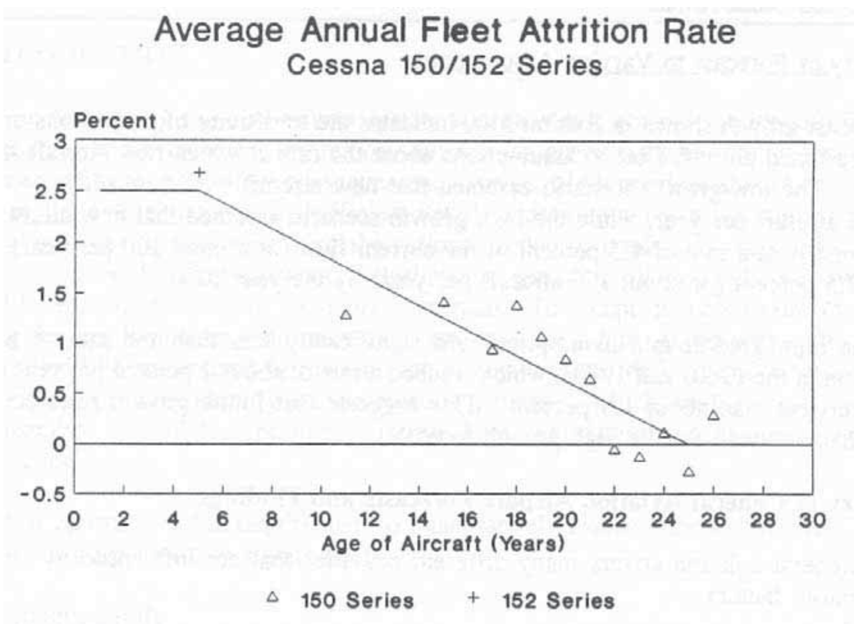
Aircraft Data Considerations

An analysis of aircraft attrition and new aircraft acquisition rates could be based on the national data on the registered aircraft fleet maintained by the Federal Aviation Administration, although potential difficulties could arise from inaccuracies in the registered aircraft data. Because aircraft registrations do not currently need to be renewed on an annual basis (in the way that automobile registrations do), there is a concern that the current registered aircraft database includes a large number of aircraft that are no longer active or whose owners may have moved, although efforts are currently underway within the FAA to improve the accuracy of the aircraft registration database. However, California County Assessors also maintain databases of aircraft based within the county for tax purposes. These data are likely to be reasonably accurate because aircraft owners will notify the County Assessor if their aircraft have been disposed of. By basing the attrition analysis on the County Assessor data, it should be possible to obtain a reasonably accurate picture of the evolution of the aircraft fleet in the Southern California region.

Aircraft Fleet Attrition Models

An early model of attrition in the general aviation fleet was developed by Rocks (1976). Although the data on which this study is based is now quite dated, the underlying relationship between the age of an aircraft and the likelihood that it will cease to be used or scrapped that is described by the model may not have changed all that much over the past three and a half decades. Aircraft have very long lives if properly maintained and much of the existing general aviation aircraft fleet is not significantly different from the fleet studied by Rocks. Indeed, many of the aircraft in the current fleet were already in the fleet that was studied by Rocks.

A representative aircraft fleet attrition model was developed for the 1994 update of the San Francisco Bay Area Regional Airport System Plan (MTC, 1994). Using data for the Cessna 150/152 series aircraft, it was found that the annual fleet attrition rate declined from about 2.5% per year for relatively new aircraft to around zero for aircraft 25 years old or older, as shown in Figure 2-3. Negative attrition rates beyond 20 years observed in the data could be due to data errors or inactive aircraft being returned to operation.

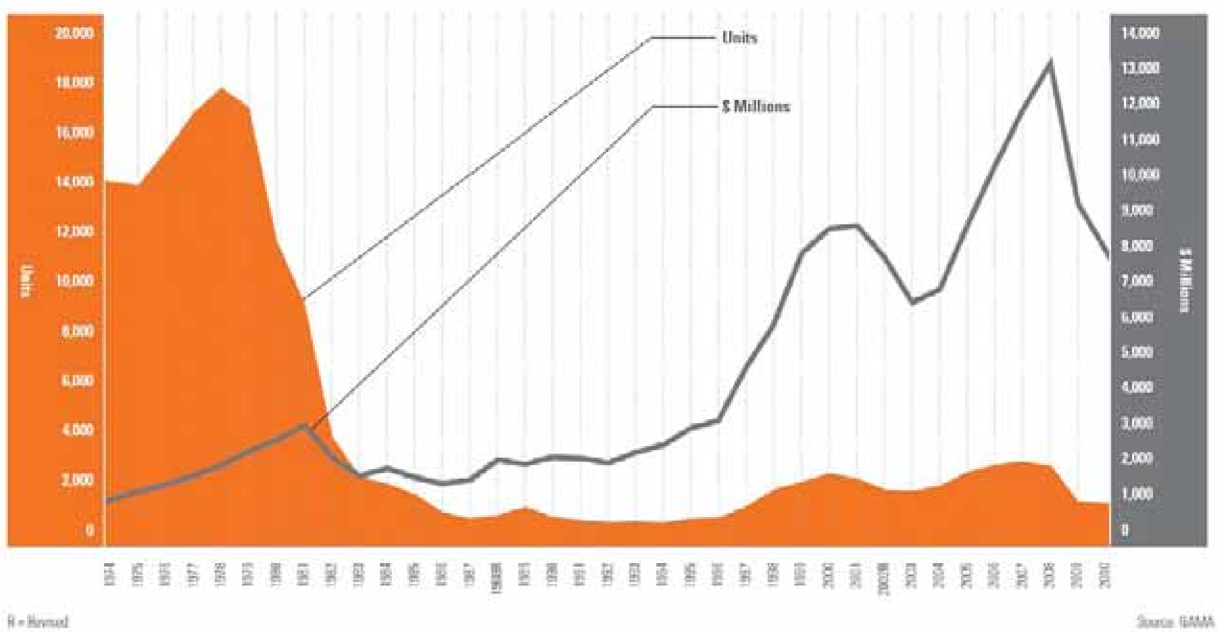


Source: MTC, *Regional Airport System Plan Update – San Francisco Bay Area*, Oakland, Calif., Nov. 1994, Exhibit 5-64.

Figure 2-3. Representative General Aviation Fleet Attrition Rates

It was found at the time that new aircraft were being added to the fleet at a rate of only about 0.2 percent per year. This is likely to have changed significantly in recent years, particularly for turbojet aircraft. Figure 2-4 shows the trend in GA aircraft shipments over the past 37 years. In recent years shipments of new aircraft have been running at about 2,000 units per year, although this has declined sharply since the onset of the recession in 2008. Even so, the average rate over the previous 10 years was still only about one percent of the active GA fleet per year, well under the average attrition rate. Furthermore, many of the U.S. manufactured aircraft are exported.

Figure 2-4 also shows the total value of the new aircraft shipments. It is clear that the average value per unit shipped has increased significantly since the late 1970s. In 1975, when over 14,000 units were shipped, the average sale price per aircraft was around $73,000. By 2007, when about 3.300 units were shipped, the highest number in recent years, the average sale price per aircraft had increased to about $3.6 million. By 2010, when the number of units shipped had declined to about 1,300, the average sale price had increased to $5.9 million. Clearly, not only has the number of GA aircraft produced declined significantly, but the nature of the aircraft entering the fleet has also changed. This has profound implications for the long-term composition of the aircraft fleet and the type of flying that is done, as the number of older, less expensive aircraft declines, and these aircraft are replaced by more modern, more capable, and much more expensive aircraft.



Source: General Aviation Manufacturers Association, *2010 General Aviation Statistical Databook & Industry Outlook*, Washington, DC, 2011.

Figure 2-4. Shipments of General Aviation Airplanes Manufactured in the U.S. (1974-2010)

The RASP analysis did not consider the net effect of imports and exports to and from the region, although it noted that these are likely to be fairly small in relation to the size of the total fleet and will tend to offset each other. A more explicit accounting of net exports will be undertaken as part of the project, as discussed above.

The attrition pattern developed for the Bay Area RASP is now over 15 years old, and will need to be updated and expanded for the current study. The literature review has not identified any more recent application of a formal general aviation fleet attrition model, although the FAA includes assumptions about GA fleet attrition in its annual forecasts of the future GA fleet.

<u>Aircraft Owner Distribution</u>

In addition to the size of the future regional based aircraft fleet, it is also necessary to consider whether the geographic distribution of aircraft owners will change in the future. Although this is not part of the Aircraft Fleet Attrition/Replacement Model, it is a necessary step before allocating the projected future aircraft fleet to airports within the region. Data on the current distribution of aircraft owners by zip code can be obtained from the registered address of the aircraft owner and aggregated to suitable sub-regional analysis zones that are selected to contain a similar number of current aircraft owners.

In the case of corporately owned aircraft, it may be necessary to make adjustments to the registered location, since the aircraft registration may use the address of a corporate office that bears little relationship to the operating units using the aircraft, and may even be outside the region. For example, an aircraft may be registered using the address of a corporate flight department that is located at the airport where the aircraft is based, although the choice of airport at which to locate the flight department was influenced by the location of the principal corporate offices in the region.

Rather than simply assume that the geographic distribution of aircraft owners will remain unchanged, an aircraft owner distribution model will be developed using linear regression. In the case of personally owned aircraft, the independent variables that are most likely to provide a reasonable fit to the data are population and average household income, although other socioeconomic factors will also be explored. Identifying suitable independent variables in the case of corporately owned aircraft is likely to be more difficult and will require some exploratory analysis. The challenge is not so much identifying measures of business activity that are correlated with aircraft ownership but selecting measures for which long-term forecasts are available at a sub-regional level. It may therefore be necessary to use a more general measure of business activity, such as employment, for which forecasts are available but is not particularly well correlated with aircraft ownership and then apply sub-regional adjustment factors that reflect the current distribution of aircraft owners. This will at least ensure that projected future regional changes in the distribution of employment will be reflected in the forecast distribution of aircraft owners.

Although the resulting regression models will not necessarily produce the correct number of aircraft owners for a future year based on the projected size of the aircraft fleet, since aircraft ownership levels may change over time due to factors other than changes in household income or business activity, this is not a concern since all that is needed is the geographic distribution of those owners, so the model projections can be factored to give the correct totals.

The other major advantage of developing aircraft owner distribution models of this type is that they provide a means to allocate the forecast number of aircraft owners to smaller geographic zones (such as regional travel analysis zones), in a consistent way. This becomes important in applying the based airport choice models, since the relative proximity to alternative airports is a major consideration in the choice of airport and the analysis zones for this need to be relatively small in order to properly account for differences in airport proximity.

Personally Owned Aircraft Based Airport Choice Model

This model (referred to in Figure 2-1 as the Personal Based Aircraft Choice Model for brevity) predicts the choice of airport at which to base a personally owned aircraft, considering the geographic distribution of aircraft owners and the facilities and services available at the different airports in the region. The general form of the model is a multinominal logit discrete choice model that predicts the probability of a given aircraft owner *k* choosing airport *j* as a function of the proximity of each of the set of *N* alternative airports and the facilities and services at those airports. The number of based aircraft at each airport, as well as the geographic distribution of their owners, is them obtained by summing up the probabilities for each aircraft in the regional fleet.

Mathematically, the model takes the following form:

$$P_k(j) = U_k(j) \Big/ \sum_{i=1}^{N} U_k(i)$$

where the perceived utility $U_k(i)$ provided by airport i is given by:

$$U_k(i) = a_0 + a_1 * d_{ki} + \sum_{l=1}^{L} a_{l+1} * x_{li}$$

and d_{ki} = distance from location of owner k to airport i
x_{li} = value of airport-specific variable l for airport i
a's = estimated coefficients

The airport-specific variables for each airport can be continuous (e.g. hangar rental rates) or dummy variables (e.g. the presence of a control tower). Exploratory model development will be required to determine which variables are statistically significant. It is likely that owners of different types of aircraft may value airport facilities and services differently. For example, owners of larger aircraft that are used primarily for business may be more concerned that an airport has a control tower and an instrument landing system than owners of aircraft used primarily for recreation. Therefore it may be possible to obtain a better fit to the data by estimating separate models for different classes of aircraft. Although the primary use of the aircraft may be most important determining factor, this information is not generally available at the level of specific aircraft. It will therefore be necessary to use aircraft type as a surrogate criterion for primary use. In any case, the forecast of the future GA fleet only provides information on aircraft type, so future levels of primary use have to be assigned to the aircraft fleet anyway based on the current pattern of use by aircraft type.

One important consideration in airport choice is the limitation imposed on owners of larger aircraft by runway length or other airfield design criteria at particular airports. Rather than attempt to account for this through the independent variables in the choice model, it is simpler and more reliable to restrict the choice set of alternative airports available to those owners.

A related consideration is the large number of GA airports in the region, many of which will be so far from a given aircraft owner that they are not likely to enter into the choice set. In order to avoid having too many alternatives for a given owner, which will tend to place too much reliance on the distance variable to avoid unrealistic choices, it is likely that restricting the choice set on the basis of some distance criterion will produce more reliable model estimations. An analysis of the current geographic distribution of aircraft owners for each airport will be undertaken to identify a suitable distance threshold for different aircraft categories.

Corporately Owned Aircraft Based Airport Choice Model

This model (referred to in Figure 2-1 as the Corporate Based Aircraft Choice Model for brevity) predicts the choice of airport at which to base a corporately owned aircraft, considering the geographic distribution of the primary aircraft users and the facilities and services available at the different airports in the region. The general form of the model is the same as that for personally owned aircraft, although the model coefficients will most likely be different and some independent variables for airport facilities and services that are not found to be statistically significant for personally owned aircraft may turn out to be important for corporately owned aircraft. For example, the presence of a control tower may not be an important factor in airport choice for personally owned aircraft but may be very important for corporately owned aircraft.

Because many of the facilities and services are necessarily represented by dummy variables (either an airport has a control tower or it does not) and many are likely to be highly correlated across different airports (e.g. all airports with instrument landing systems also have control towers), it may not be possible to identify different coefficients for some airport variables that it would appear reasonable to assume would influence the choice of airport. This does not affect the reliability of the model, since the effect of the omitted variable is accounted for by the coefficient of the correlated variable that this included in the model, unless a situation arises in the future in which an airport has one feature but not the other (e.g. an instrument landing system is installed at an airport without a control tower). This situation can be handled through the inclusion of an additional variable, with the coefficient value of the correlated variable included in the estimated model split between the two variables on the basis of judgment or separate analysis (e.g. past surveys of aircraft owners on the relative importance of different factors in their choice of airport).

Flight Activity by Airport

The number of aircraft operations at a given airport result from activity by based aircraft and itinerant operations by transient (or visiting) aircraft that are based elsewhere. The aircraft operations by based aircraft can be estimated from the forecast number of flight hours and the number of operations per flight hour. These parameters are likely to vary considerably by aircraft type and can be estimated from survey data on aircraft activity levels.

Local operations largely result from flight training activities and some proficiency flights, as well as aerial activity and observation. There may also be a fairly small number of local operations by visiting aircraft. Thus the number of local and itinerant operations can be projected by estimating a relationship between the tower count data and the operations estimates derived from the flight hour analysis. The coefficients of this relationship perform two functions. First they adjust the number of operations derived from the flight hour analysis to achieve consistency with the tower count data. Second, they account for the varying split between local and itinerant operations by different aircraft uses.

Itinerant Operations by Transient Aircraft

Projecting itinerant operations by transient aircraft needs to utilize a different approach, since the number of such operations is not directly related to the number of based aircraft. Rather these operations can be expected to increase from current levels at each airport in proportion to the growth in the regional total of itinerant operations by based aircraft, reflecting the changes in the underlying factors driving the demand for general aviation activity. This assumes that these factors change elsewhere in the country in the same way that they do in Southern California. Since many of these factors, such as the price of aviation fuel, the general state of the economy, and corporate tax policies, are largely determined at a national level anyway, this does not seem an unreasonable assumption. Even if the Southern California economy is assumed to grow at a different rate from the national economy, to reflect that difference in the relative growth of itinerant operations by based aircraft and visiting aircraft would require a model of the demand for itinerant operations that incorporates separate measures of economic activity at both the origin and destination end of the trip.

The only known example of such a model is the Virgina Tech Transportation Systems Analysis Model. However, this model forecasts total person-trips on a county-to-county basis divided into five household income groups, where the highest income group has a household income greater than $150,000 in 2000 dollars. While different economic growth assumptions in different regions of the country would change the number of households in this income category, this is likely to be a fairly poor measure of the effect on the use of general aviation. In the first place, most users of general aviation for business or corporate travel are likely to have a household income significantly higher than $150,000, so changes in the number of households in this category do not necessarily reflect changes in the number of trips made by travelers likely to consider using general aviation rather than commercial airlines. Secondly, most such travel decisions to use general aviation are made by businesses or government agencies, rather than individual travelers, and the number of households in the highest income category does not really reflect the considerations that would lead to decisions to use general aviation for specific trips.

Thus while the planned approach ignores the effect of possible factors that could change the ratio of the number of itinerant operations by visiting aircraft to Southern California airports to the number of itinerant operations by based aircraft, a more detailed analysis of the pattern of itinerant GA operations to and from the region is beyond the resources of the current study.

Data Requirements and Sources

Implementation of the forecasting approach described in this working paper requires extensive data on:

a) Pilot population and flight activity
b) Based aircraft and aircraft ownership
c) Airport characteristics and fees
d) Airport activity by based and transient aircraft
e) Regional socioeconomic data

These data requirements and available data sources are discussed in more detail in the remainder of this section. While much of the required data is available from FAA and other government sources, information on the flight hours of individual pilots is not publicly available (the FAA collects this information when pilots renew their medical certificates, but it is not releasable for privacy reasons). Furthermore, without identifiable data on individual pilots, it is not possible to link the flight activity of the pilot community to the flight activity of the aircraft fleet, obtained from aircraft activity surveys. In order to address this missing link in the data, a survey of AOPA members is being undertaken as part of the current study, as described in more detail below.

Pilot Population and Activity

Statistical data on the U.S. pilot population is available from the annual FAA *U.S. Civil Airmen Statistics* (FAA, 2011e). Data on individual pilots from the FAA Airmen Registration Database, including their address, pilot certificates, and date of their most recent medical certificate, can be downloaded from the FAA website (FAA, 2011d). However these data do not include the pilot's age or flight experience and exclude the records of airmen who have requested that their address not be released. Totals of active airmen by county (including those who have requested their address not be released) are also available online (FAA, 2011f). Unfortunately, the FAA updates the downloadable data monthly and does not formally archive these data. Only the most recent version is shown on the FAA website, although prior versions remain on the server for some time and can still be accessed by entering the correct URL for the files. However the data available in this way only goes back about two years. Luckily, an earlier version from October 2004 was found on a web archive (http://www.archive.org). The totals of active airmen by county are presented in a PDF report that is generated by an application program from the underlying data tables that are updated even more frequently than the downloadable data. Thus these totals can change continuously and there is no way to access the data for a prior date.

However the FAA Airmen Certification Branch maintains internal reports on past totals of active airmen by county, and the relevant pages of these reports for California counties were obtained from the Branch staff for a selection of prior years.

The FAA active airman registry does not contain data on the flight time experience of each airman. However, pilots are required to provide their total flight hours to date and the flight hours in the prior six months on their application form to obtain or renew their medical certificate. The flight experience data is maintained in a separate database by the FAA Civil Aerospace Medical Institute (Peterman, Rogers, *et al.*, 2008) and has been used in a recent study of U.S. pilot characteristics (Rogers, Véronneau, *et al.*, 2009). An attempt will be made to gain access to these data for use in the current study. Failing this, the change in average flight hours for holders of different classes of medical certificate over time is given by Rogers Véronneau, *et al.* (2009) and these data can be combined with data on the changing age distribution of the pilot population from the *U.S. Civil Airmen Statistics* to estimate the average annual flight hours for different age groups and class of pilot certificate. In addition, data on pilot flight experience will be obtained from the survey of AOPA members discussed below.

The AOPA Member Survey

With the assistance of the Aircraft Owners and Pilots Association an online survey was performed of the California AOPA membership by SCAG and the California Department of Transportation (Caltrans) Division of Aeronautics. The AOPA has agreed to invite its California members to participate in the survey and provide them with the web address of the survey website where they can complete the survey. Survey respondents were not asked to provide identifying information, but they were asked to provide their zip code of residence and (if they are an aircraft owner) the airport where they base their aircraft. They were also asked to provide the following information:

- Whether they have flown general aviation aircraft in the past six months
- How long ago they last flew as general aviation pilot (if no longer active)
- The highest level of pilot certificate that they currently hold (or have held)
- Their total flight hours in all types of aircraft
- Their flight hours in general aviation aircraft in the past year
- Whether they are a current or former aircraft owner
- The type(s) or aircraft that they own (or owned), if any
- Their age range (in ten year intervals)

In addition, the survey asked a number of questions about services that the respondents have used or would like to see at airports that they use, as well as issues that they believe should be addressed at the airport where they base their aircraft or use most frequently, or that should be considered in developing a general aviation demand forecast.

The findings of the survey thus provide a more detailed profile of the pilot population in the SCAG region than can be obtained from the more aggregate data available from the FAA.

Aircraft Ownership and Based Airport

Detailed data on the composition and ownership of the current aircraft fleet is available from the aircraft registration data maintained by the County Assessors. These data provide the registered location of the aircraft owners by zip code, the type and age of each aircraft, and in most cases the airport where the aircraft is based. In general it is possible to determine whether an aircraft is owned by one or more individuals, a business, a government agency, an educational institution, or some other type of organization, such as a nonprofit association, from the name of the registered owner. In the case of aircraft owned by businesses, it is also necessary to classify the business by industry sector for use in developing the aircraft owner distribution models discussed above. In some cases this is obvious from the name of the owner. In other cases, some research will be needed to classify the owner into the appropriate industry sector.

Data on the total number of based aircraft at each airport is available from the FAA Form 5010, available online for each airport on the Caltrans Division of Aeronautics website, as well as other online aviation data sources, such as AirNav.com (http://www.airnav.com). While the FAA Form 5010 data is updated each year and the online sources do not provide historical data, the Caltrans Division of Aeronautics maintains an historical data file of based aircraft counts for every airport in the state.

Airport Characteristics and Fees

Airport facilities and fees are likely to be factors in the decisions of aircraft owners on where to base their aircraft. Information on airport facilities, such as runway length and the presence of a control tower, is available from the FAA Form 5010. Additional information on airport businesses, including fuel prices, is available online from AirNav.com. Hangar and tiedown rental rates are available for some airports on the airport websites. In other cases it may be necessary to survey airport managers to determine current fees.

Airport Activity by Based and Transient Aircraft

Airport operations counts for towered airports are available from the FAA Air Traffic Activity Data System (ATADS) at http://aspm.faa.gov. This provides daily, monthly, and annual traffic counts, distinguishing between air carrier, air taxi, general aviation, and military operations, with separate counts for local and itinerant operations, Estimates of annual operations at non-towered airports are available from the FAA Form 5010 data, separated into air carrier, air taxi, GA local ,GA itinerant, and military operations.

However, these airport activity counts do not distinguish between itinerant operations by based aircraft and transient (visiting) aircraft. In some cases, airport management may be able to provide an indication of the amount of activity by transient aircraft from records such as fuel sales receipts, overnight aircraft parking fees, or airport noise monitoring systems (which can generate reports of airport operations by tail number). As part of the current study, a survey of airport managers has been undertaken to identify the availability of information on activity by transient aircraft at each airport.

Data on average flight hours for different purposes by different types of aircraft are available from annual FAA *General Aviation Activity and Part 135 Activity Surveys* (FAA, 2011c). While these are national data, the utilization rates for different aircraft types can be applied to the aircraft fleet in the Southern California region. Some adjustment factors may be necessary to generate a level of activity that is consistent with the airport operations counts after making allowances for operations by visiting aircraft and the number of landings made outside the region by aircraft based at Southern California airports.

Regional Socioeconomic Data

SCAG has developed forecasts of households, population and employment at the travel analysis zone (TAZ) level. These forecasts give the number of households in four income ranges (less than $25,000, $25,000 to $49,999, $50,000 to $99,999, and $100,000 and over, in 1999 dollars) and the total population in the zone, as well as the number of households with no children, one child, two children, and three or more children. The employment forecasts give the total employment in the zone in three income ranges (less than $25,000, $25,000 to $49,999, and $50,000 and over, also in 1999 dollars), as well as the total employment in 13 industry sectors, based on the two-digit North American Industry Classification System (NAICS) codes.

Although the SCAG data on employment by industry sector does not include information on the number of businesses in a given zone, the current distributions of businesses by industry sector and size are available at the zip code level from the U.S. Census Bureau data on County Business Patterns. These data provide the number of businesses in each zip code by industry sector and size, expressed in terms of number of establishments by employment size ranges, using the NAICS codes.

Key Assumptions

Although the forecasting approach described in this report is based on an analysis of current trends in the pilot population, the composition and use of the general aviation fleet, and patterns of aircraft ownership, there are a number of key assumptions that will drive the forecasts.

The most significant of these is the future rate at which student pilots take up flying. This has a profound effect on the size of future pilot cohorts. While recent trends in the number of student pilot certificates issued can give an indication of the likely future rate of new pilot starts, these trends have changed over time and will most likely do so again. Thus establishing the assumptions for the future trend in new student pilot certificates issued involves a judgment about how many people will decide to take up flying in the future. This is likely to be influenced in part by the demand for airline and commercial pilots, as well as the general state of the economy and the cost of flying relative to other recreational pursuits or means of transportation.

A second set of key assumptions involves the rates at which pilots transition to higher levels of certificates, or become inactive, as well as the average number of hours that they fly each year at different stages of their life-cycle as a pilot. While data exists on the recent trends in these rates, there is an open question how long these trends will continue or how they will change in the future. Therefore assumptions must be made about how these rates will change over the forecast period.

Because aircraft have quite long operational lives and the average utilization in flight hours per year is quite low for a large part of the fleet, the aircraft fleet can continue to grow for a time, even if the level of flying activity is reducing. However, eventually older aircraft will be scrapped or sold outside the region and not replaced. Therefore assumptions are needed on how the current trends in both aircraft attrition and new aircraft acquisition are likely to evolve in the future.

Since the level of activity by corporately-owned aircraft is driven by the transportation or operational needs of the aircraft owners or customers, rather than being determined by the size of the pilot population, assumptions are also needed on how the use of general aviation by businesses may change in the future. The introduction of fractional ownership has made the use of general aviation more affordable to a range of companies, which may eventually decide to acquire their own aircraft. Thus it will also be necessary to make assumptions about future trends in the use of general aviation by different types of businesses in response to changing economic conditions, including those that currently operate aircraft directly or use chartered aircraft as well as those that do not currently make use of general aviation.

These key assumptions will be documented and reviewed with the SCAG Aviation Technical Advisory Committee for suggested changes prior to being used to develop the Regional General Aviation Demand Forecast.

Summary and Implementation

The forecast approach adopted for this study is based on an analysis of the underlying factors that will influence the future levels of aircraft ownership and general aviation activity, including changes in the composition and activity of the pilot population, attrition of the current aircraft fleet based in the region and addition of new aircraft to the fleet, and the future level of general aviation activity by businesses and other organizations in the region. The planned approach considers the geographical distributions of aircraft owners and the factors that influence where those aircraft owners choose to base their aircraft. The approach is thus sensitive to a range of assumptions about how these factors may change in the future and by varying these assumptions can generate alternative scenarios for the future size and composition of the general aviation fleet and activity in the region, and how that activity is likely to be distributed among the counties and airports in the region.

The analytical framework to support this forecasting approach will be implemented through a series of linked worksheets in a Microsoft Excel workbook. An input and control worksheet will provide a dashboard approach to varying the model assumptions and displaying a summary of the forecast results for the current scenario. Additional sheets will display more detailed results and provide a "drill-down" capability to examine the changes in forecast activity at a county and airport level. The various analytical modules will be implemented in additional linked worksheets. While it is not anticipated that users will modify the way that the calculations are performed on these sheets, they will provide users with the ability to examine how the analytical modules function and review the intermediate calculations, thus providing a high level of transparency to the forecast process.

3. Federal Aviation Forecasts of General Aviation Activity

The Federal Aviation Administration (FAA) prepares two annual forecasts that address future levels of general aviation (GA) activity: the FAA Aerospace Forecast, which provides projections of future GA activity at a national level, and the FAA Terminal Area Forecast, which provides projections of GA activity at the level of individual airports, from which projections of future GA activity in the Southern California region can be derived.

FAA National Aerospace Forecast

The FAA Aerospace Forecast is updated annually and provides projections for a wide range of aviation system metrics at a national level, for both commercial and general aviation. The most recent forecast (FAA, 2011a) provides projections to 2031, using a base year of 2010. The forecast includes the following metrics for the GA system:

- Active GA and air taxi aircraft by category of aircraft
- Active GA and air taxi hours flown by category of aircraft
- Active pilots by type of certificate
- GA aircraft fuel consumption by category of aircraft
- GA aircraft operations at FAA and contract control towers
- GA operations at Terminal Radar Approach Control (TRACON) facilities
- Instrument flight rules (IFR aircraft handles at FAA Air Route Traffic Control Centers

The forecast report includes a brief discussion of recent trends in the GA sector, with particular reference to the effect of the most recent recession on shipments of new GA aircraft and the decade-long declining trend in GA aircraft operations at FAA and contract control towers. However, it noted that GA activity at TRACONs in fiscal year 2010 declined by less than the decline at the control towers, while GA aircraft handled at en route centers (Air Route Traffic Control Centers) rose by 3.4 percent. This appears to reflect the continuing growth in the number of higher-end GA aircraft (business jet aircraft), which tend to make much greater use of en route and terminal control facilities than smaller GA aircraft. Higher-end GA aircraft typically operate under an FAA flight plan, which requires then to be under the control of

TRACONs and en route centers, while much of the smaller GA aircraft activity operates under visual flight rules (VFR), and only uses control tower facilities.

The forecast report mentions that the forecasts of GA activity are primarily based on information from the FAA *General Aviation and Part 135 Activity Survey* (FAA, 2011c), which has been significantly improved and expanded in recent years. The survey results are used as a baseline to which assumed growth rates are applied. There is no discussion in the report of the source or justification of these assumed growth rates. Although the survey results distinguish between activity by aircraft in GA and air taxi (Federal Aviation Regulations Part 135) operations, the forecast projections combine these categories for both active aircraft and hours flown by category of aircraft.

Outlook for General Aviation Activity

The FAA projections show the recent decline in the number of active single-engine piston aircraft (the largest category of GA aircraft) continuing until about 2018, with a slow growth thereafter. This category of aircraft experienced an average annual decline of about 0.7 percent from 2000 to 2010. The projections indicate that the number of active aircraft will further decline by about 2 percent from 2010 to 2018 (an average annual rate of about 0.1 percent per year), with an average annual growth rate from 2018 to 2031 of about 0.6 percent per year. The combined effect results in a projected increase in the number of active aircraft in this category of about 6 percent from 2010 to 2031. Given the recent trend in the number of active aircraft in this category, this projection appears rather optimistic. The projection implies a net increase in the active U.S. single-engine piston aircraft fleet over the 21-year period between 2010 and 2031 of about 8,000 aircraft. Given the average age of this segment of the U.S. GA aircraft fleet and the likely attrition rates over the next two decades, an increase of this size implies a significant increase in production over current levels. Over the past decade U.S. aircraft manufacturers have produced about 12,300 single-engine piston aircraft, net of exports. During this period the active single-engine aircraft fleet declined by about 9,400 aircraft, giving an overall attrition (net of imports) of about 21,700 aircraft. Thus an increase of 8,000 aircraft over the next 20 years implies more than a doubling of production compared to the past decade.

The number of multi-engine piston aircraft is projected to continue its recent decline through 2031, as this category of aircraft is becoming superseded by turboprop and turbojet aircraft, with a further decline in active aircraft of about 17 percent from 2010 to 2031.

In contrast, the number of active turboprop and turbojet aircraft has been increasing at an average annual growth rate of about 5 percent per year from 2000 to 2010. This growth rate is projected to slow considerably to an average annual rate of about 3 percent per year from 2010 to 2020, increasing slightly thereafter to an average annual rate of 3.1 percent per year from 2020 to 2031. The number of active rotorcraft has also been increasing steadily in recent years, with piston-powered rotorcraft increasing at an average annual rate of 2.9 percent per year from 2000 to 2010 and turbine-powered rotorcraft increasing at a higher average annual rate of 4.0 percent per year over the same period. The growth rate for turbine-powered rotorcraft is projected to slow over the forecast period, to an annual average rate of about 2.4 percent per year, while that for piston-powered rotorcraft is projected to increase slightly over the period 2010 to 2020 and slow thereafter, giving an average annual growth rate from 2010 to 2031 of about the same as the past ten years.

The numbers of both experimental and sport aircraft are projected to continue their recent growth, with the number of active experimental aircraft increasing at an average growth rate of 1.4 percent per year between 2010 and 2031 and the number of active sport aircraft increasing at a higher average annual rate of about 3.3 percent per year.

The number of hours flown by single-engine piston aircraft are projected to decline more rapidly between 2010 and 2018 than the decline in the number active aircraft, at an average annual rate of 0.5 percent per year, and increase thereafter at a higher rate than the number of active aircraft, at an average annual rate from 2018 to 2031 of 1.8 percent per year. The combined effect is to increase the number of hours flow by this category of aircraft between 2010 and 2031 by about 19 percent. The number of hours flown by turbojet aircraft and rotorcraft are projected to increase faster than the projected increase in active aircraft, implying an increase in aircraft utilization. Hours flown by turbojet aircraft are projected to almost triple from 2010 to 2031 (an increase of 195 percent), while hours flown by rotorcraft over the same period are projected to increase by about 85 percent.

The number of active student pilots are projected to decline by about percent from 2010 to 2016 before growing slowly to return to slightly above the 2010 level in 2031. The numbers of active private and commercial pilots are projected to follow a similar trend, with the number of private pilots ending up in 2031 about 6 percent above the 2010 level and the number of commercial pilots increasing by about 10 percent from 2010 to 20131.This of course implies that a higher proportion of student pilot progress to obtain private and commercial pilot certificates. The number of active airline transport pilots is projected to steadily increase from 2010 to 2031, ending up about 15 percent above the 2010 level by 2031. While most flying by airline transport pilots is not general aviation, training the increased numbers of airline pilots does involve general aviation, and of course some airline pilots do engage in general aviation flying as well as airline flying.

Although the number of active student, private, and commercial pilots are projected to decline from 2010 to 2016, this is not reflected in the projected numbers of hours flown by different categories of aircraft or the associated projects of GA aircraft operations handled by FAA and contract control towers, TRACONs, or en route centers, most of which increase steadily from 2010 (or 2011 in the case of the control towers). While the number of hours flown by single-engine piston aircraft is projected to decline by about 6 percent from 2010 to 2017, the number of active student pilots is projected to decline by about 8 percent over the same period, while the number of active private pilots is projected to decline by about 7 percent. While these differences are not large, they imply a small increase in the average number of hours flown per pilot at a time when the number of active pilots is declining.

FAA Terminal Area Forecast

The latest FAA Terminal Area Forecast (FAA, 2011b) provides projections at the airport level for the period from 2010 to 2030 using a base year of 2009 for the following general aviation metrics:

- Itinerant aircraft operations
    - Air taxi
    - General aviation
    - Military
- Local aircraft operations
    - Civil (general aviation)
    - Military
- Based aircraft:
    - Single-engine propeller fixed wing
    - Multi-engine propeller fixed wing

- Jet fixed wing
- Helicopters
- Other

The category of air taxi operations is ambiguous, because in the case of commercial service airports it includes regional airport (also termed commuter airline) operations, as well as true air taxi (Part 135) operations.

The forecasts cover 42of the 54 airports in the regionthat are currently available for public use, as well as Palmdale Regional Airport, which is currently operating as a military airfield and may only be used by civilian flights on a pre-arranged basis. The following airports are not included in the TAF data:

Imperial County

Cliff Hatfield Memorial Airport, Calipatria (CLR)

Holtville Airport (L04) (closed)

Salton Sea Airport, Salton City (SAS)

Los Angeles County

Agua Dulce Airpark (L70)

Catalina Airport, Avalon (AVX)

Riverside County

Bermuda Dunes Airport (UDD)

Chiriaco Summit Airport (L77)

Desert Center Airport, Palm Desert (CN64)

FlaBob Airport, Riverside (RIR)

Perris Valley Airport, Perris (L65)

San Bernardino County

Baker Airport (0O2)

Hesperia Airport (L26)

Roy Williams Airport, Joshua Tree (L80) (closed)

Yucca Valley Airport (L22)

Ventura County

Santa Paula Airport (SZP)

The forecast general aviation activity for each county and the region as a whole for 2010 and 2030 is shown in Table 3-1.

Table 3-1. Forecast Aircraft Operations – FAA Terminal Area Forecast

		Itinerant Operations				Local Operations		
County		Air Taxi	GA	Military	Total	GA	Military	Total
Imperial								
	2010	2,287	46,280	1,720	50,287	53,134	0	53,134
	2030	2,287	46,280	1,720	50,287	53,134	0	53,134
	Growth	0.0%	0.0%	0.0%	0.0%	0.0%		0.0%
Los Angeles								
	2010	147,189	730,634	11,939	889,762	597,667	10,572	608,239
	2030	206,125	867,105	11,717	1,084,947	692,125	10,572	702,697
	Growth	40.0%	18.7%	-1.9%	21.9%	15.8%	0.0%	15.5%
Orange								
	2010	10,423	154,510	67	165,000	100,807	58	100,865
	2030	10,702	205,488	67	216,257	117,628	58	117,686
	Growth	2.7%	33.0%	0.0%	31.1%	16.7%	0.0%	16.7%
Riverside								
	2010	19,938	208,893	2,590	231,421	236,780	218	236,998
	2030	30,793	223,468	2,590	256,851	245,208	218	245,426
	Growth	54.4%	7.0%	0.0%	11.0%	3.6%	0.0%	3.6%
San Bernardino								
	2010	21,059	203,901	24,446	249,406	323,848	9,257	333,105
	2030	23,354	228,751	24,446	276,551	342,145	9,257	351,402
	Growth	10.9%	12.2%	0.0%	10.9%	5.6%	0.0%	5.5%
Ventura								
	2010	8,531	95,408	136	104,075	111,108	73	111,181
	2030	9,968	100,888	136	110,992	116,136	73	116,209
	Growth	16.8%	5.7%	0.0%	6.6%	4.5%	0.0%	4.5%
SCAG Region								
	2010	209,427	1,439,626	40,898	1,689,951	1,423,344	20,178	1,443,522
	2030	283,229	1,671,980	40,676	1,995,885	1,566,376	20,178	1,586,554
	Growth	35.2%	16.1%	-0.5%	18.1%	10.0%	0.0%	9.9%

The projected growth in itinerant and local GA operations at a regional level (16 percent and 10 percent respectively) are somewhat lower than the forecast growth in total hours flown by single-engine piston aircraft in the FAA national Aerospace Forecasts, which are projected to grow by 19 percent between 2010 and 2031. Since this category of aircraft accounts for the majority of local operations, this suggests that either that the FAA is projecting future growth in general aviation activity in the Southern California region to be well below the national average or that there is a significant disconnect between the TAF projections and the FAA Aerospace Forecast projections.

While the projected growth in itinerant GA operations at a regional level is somewhat higher, these operations include almost all the activity by jet aircraft, the flight hours for which are projected to almost triple between 2010 and 2031 in the FAA national Aerospace Forecast. Although the FAA airport operations counts do not distinguish between operations by piston aircraft and those by jet aircraft, the hours flown by turbine aircraft in 2010 are about half those flown by piston aircraft, according to the data presented in the FAA Aerospace Forecast. If the average flight duration of turbine aircraft is twice that of piston aircraft, this suggests that turbine aircraft account for about 20 percent of airport itinerant GA operations in 2010. Thus a tripling of flight hours by turbine aircraft, assuming that average flight duration remains about the same, would increase the total number of itinerant operations by about 55 percent, or about three times the increase in flight hours projected for single-engine piston aircraft.

The results for each county shown in Table 3-1 suggest that growth rates vary widely across the counties, with Orange County having by far the highest growth in GA aircraft operations for both itinerant and local operations, followed by Los Angeles County, with the airports in Imperial County projected to have no growth in aircraft operations at all. This is largely a consequence of the fact that none of the airports in Imperial County have a control tower, and the TAF forecast methodology generally assumes no growth at airports without a control tower.

The forecast growth in the number of based aircraft at a regional level is shown in Table 3-2. Generally the number of based aircraft increases by more than the number of GA itinerant and local aircraft operations, which implies a reduction in aircraft utilization. While this could occur if new aircraft are added to the fleet without replacing the older ones, which then experience a dramatic reduction in utilization and pull down the fleet average utilization, this is also inconsistent with the national forecasts of aircraft flight hours. In particular, the 18 percent increase in the number of jet aircraft based in the region is entirely inconsistent with the forecast tripling of aircraft flight hours.

Table 3-2. Forecast Based Aircraft – FAA Terminal Area Forecast

	Single engine Piston	Multi engine Piston	Jet	Helicopter	Other	Total
SCAG Region						
2010	6,399	814	687	338	225	8,463
2030	7,759	1,053	810	407	225	10,254
Growth	21.3%	29.4%	17.9%	20.4%	0.0%	21.2%

Recent Trends in Based Aircraft and Aircraft Operations in Southern California

In order to put the FAA forecasts into context, it is worth considering the trends in the number of based aircraft and GA aircraft operations at airports in the Southern California region over the past ten years.

Data on the number of general aviation aircraft based at each airport are given on the FAA Form 5010 *Airport Master Record*, divided into the following categories:

- Single-engine propeller aircraft
- Multi-engine propeller aircraft
- Jet aircraft
- Helicopters
- Gliders
- Ultra-light aircraft
- Military aircraft

Although the FAA Form 5010 only provides the most recent count of based aircraft at each airport, the Caltrans Division of Aeronautics (DOA) maintains a database of historical data from the FAA Form 5010 for each airport in the state. Using the Caltrans database, the based aircraft counts for each airport were assembled for the period 2001 to 2010, and the total for the Southern California region calculated, as shown in Table 3-3.

Table 3-3. Trend in Based Aircraft – Southern California Region

Year	Single Engine Propeller	Multi Engine Propeller	Helicopter	Glider	Jet	Military	Ultralight	Total
2001	8,752	1,068	216	138	329	35	149	10,687
2002	8,649	1,227	248	134	631	44	149	11,082
2003	8,668	1,227	248	134	362	44	147	10,830
2004	8,668	1,227	248	134	362	44	147	10,830
2005	8,669	1,230	248	134	362	44	147	10,834
2006	8,778	1,090	276	102	449	63	156	10,914
2007	8,757	1,055	267	103	549	64	154	10,949
2008	8,463	1,062	269	104	623	64	152	10,737
2009	8,116	993	286	101	627	45	150	10,318
2010	7,919	935	314	103	776	47	178	10,272

The total number of based aircraft in the region increased from 2001 to 2002 then remained fairly stable until 2007, since when it has declined steadily to a level in 2010 about 6% below that of 2007. However, this overall trend conceals significant differences among the various categories of aircraft. Over the ten year period the number of based jet aircraft and helicopters has increased significantly, by 136% and 45% respectively, while the numbers of single-engine and multi-engine propeller aircraft have declined. The number of single-engine propeller aircraft, which comprised 82% of the fleet in 2001, has declined by about 10% over the ten-year period and by 2010 comprised only about 77% of the fleet, while the number of multi-engine propeller aircraft has declined by about 12% over the period. The number of gliders has declined by about 25% over the ten-year period, while the number of ultra-light aircraft has increased by about 20%.

Data on the number of general aviation aircraft operations at each airport are available from two different sources. Airport operations counts for towered airports (those with a control tower) are available from the FAA Air Traffic Activity Data System (ATADS) at http://aspm.faa.gov. This provides daily, monthly, and annual traffic counts, distinguishing between air carrier, air taxi, general aviation, and military operations, with separate counts for local and itinerant operations, Estimates of annual operations at non-towered airports are available from the FAA Form 5010 data, separated into air carrier, air taxi, GA local ,GA itinerant, and military operations.

Aircraft operations counts for each airport were obtained from the TAF database, supplemented with data from the Caltrans DOA Form 5010 database for airports not included in the TAF database or where the TAF database was missing data for particular years. The resulting counts for each airport were summed to give the regional totals shown in Table 3-4.

Table 3-4. Trend in Aircraft Operations – Southern California Region

	Itinerant Operations					Local Operations		
Year	Air Carrier	Air Taxi	General Aviation	Military	Total Itinerant	General Aviation	Military	Total Operations
2001	816,749	378,194	2,064,481	47,643	3,307,067	1,836,982	22,174	5,166,223
2002	706,603	351,509	2,101,140	46,248	3,205,500	1,841,830	17,283	5,064,613
2003	709,012	351,419	2,064,131	46,004	3,170,566	1,810,344	16,771	4,997,681
2004	733,320	367,024	1,999,926	47,094	3,147,364	1,783,320	21,003	4,951,687
2005	730,556	385,531	1,978,467	48,070	3,142,624	1,774,894	22,024	4,939,542
2006	735,023	367,870	1,895,914	46,066	3,044,873	1,669,023	30,417	4,744,313
2007	747,948	381,418	1,844,919	43,464	3,017,749	1,695,764	30,123	4,743,636
2008	734,353	363,596	1,692,746	41,269	2,831,964	1,644,991	23,650	4,500,605
2009	687,430	243,001	1,551,533	40,778	2,522,742	1,574,560	21,127	4,118,429
2010	697,089	219,693	1,551,208	40,968	2,508,958	1,571,944	20,178	4,101,080

Overall, total operations, including air carrier and air taxi, have declined by about 21% from 2001 to 2010. This decline has occurred in all categories of operation, but the decline in general aviation (GA) and air taxi has been steeper than for air carrier operations. While air carrier operations declined by about 15% over the period, air taxi operations declined by over 40%. However, the decline in air taxi operations has occurred mostly in the two-year period from 2008 to 2010. Over the ten-year period, GA itinerant operations declined by about 25% and GA local operations declined by about 16%.

Therefore, in contrast to the growth projected in the TAF for airports in the Southern California region, the number of based aircraft has been fairly stable until recent years, when it has started to decline, while the number of aircraft operations has been declining steadily for the past decade.

4. Pilot Cohort Analysis

A key element of the planned forecast approach is an analysis of expected future changes in the composition of the pilot community in Southern California and the implications for the amount and type of flying that this pilot community will perform.

This chapter summarizes previous studies into characteristics of the general aviation pilot community and recent trends in the composition and activity levels of the GA pilot community, available data on the composition and activity levels of the GA pilot community, and the results of the analysis of those data undertaken as part of the current study. In addition the chapter presents the relevant findings from the results of a survey of members of the Aircraft Owners and Pilots Association (AOPA) that was conducted by SCAG and the California Department of Transportation (Caltrans) Division of Aeronautics with the support of the AOPA.

Previous Studies

In spite of the large amount of general aviation activity and the number of general aviation airports in the United States and the recurring need to prepare forecasts of future general aviation activity as part of studies to update airport master plans, prepare statewide and regional airport system plans, and for other purposes, recent trends in the composition of the GA pilot community and the flying activity undertaken by those pilots has received surprisingly little attention in the aviation planning literature.

A small number of studies have examined changes in the characteristics of the pilot population over time, although these have most commonly addressed the influence of pilot characteristics on accident risk (e.g. Li, Baker, *et al.*, 2003; Rebok, Qiang, *et al.*, 2009). A study in the early 1970s (Booze, 1972) examined pilot attrition by age and a more recent study (Rogers, Véronneau, *et al.*, 2009) examined changes in the pilot population over time from 1983 to 2005. The latter study was undertaken in order to examine the effect of changes in the regulations that raised the age limit for pilots to perform the duties of pilot or co-pilot of a commercial passenger or cargo aircraft with ten or more passenger seats or 7,500 payload-pounds of cargo capacity from age 60 to 65, although the analysis in the study addressed broader trends. This study showed that the average age of pilots has been steadily increasing, and with it the average number of flight hours experience.

Pilot Attrition

Pilot attrition refers to the percentage of active pilots holding a given pilot certificate who stop flying for whatever reason. Reasons for a pilot to become inactive include age, medical reasons, loss of interest, or financial limitations. Pilots report the number of hours they have flown in the previous six months as well as their total flight time to date when they apply to renew their medical certificate. If a pilot fails to renew his or her medical certificate when it expires, the FAA classifies that pilot as inactive until such time as the pilot again applies for a medical certificate. In July 2008 the FAA extended the validity of a third class medical certificate (required for pilots holding a private pilot or recreational pilot certificate, or for student pilots flying solo) for pilots under age 40 from three years to five years from the date of issue. A third class medical certificate for pilots age 40 and over is valid for two years from the date of issue. Thus the first indication in the FAA pilot registration database that a student, private or recreational pilot under age 40 is no longer active is five years after their most recent medical certificate was issued, although of course they could have stopped flying well before that. This is particularly true for student pilots, who may have effectively given up learning to fly fairly soon after receiving their medical certificate.

In spite of the obvious importance of the extent of and trends in pilot attrition to the future size and composition of the GA pilot community, a review of the literature on the composition of the GA pilot community failed to identify any studies on recent trends in pilot attrition. Indeed the only formal study on the topic by Booze (1972) is now very dated, although the basic pattern of the attrition rates found in that study may still be reasonably valid. Although the study by Booze was primarily intended to explore the effect of the occurrence of medical problems on attrition from active airman status, it found that these only accounted for less than one percent of the overall attrition rate of active airmen, which Booze stated amounted to approximately 17 percent annually (although the data presented in the report suggest a somewhat higher figure of about 21 percent annually).

At the time of the study, a third class medical certificate was valid for 24 months. The study classified all airmen who obtained a medical certificate of any class in 1968 but did not hold a valid medical certificate 24 months later in 1970 to have become inactive. These airmen were termed the “attrition group,” which comprised 151,917 airmen. The report presents a breakdown of the attrition group by age (in five-year increments) and class of medical certificate.

The report gives the total active airman population at the end of 1970, but does not show the age breakdown or how this was divided among the various levels of pilot certificate. Although the report refers to “airmen” throughout, the data for the population of active airmen indicates that the study only considered those holding pilot certificates, and not those holding non-pilot airman certificates. The report does provide the average age for the active airman population holding the various classes of medical certificate, as well as the corresponding average ages for the attrition group. The report also provides data on the total flight time and flight time in the six months prior to the last medical examination for the attrition group, but not for the population.

The average age for airmen in the attrition group and the active airman population holding each class of medical certificate is shown in Table 4-1.

Table 4-1. Average Age of Active Airmen Population and the 1970 Attrition Group

	Class of Medical Certificate		
	Third	Second	First
Airmen Population	35.4	35.1	35.1
Attrition Group	34.0	35.2	30.9

Source: Booze, 1972.

The average age for airmen in the attrition group holding a third class medical certificate is somewhat lower than for the corresponding population of active airmen, as could be expected since attrition is likely to be higher among younger airmen, particularly student pilots who do not progress to a private pilot certificate or become inactive soon after gaining their private pilot certificate. The average age for airmen in the attrition group holding a second class medical certificate is almost the same as the corresponding population of active airmen (actually slightly higher), suggesting that the attrition rate in this category of airmen is fairly constant across the different age ranges. The average age for airmen in the attrition group holding a first class medical certificate is significantly lower than the average age of the corresponding population of active airmen, again as could be expected due to younger pilots obtaining a first class medical certificate in the hope of pursuing a career as an airline pilot but giving up for a variety of reasons.

The number of airmen in the attrition group by age, class of medical certificate, and whether they had a previous medical examination to the one for the certificate that had just expired is shown in Table 4-2.

Table 4-2. Age Distribution of the 1970 Attrition Group

	Attrition Group 1968-1970 by Medical Certificate Class					
	Third Class		Second Class		First Class	
Age Group	Prev Exam	No Prev Exam	Prev Exam	No Prev Exam	Prev Exam	No Prev Exam
<20	65	4,861	23	260	13	132
20-24	3,362	16,908	2,435	3,494	727	1,122
25-29	4,867	13,903	5,086	4,206	1,382	1,000
30-34	5,305	8,791	4,567	2,085	1,143	400
35-39	5,778	6,573	4,435	1,377	536	177
40-44	7,076	5,182	3,206	842	278	72
45-49	5,906	3,496	3,882	1,033	309	81
50-54	3,649	1,833	2,493	531	234	35
55-59	2,165	799	831	114	96	12
60-64	1,051	283	299	22	93	
65-69	465	99	151	11	4	1
70-74	133	18	38	1	1	
75-79	47	7	9	1		
80-84	10	1		1		
>84	3					
Total	39,882	62,754	27,455	13,978	4,816	3,032

Source: Booze, 1972.

Airmen with no previous medical examination can be assumed to be mostly student pilots, although it would be possible for a fairly determined student pilot to advance to private pilot or even commercial pilot within the 24-month validity period of the initial medical certificate. The number of pilots holding a second-class or first-class medical certificate with no previous medical examination is initially surprising, although this could result from student pilots who intended to progress to a commercial or airline transport pilot certificate and obtained the appropriate medical certificate on their first medical examination.

As could be expected, the largest component of the attrition group is airmen holding a third class medical certificate with no previous medical examination, since this group largely comprises student pilots who become inactive within the first two years of their initial medical certificate. The age distribution of airmen holding a first class medical certificate who become inactive is surprising for the relatively small number of this group who become inactive at age 60.. At the time of the study, airmen holding an airline transport pilot certificate (which requires a first-class medical certificate) could no longer exercise the privileges of that certificate after they reached age 60. They could continue to fly as a private or commercial pilot as long as they held a valid medical certificate appropriate for the type of flying they were doing, so it is possible that many airline pilots continued to maintain a valid medical certificate after they reached age 60, and therefore .were not included in the attrition group.

Although the report by Booze does not provide a comparable age distribution of the active airmen population, a copy of the *1969 U.S. Civil Airmen Statistics* (FAA, 1970) was located in the library of the Institute of Transportation Studies at the University of California, Berkeley, which included the age distribution of active pilots by type of pilot certificate, as shown in Table 4-3.

Table 4-3. Active U.S. Pilots by Age Group, 1969

	Active Pilots, as of December 31, 1969				
Age Group	Student	Private (Note 1)	Commercial (Note 2)	Airline Transport	Total
<20	24,995	7,508	627		33,130
20-24	50,498	33,036	15,662	164	99,360
25-29	42,490	42,693	38,057	1,712	124,952
30-34	28,157	42,076	29,309	3,735	103,277
35-39	21,675	44,767	26,155	5,480	98,077
40-44	16,139	49,387	18,559	5,030	89,115
45-49	10,287	38,817	30,103	8,134	87,341
50-54	5,411	23,212	15,879	4,818	49,320
55-59	2,464	12,211	5,348	1,648	21,671
60+	1,404	8,411	3,249	721	13,785
Total	203,520	302,118	182,948	31,442	720,028

Notes: 1. Includes glider (only)

2. Includes helicopter (only) and other

Source: FAA, 1970.

Because the data on the age distribution of the attrition group were expressed in terms of medical certificate held while the data on active pilots were expressed in terms of the pilot certificate, it was necessary to make a number of assumptions in order to relate the two datasets:

- All pilots in the attrition group with no previous medical examination were assumed to be student pilots
- All pilots in the attrition group holding a third-class medical certificate with a previous medical examination were assumed to hold a private pilot certificate
- All pilots in the attrition group holding a second-class medical certificate with a previous medical examination were assumed to hold a commercial pilot certificate
- The attrition rate for pilots holding a first-class medical certificate with a previous medical examination and between the ages of 20 and 34 was assumed to be the same for pilots holding a commercial pilot certificate or an airline transport certificate
- All pilots in the attrition group holding a first-class medical certificate with a previous medical examination and aged 45 or above were assumed to hold an airline transport certificate.

The fourth assumption shown above implies that the number of pilots in the attrition group holding a first-class medical certificate with a previous medical examination and holding either a commercial pilot or an airline transport pilot certificate was proportional to the number of active pilots holding those pilot certificates. The fifth assumption shown above is based on the underlying assumptions that pilots holding a commercial pilot certificate with the intention of becoming an airline pilot or taking a job that requires an airline transport pilot certificate will have done so by age 45 and that since the first-class medical certificate requires more frequent medical examinations (every six months), a pilot holding a commercial pilot certificate who does not require a first-class medical certificate will choose to obtain a second-class medical certificate instead. In addition, it was assumed that the attrition rate for pilots holding an airline transport pilot certificate aged 35 to 44 is the same as for those aged 30 to 34.

These assumptions allow the number of pilots in the attrition group in each age range holding the different classes of medical certificate to be assigned to an assumed type of pilot certificate and the resulting attrition rate by age group and type of pilot certificate calculated, as shown in Table 4-4. Since the attrition group was defined as the number of pilots who obtained a medical certificate in 1968 but did not hold a valid medical certificate two years later, the annual attrition rates are approximately half those shown in Table 4-4.

Table 4-4. Two-Year Attrition Rates of Active U.S. Pilots by Age Group, 1968-1970

	Attrition Rate by Pilot Certificate			
Age Group	Student	Private	Commercial	Airline Transport
<20	21.0%	0.9%	5.7%	
20-24	42.6%	10.2%	20.1%	4.6%
25-29	45.0%	11.4%	16.8%	3.5%
30-34	40.0%	12.6%	19.0%	3.5%
35-39	37.5%	12.9%	18.3%	3.5%
40-44	37.8%	14.3%	17.8%	3.5%
45-49	44.8%	15.2%	12.9%	3.8%
50-54	44.3%	15.7%	15.7%	4.9%
55-59	37.5%	17.7%	15.5%	5.8%
60+	31.7%	20.3%	15.3%	13.6%
Total	39.2%	13.2%	16.9%	15.3%

Source: Author calculations as discussed in text.

As can be expected, the estimated attrition rates for student pilots are significantly higher than for the other types of pilot certificate, although apart from those student pilots under 20 do not vary greatly with age. Attrition rates for student pilots increase through their twenties, then decline through their thirties, increase again through their forties, then decline thereafter. In contrast, attrition rates for private pilots increase steadily with age. Attrition rates for commercial pilots also do not vary greatly with age, being are highest in their early twenties, as could be expected as those initially seeking a career as a commercial pilot are unable to find a job or find the career less attractive than they had expected and give up. The attrition rate drops slightly in their late twenties before rising again in their early thirties, then declining until their late forties and remaining fairly constant from their early fifties on. Attrition rates for airline transport pilots remain fairly low until their mid-forties then increase steadily until their sixties, when airline transport pilots (at the time) were no longer allowed to fly airline aircraft.

While the variation of these estimated attrition rates by age seem inherently plausible, they should be viewed with some caution due to the assumptions required to combine the data on the size of the attrition group by class of medical certificate with the number of active pilots by type of pilot certificate.

Weighting the attrition rates for each type of pilot certificate by the number of active pilots holding that type of certificate gives an overall attrition rate over two years of 21.6% of all active pilots, or an average attrition rate per year of about 10.8%.

Since the number of active pilots in each age range holding a given type of pilot certificate changes from year to year, reflecting the number of new pilot certificates issued as well as those pilots becoming inactive, the estimated annual attrition rates are only approximate. However, the growth in the size of the pilot population during the period of the study was slowing fairly rapidly, as shown in Table 4-5, increasing by only about one percent from 1969 to 1970, suggesting that attrition rates based on the active pilot population at the end of 1969 (two thirds of the way through the attrition period used in the study) provide a reasonable estimate of the average attrition rate.

Table 4-5. U.S. Active Pilot Population, 1968-1970

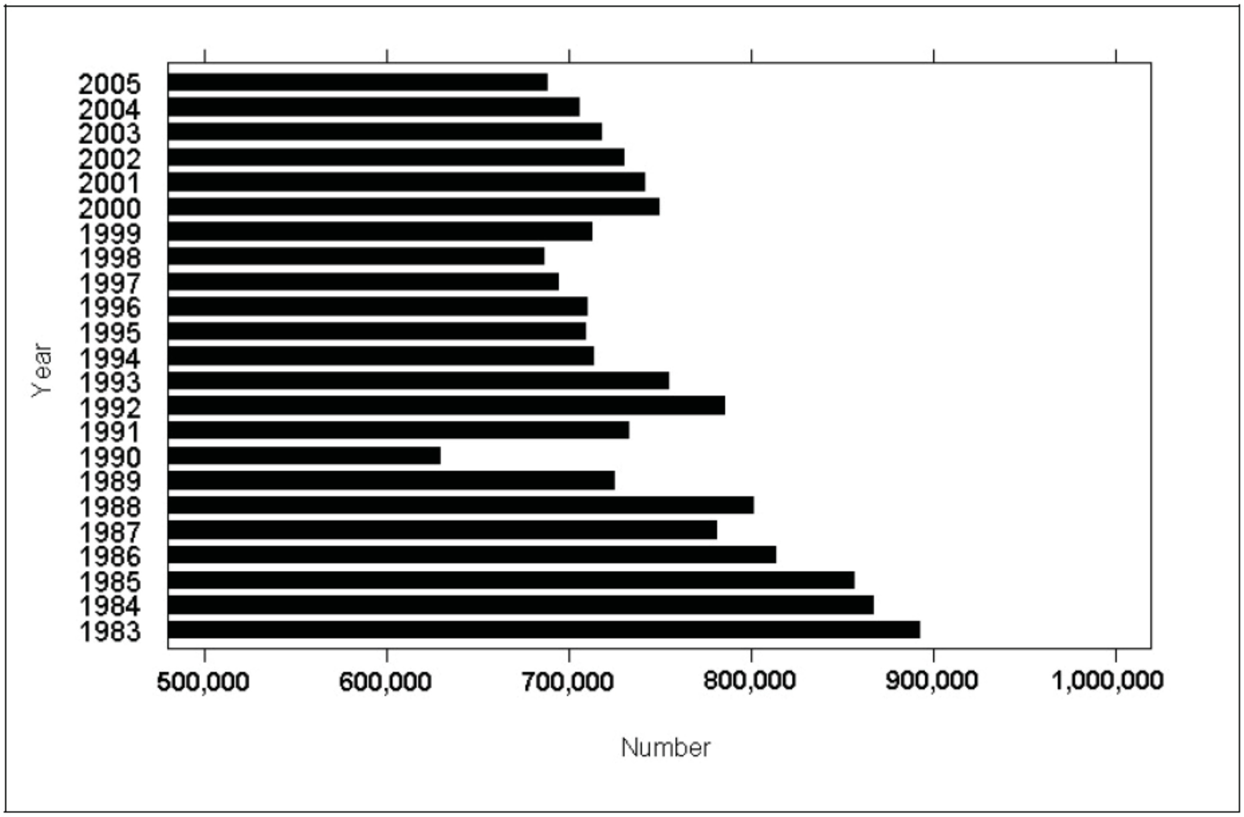
	Active Pilot Population as of December 31	Growth
1967	617,931	
1968	691,695	11.9%
1969	720,028	4.1%
1970	727,430	1.0%

Source: FAA, 1970; Booze, 1972.

Recent Trends in the Pilot Community

The recent study of the U.S. pilot population by the FAA Civil Aerospace Medical Institute (Rogers, Véronneau, *et al.*, 2009) combined data on the number of pilot certificates held and airmen medical certificates issued to analyze changes in the size and composition of the pilot community as well as the average flight hours reported by pilots at the time of their most recent medical examination (pilots report their total flight hours to date on the application form for a medical examination). Although the authors frequently refer to “active airmen” in the report, the description of the study makes it clear that the analysis only considered active pilots and not non-pilot airmen (such as flight engineers).

The study showed that the number of active pilots has been steadily declining each year since 1983, as shown in Figure 4-1, although with some apparent short-term increases in several years.



Source: Rogers, Véronneau, *et al.*, 2009

Figure 4-1. Number of Active Pilots per Year

The authors note that the apparent drop in the number of active pilots in 1990 is a data anomaly due to a technical problem in the entry of the results of medical examinations conducted in 1989 into the electronic records at the time that resulted in data for a large number of the medical examinations being omitted from the electronic records. This impacted the estimate of the number of active pilots for 1989 and the following two years, because those pilots whose medical examination results were omitted from the electronic records were erroneously counted as having become inactive until the results of their next medical examination caused them to be counted as active again. This effect persisted for two years because third class medical certificates at the time were valid for 24 months, so even pilots who had a first-class medical certificate, which was only valid for six months, .were considered active for two years from the date of their last medical since they could continue to exercise the privileges of a third-class medical certificate for two years.

The authors also note that the drop in the number of active pilots in 1986 and 1987, and again in 1993 and 1994, were due to unexplained missing records for medical examinations in 1986 and 1993, which resulted in a number of pilots being incorrectly classified as inactive for up to two years.

A change in the rules governing the validity of medical certificates in September 1996 contributed to the apparent increase in active pilots in 1999 and 2000. The rule change extended the validity of third-class medical certificates for pilots under the age of 40 at the time of their medical examination to three years. This resulted in pilots who would otherwise have been counted as inactive two years later being counted as active for an additional year.

The number of active pilots shown in Figure 4-1 for a given year is significantly higher than the number reported in the annual FAA *U.S. Civil Airmen Statistics* (FAA, 2011e) for the same year. The report does not comment on or explain this discrepancy, but it appears to result from a different way of counting active pilots for a given year. The *U.S. Civil Airmen Statistics* counts active airmen for a given year as those holding a valid medical certificate as of December 31 of that year. The authors mention that for each pilot in their database they calculate a variable called "months contributed" which measures the number of months in the year that the pilot held a valid medical certificate. Although the report does not state how the number of active pilots in a given year is determined, it seems plausible that pilots who become inactive during the year are counted as a fraction of an active pilot based on the number of months they were considered active (since otherwise there would be no reason to calculate the variable "months contributed"). This would give a higher total of active pilots for a given year than the *U.S. Civil Airmen Statistics*, since pilots becoming inactive during the year are not counted in the total for that year using the approach adopted in the *U.S. Civil Airmen Statistics*.

Assuming this to be the case, this has an interesting side effect that the difference between the number of active pilots for a given year given in the report and that given in the *U.S. Civil Airmen Statistics* provides a direct measure of the attrition rate for that year. Unfortunately, since the more detailed data on active pilots in the report are presented in terms of the class of medical certificate held, while the data in the *U.S. Civil Airmen Statistics* are presented in terms of the type of pilot certificate held, estimating differences in attrition rate by type of pilot certificate, which as suggested by the earlier study by Booze (1972) are likely to be significant, would require assumptions about the proportion of active pilots holding a given class of medical certificate who also hold a given type of pilot certificate. Furthermore, the authors only present the results of their analysis graphically in the report, and do not provide the underlying numerical data, so it is necessary to measure the values from the figures, which introduces some inaccuracy in any analysis.

Even so, the resulting estimates of the overall attrition rate of active pilots shown in Table 4-6 provide a useful check on the earlier estimates by Booze (1972), as well as providing an indication of the extent to which attrition rates appear to been changing over time.

Table 4-6. Annual Attrition Rate of Total Active Pilot Population

	Active Pilots		
Year	Partial Year Data	As of Dec. 31	Attrition Rate
1983	892,000	718,004	
1984	866,000	722,376	20.0%
1985	856,000	709,540	20.3%
1986	813,000	709,118	14.6%
1987	781,000	699,653	11.5%
1988	801,000	694,016	15.3%
1989	726,000	700,010	3.7%
1990	629,000	702,659	
1991	734,000	692,095	6.0%
1992	785,000	682,959	14.7%
1993	753,000	665,069	12.9%
1994	714,000	654,088	9.0%
1995	710,000	639,184	10.8%
1996	710,000	622,261	13.7%
1997	694,000	616,342	12.5%
1998	686,000	618,298	11.0%
1999	714,000	635,472	12.7%
2000	750,000	625,581	19.6%
2001	742,000	612,274	20.7%
2002	730,000	631,762	16.0%
2003	718,000	625,011	14.7%
2004	706,000	618,633	14.0%
2005	686,000	609,737	12.3%

Source: Author calculations as discussed in text.

The calculated attrition rates vary from 9% per year to about 21% per year, and appear to have been declining from 2001 to 2005, the last year of data in the study. No attrition rate could be calculated for 1990 due to the data anomaly in 1990 discussed above, and the attrition rates for 1989 and 1991 appear to be unreasonably low, possibly for reasons related to the 1990 data anomaly. Excluding these three years, the average attrition rate for the period from 1998 to 2005 is 14.5% per year. This rate is somewhat higher than the average annual attrition rate across all active pilots of 10.8% found by Booze (1972), but not greatly so and the average value found by Booze lies within the range of values estimated from the data in the study.

Based on the total number of active pilots in each year, the authors developed a regression model of the total number of active pilots in each year that includes a dummy variable to account for the change in duration of the validity of third-class medical certificates in 1996, but otherwise assumes a linear decline in the total number of active pilots over time. The dummy variable was applied to years from 1999 on, assuming that the effect of the rule change did not appear in the estimated number of active pilots until 1999.

This gave the following regression equation:

$$P = 25{,}136{,}097 - 12{,}238.38 * Y + 85{,}691 * D$$

where P = the total number of active pilots in a year

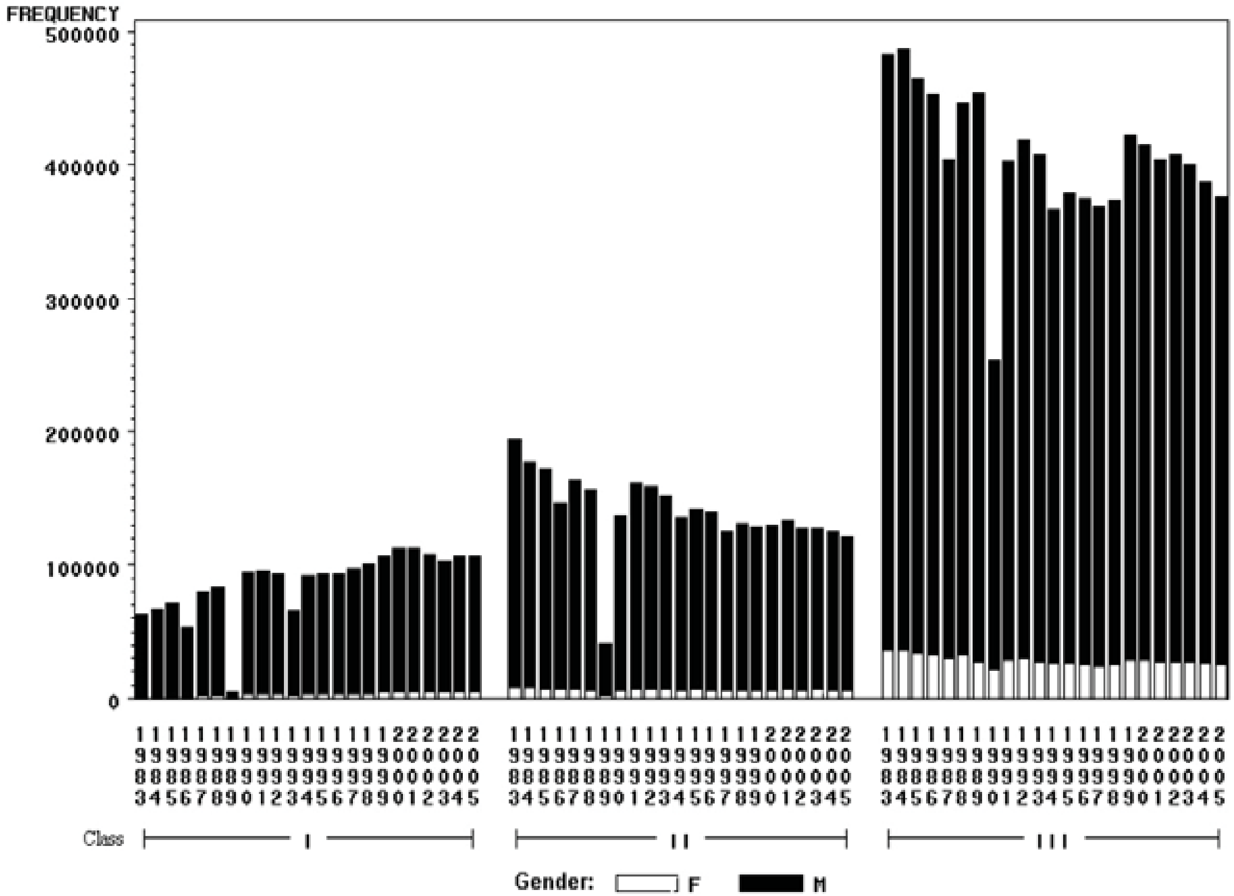
Y = the year

D = a dummy variable set to 1 for years from 1999 on, 0 otherwise

This model suggests that if the trend over the period from 1983 to 2005 continues, the total number of active pilots will decline by about 12,200 per year. This would give an estimated number of active pilots in 2010 of 622,646. In fact the number of active pilots at the end of 2010 according to the *U.S. Civil Airmen Statistics* was 627,588. However, the regression model is based on the definition of active pilots used in the study, which gives a higher estimate of active pilots from the *U.S. Civil Airmen Statistics* by about 15%, for the reasons discussed above, as shown in Table 4-6. In addition, a further change in the rules governing the duration of the validity of medical certificates in July 2008 increased the duration of the validity of third-class medical certificates for pilots under age 40 to five years, which would have the effect of increasing the number of pilots considered to be active. From 2009 to 2010 the number of active student pilots reported in *U.S. Civil Airmen Statistics* increased by about 47,000 (or about 7% of all active pilots in 2010) at a time when the number of active pilots holding most other categories of pilot certificates declined. The combined effect of these two factors suggests that the decline in the number of active pilots since 2005 has been somewhat slower than predicted by the regression model.

In addition to the total number of active pilots, the report provides a breakdown of the number of active pilots by the class of the medical certificate held at the end of each year, as well as by gender, as shown in Figure 4-2. As expected, the data is dominated by the number of pilots holding a third-class medical certificate (student and private pilots). The decline in the number of active pilots over time occurred for pilots holding a second-class medical certificate (primarily those holding a commercial pilot certificate) as well as a third-class medical certificate. The data in Figure 4-2 for active pilots holding a third-class medical certificate clearly shows the increase in the number of active pilots in 1999 due to the change in the validity of a third-class medical certificate for pilots under age 40 that became effective in September 1996 and extended the period of validity from two to three years. This did not begin to affect the number of active pilots until late 1998 when pilots who would otherwise have been considered inactive if they had not renewed their medical certificate were not now counted as inactive for another year.

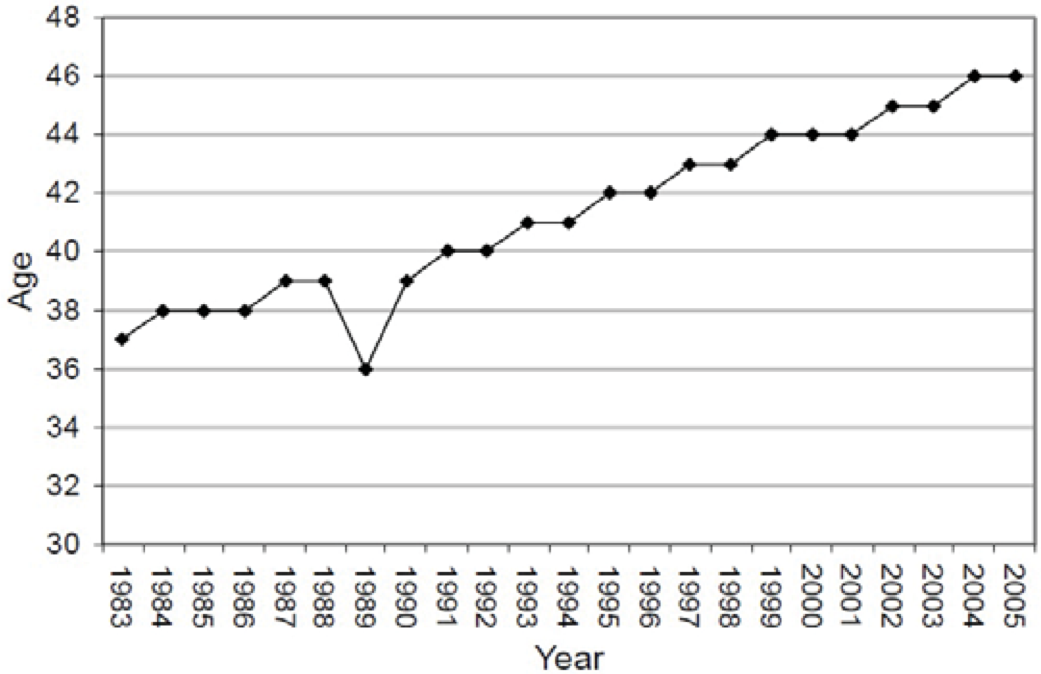
In contrast to the declining trend for pilots holding a third-class or second-class medical certificate, the number of active pilots holding a first-class medical certificate (primarily those holding an airline transport pilot certificate) shows an increasing trend until 2001, followed by a decline through 2003 and a modest recovery in 2004 and 2005. The changes since 2001 would appear to reflect the contraction of the airline industry in the aftermath of the 9/11 terrorist attacks in 2001, followed by the modest recover beginning in 2004. As airlines reduced capacity and furloughed pilots after September 2001, this would have had two effects on the number of active airline pilots. First, some furloughed pilots may have decided not to renew their medical certificate when it expired until it became clear whether they would be able to return to flying, and some may have decided to give up flying permanently. The second effect would have been a significant drop in the number of commercial pilots seeking positions as airline pilots, since with a large number of furloughed pilots there were very few entry-level positions available. As older airline pilots were forced to stop flying by their age, they were not being replaced by younger pilots transitioning from jobs as a commercial pilot, resulting in a decline the number of pilots holding a first-class medical certificate.



Source: Rogers, Véronneau, *et al.*, 2009

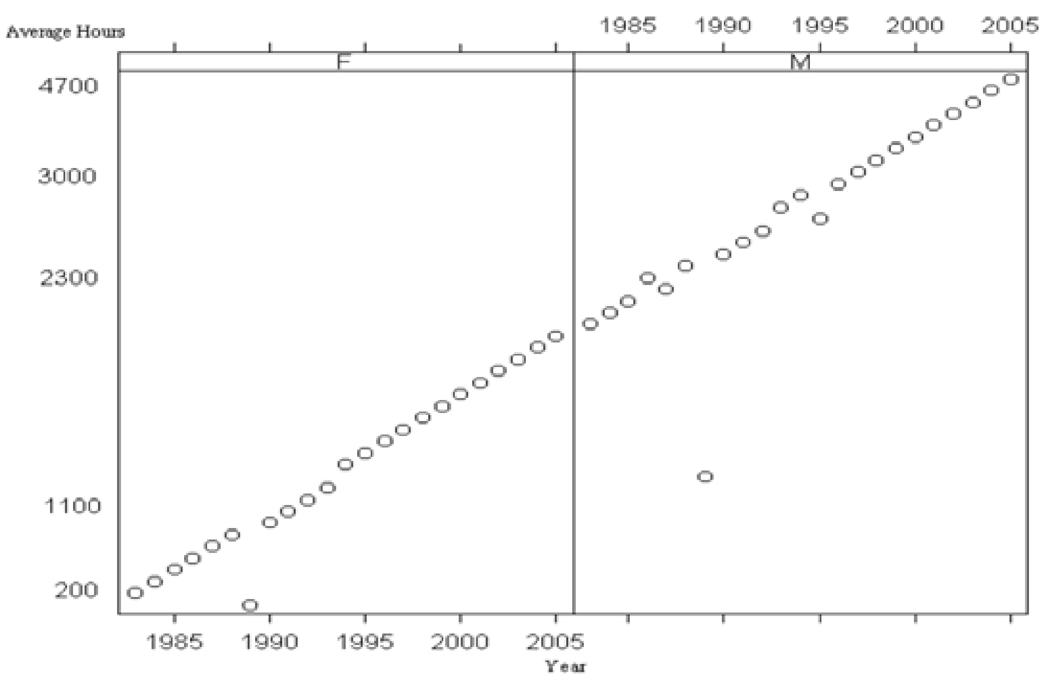
Figure 4-2. Number of Active Pilots by Medical Class and Gender

As the number of new pilot starts declined, the median age of active pilots steadily increased, apart from the 1989 data anomaly, as shown in Figure 4-3. Since pilots accumulate more flight time as they get older, the average total hours flown reported by applicants for a medical examination increased steadily from 1983 to 2005, as shown in Figure 4-4, in which the left panel shows the average total flight hours for female pilots and the right panel shows the average total flight hours for male pilots.



Source: Rogers, Véronneau, *et al.*, 2009

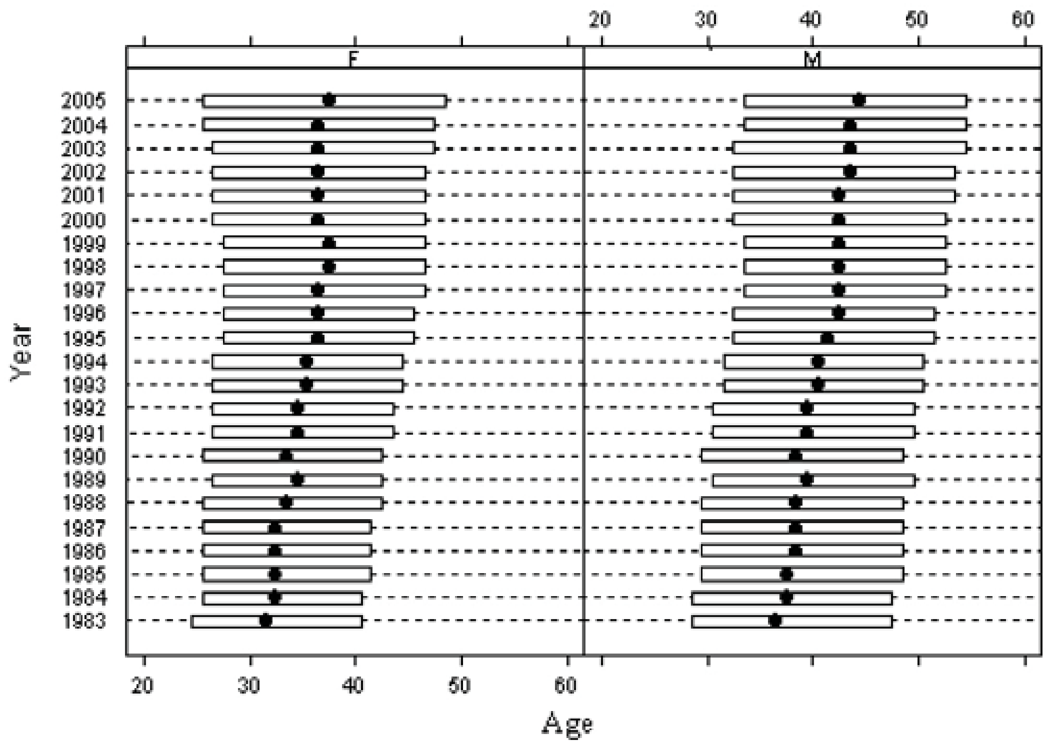
Figure 4-3. Median Age of Pilots Who Received a Medical Examination



Source: Rogers, Véronneau, *et al.*, 2009

Figure 4-4. Average Hours Flown Reported by Pilots at Time of Medical Examination

As can be seen from Figure 4-4, the average total hours flown by female pilots are significantly lower than those of male pilots, as can be expected since the age distribution of female pilots is somewhat younger than that of male pilots, as shown by Figure 4-5. In addition a smaller proportion of female pilots hold commercial pilot or airline transport pilot certificates than male pilots, pilot categories that generally have much higher levels of flight experience.



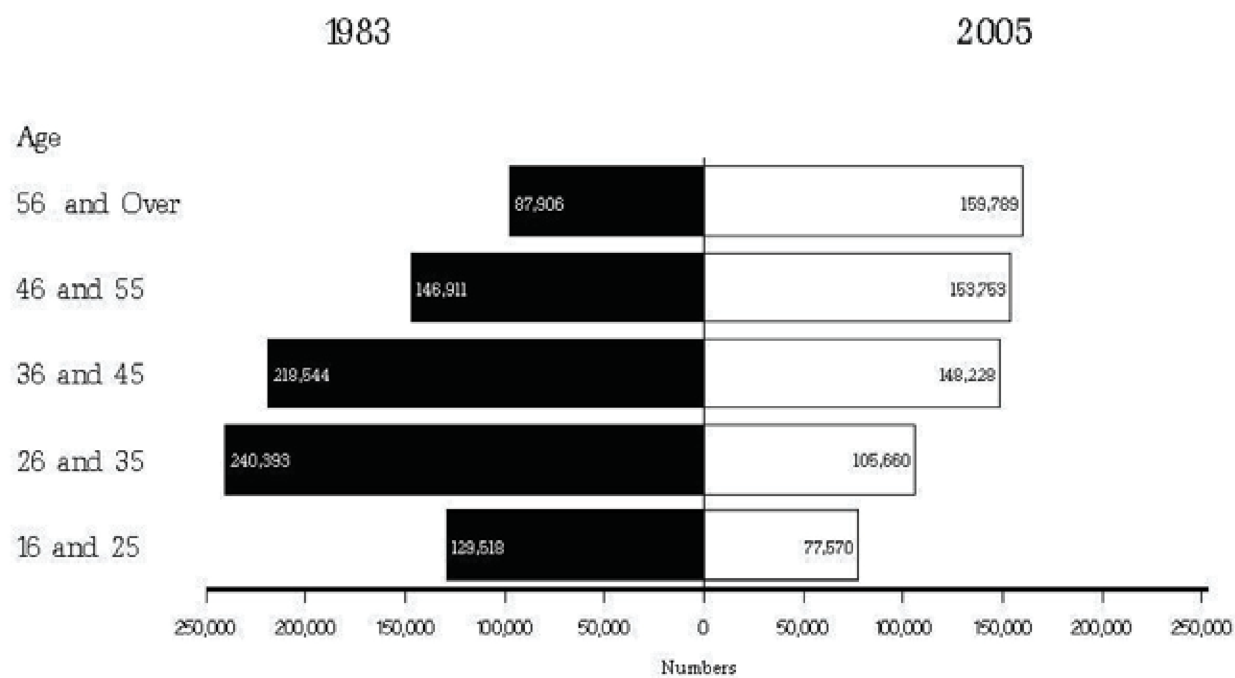
Source: Rogers, Véronneau, *et al.*, 2009

Figure 4-5. Median Age of Active Airmen by Gender

The report provides similar figures for the average flight experience of pilots holding third-class, second-class and first-class medical certificates. These generally show a similar pattern, although the average number of total hours flown for a given year differs between the classes of medical certificates, as could be expected, with holders of first-class medical certificates reporting the highest average flight experience for a given year, followed by the holders of second-class medical certificates. The average number of hours flown by holders of first-class medical certificates also shows the greatest amount of variability from year to year, for reasons that are not entirely clear.

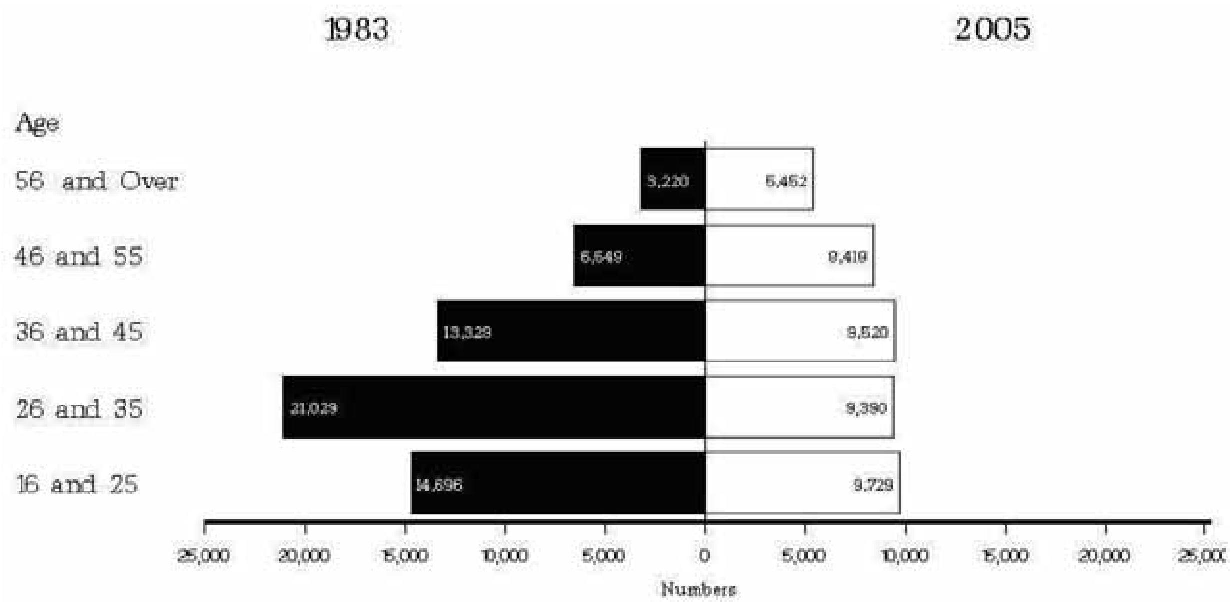
While the report shows the change in average hours flown over time, it does not provide a breakdown of the average hours flown per year by pilots in a given age group, nor numerical values for the average flight hours shown in the figures. In addition, it is clear from Figure 4-4 (and from the other figures in the report for the average flight hours for different classes of medical certificate) that the vertical scale on the figures is non-linear (or the values shown on the vertical axis of the figures are wrong). Either way, this makes it effectively impossible to measure the values from the figures.

The report also presents the data on the age distribution for male and female pilots as population pyramids, as shown in Figures 4-6 and 4-7. The shift in age distribution of male pilots (by far the largest proportion of the pilot community, as shown in Figure 4-2) between 1983 and 2005 is striking. It is clear that as those pilots aged 36 and above in 2005 move into older age cohorts and become inactive they will not be replaced by younger pilots, because there simply are not enough of them in the younger age cohorts. The inevitable conclusion is that the population of active pilots in the U.S. is almost certain to collapse over the next 20 years.



Source: Rogers, Véronneau, *et al.*, 2009

Figure 4-6. Age Pyramid of Active Male Airmen



Source: Rogers, Véronneau, *et al.*, 2009

Figure 4-7. Age Pyramid of Active Female Airmen

Although the age pyramid of female pilots in 2005 does not show a similar decline in the proportion of younger pilots that is shown in Figure 4-6 for male pilots, it also does not show the high proportion of active pilots in the age cohort from 26 to 25 shown in the data for 1983. Given the inevitable attrition that is likely to occur in the number of active female pilots as they move into older age cohorts, the number of active female pilots in the age cohorts aged 26 and younger is not sufficient to sustain the existing female pilot population in the older age cohorts.

Thus while the decline in active female pilots over the next 20 years is not likely to be as severe as for male pilots, it too will decline.

Data on Pilot Characteristics

As discussed in Chapter 2, statistical data on the U.S. pilot population is available from the annual FAA *U.S. Civil Airmen Statistics* (FAA, 2011e), while data on individual pilots can be downloaded from the FAA Airmen Registration Database (FAA, 2011d), including their address, pilot certificates, and date of their most recent medical certificate, although these data do not include the pilot's age or flight experience and exclude the records of airmen who have requested that their address not be released. Although the FAA updates the downloadable data monthly and does not formally archive these data, prior versions remain on the server for about two years and can still be accessed by entering the correct URL for the files and an earlier version from October 2004 was found on a web archive (http://www.archive.org).

As discussed in Chapter 2, the FAA Airmen Certification Branch maintains internal reports on past totals of active airmen by county, and the relevant pages of these reports for California counties were obtained from the Branch staff for a selection of prior years. In addition, in response to a special data request the Airmen Certification Branch staff performed an analysis run that generated the number of active pilots by California county and age range as of December 31, 2010.

Composition of the Southern California Pilot Community

Based on the data on the number of active airmen by California county from the FAA Airmen Certification Branch, the recent trend in the number of active pilots resident in the six-county Southern California region is shown in Table 4-7.

Table 4-7. Recent Trend in the Southern California Pilot Community

	Active Pilots as of December 31				
Type of Pilot Certificate	2001	2006	2008	2009	2010
Student pilot	3,642	4,106	3,654	3,067	5,093
Private pilot	11,272	11,050	11,116	10,492	9,970
Commercial pilot	4,906	5,254	5,370	5,282	5,119
Airline transport pilot	4,926	4,604	4,623	4,567	4,439
Recreational or sport pilot	1	12	49	65	70
Rotorcraft or glider	1,263				
Total	**26,010**	**25,026**	**24,812**	**23,473**	**24,691**

Source: FAA, *Active Airmen Certificate Totals by Region, State, County*, Airmen Certification Branch, Oklahoma City, OK, Personal communication.

Notes: 1. Active airmen holding rotorcraft or glider certificates only were counted separately in 2001, but included in the other categories from 2006 to 2010.

2. The validity of student pilot certificates for pilots under 40 years of age was changed from 36 months to 60 months on July 1, 2010.

The total number of active pilots shows a steady decline from 2001 to 2009. The apparent increase in the number of active pilots holding a student or commercial pilot certificate from 2001 to 2006 is most likely an artifact of the change in the way that pilots holding rotorcraft or glider certificates only were counted in 2001 compared to 2006. The increase in the total number of active pilots from 2009 to 2010 is attributable to the apparent increase in active student pilots. This resulted from a change in the duration of the validity of third-class medical certificates on July 24, 2008 from three to five years for pilots under age 40, as discussed above. The FAA Airman Certification Branch began to reflect the effect of this change in the way that active student pilots are counted by changing the validity of student pilot certificates from 36 to 60 months on July 1, 2010. This increased the assumed number of active student pilots on December 31, 2010 since some pilots whose medical certificate would have expired between July and December under the former rules were still considered active.

It should be noted that the change in validity of a third-class medical certificate from 36 to 60 months with effect from July 2008 also affects private and recreational pilots under age 40 who hold a third-class medicate certificate (the majority of such pilots), although this does not appear to have been taken into account in the FAA data for active airmen as of December 31, 2010.

Because of the changes in the way that FAA counted rotorcraft and glider pilots between 2001 and 2006 and counted active student pilots in 2010, the changes in the number of active pilots between 2006 and 2009 provide the best indication of recent trends in the number of active pilots. The changes in the number of active pilots with each type of certificate over the three-year period are shown in Table 4-8. In the case of pilots holding private, commercial and airline transport certificates, for whom the FAA did not change the way that active pilots were counted, the changes in the number of active pilots from 2009 to 2010 are also shown in Table 4-8.

Over the three year period from 2006 to 2009, the number of active student pilots declined by about 25%, while the number of active private pilots declined by about 5% and the number of active airline transport pilots declined by 0.8%. However, the number of active private and airline transport pilots increased slightly from 2006 to 2008, with a correspondingly greater decrease from 2008 to 2009. While the number of active commercial pilots increased by 0.5% from 2006 to 2009, this was the result of a 2.2% increase from 2006 to 2008, followed by a decrease in the each of the following two years. The large percentage increases in the number of sport pilots, particularly from 2006 to 2008, resulted from the small number of such pilots in 2006. The sport pilot certificate was created in September 2004 and by December 2006 there were only 11 such pilots in Southern California. By December 2010 there were only 70 sport pilots in the whole region.

Table 4-8. Recent Changes in the Southern California Pilot Community

	Change			
Type of Certificate	2006-09	2006-08	2008-09	2009-10
Student pilot	-25.3%	-11.0%	-16.1%	*(note 1)*
Private pilot	-5.0%	0.6%	-5.6%	-5.0%
Commercial pilot	0.5%	2.2%	-1.6%	-3.1%
Airline transport pilot	-0.8%	0.4%	-1.2%	-2.8%
Recreational pilot	*(note 2)*	*(note 2)*	*(note 2)*	*(note 2)*
Sport pilot	491%	336%	35.4%	7.7%
Total	-6.2%	-0.9%	-5.4%	*(note 1)*

Source: Author analysis based on FAA, *Active Airmen Certificate Totals by Region, State, County*, Airmen Certification Branch, Oklahoma City, OK.

Notes: 1. Percentage change distorted by change in validity of third-class medical certificates for pilots under age 40.

2. Insufficient data for meaningful measure of percent change.

The data provided by the FAA Airmen Certification Branch also included the number of active pilots in each of the six Southern California counties by type of pilot certificate held and age group as of December 31, 2010. The totals for the six-county region are shown in Table 4-9 and Figure 4-8.

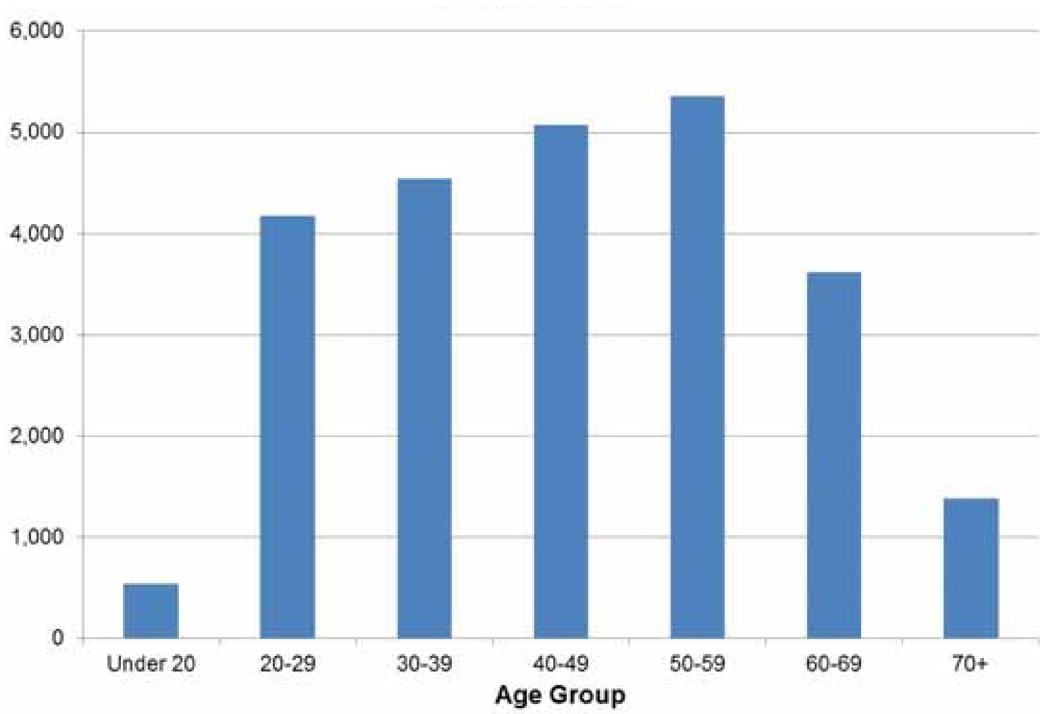
Generally the age profile of active pilots shows a somewhat higher proportion of active pilots in the younger age cohorts than the national data for male pilots in 2005 shown in Figure 4-6. However, it should be noted that the effect of the change in validity of a third-class medical certificate for pilot sunder age 40 in 2008 would increase the number of pilots in this category counted as active by the FAA, distorting the comparison.

The age distribution of active student and private pilots is shown in Figure 4-9. This shows that the majority of student pilots are in the age range between 20 and 39. Although there appear to be to more active student pilots in the age range 29 and below than active private pilots, there is a significant attrition of student pilots who never progress to gaining their private pilot certificate. In addition, the number of active student pilots below age 40 is likely inflated by the change in validity of third-class medical certificate, as discussed above.

Table 4-9. Active Pilots in Southern California by Age Group

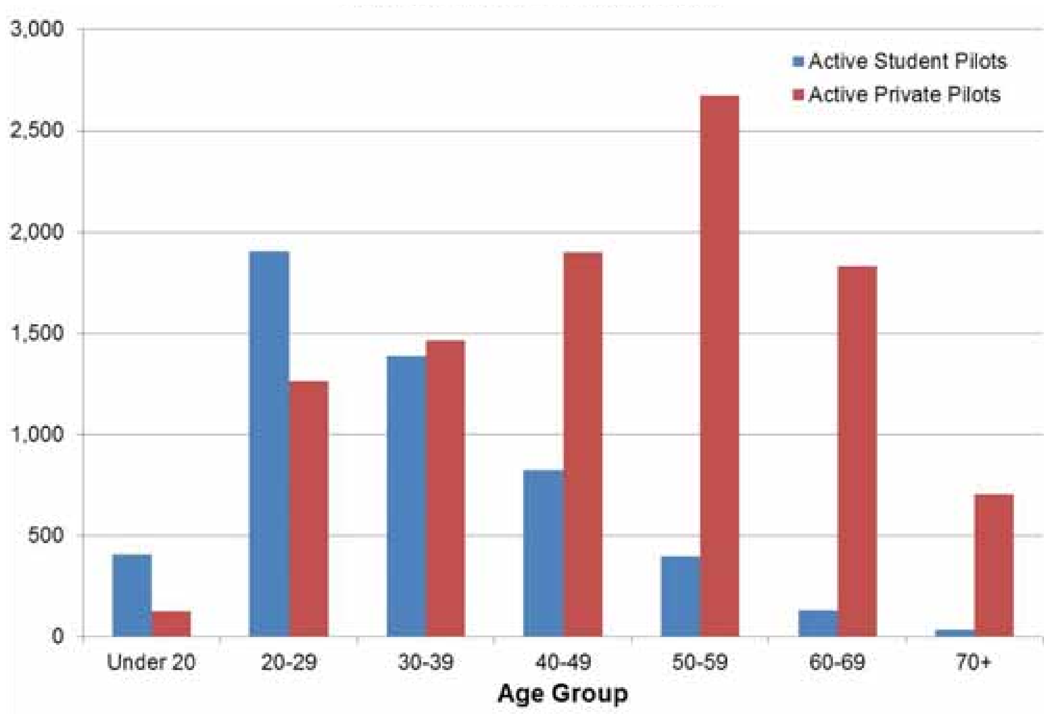
	Active Pilots as of December 31, 2010					
Age	Student Pilot	Recreational or Sport Pilot	Private Pilot	Commercial Pilot	Airline Transport Pilot	Total
Under 20	407	0	127	8	0	542
20-29	1,907	4	1,262	896	110	4,179
30-39	1,388	2	1,466	1,013	677	4,546
40-49	825	19	1,902	939	1,389	5,074
50-59	397	26	2,674	954	1,305	5,356
60-69	131	15	1,833	901	736	3,616
70+	38	4	706	408	222	1,378
Total	**5,093**	**70**	**9,970**	**5,119**	**4,439**	**24,691**

Source: FAA, *Active Airmen Certificate Totals by Region, State, County*, Airmen Certification Branch, Oklahoma City, OK, Personal communication.



Source: FAA, *Active Airmen Certificate Totals by Region, State, County*, Airmen Certification Branch, Oklahoma City, OK, Personal communication

Figure 4-8. Active Pilots in Southern California by Age Group as of December 31, 2010



Source: FAA, *Active Airmen Certificate Totals by Region, State, County*, Airmen Certification Branch, Oklahoma City, OK, Personal communication

Figure 4-9. Active Student and Private Pilots in Southern California by Age Group as of December 31, 2010

However, the implications for the future numbers of active private pilots in the region is complicated by several other factors, including the time that a student pilot takes to obtain his or her private pilot certificate and the number of student pilots who progress beyond the private pilot certificate to become commercial pilots or airline transport pilots. Therefore a more detailed cohort analysis is required that takes these factors into account in order to predict the likely number of active pilots in the region in future years. What is clear from Figure 4-9 is that the largest age cohort of active private pilots is in the age group from 50 to 59 and the younger age cohorts of active private pilots are significantly smaller. Unless the number of student pilots in those younger age cohorts who become private pilots is large enough to not only offset the attrition in the private pilot community but to make up the difference between the number of active private pilots in the 50 to 59 age group and that in the age group 40 to 49, the total number of active private pilots will decline rapidly once those in the age group from 50 to 59 start to experience the attrition shown in Figure 4-9 for the older age cohorts.

Recent Trends in New Pilot Starts

A key factor in the future composition of the Southern California pilot community is the number of new pilots who take up flying for the first time, commonly referred to as new pilot starts. This can be measured by the number of student pilot certificates issued. While the FAA reports the number of new student pilot certificates issued each year in the *U.S. Civil Airmen Statistics* (FAA, 2011e), what matters more than the recent trend is the future numbers of new student pilot certificates issued. This is likely to be influenced by a variety of factors, the most important of which are likely to comprise:

- The general state of the economy
- The demand for professional pilots
- The cost of flying
- The ease or difficulty of flying as a GA pilot in the regional airspace environment.

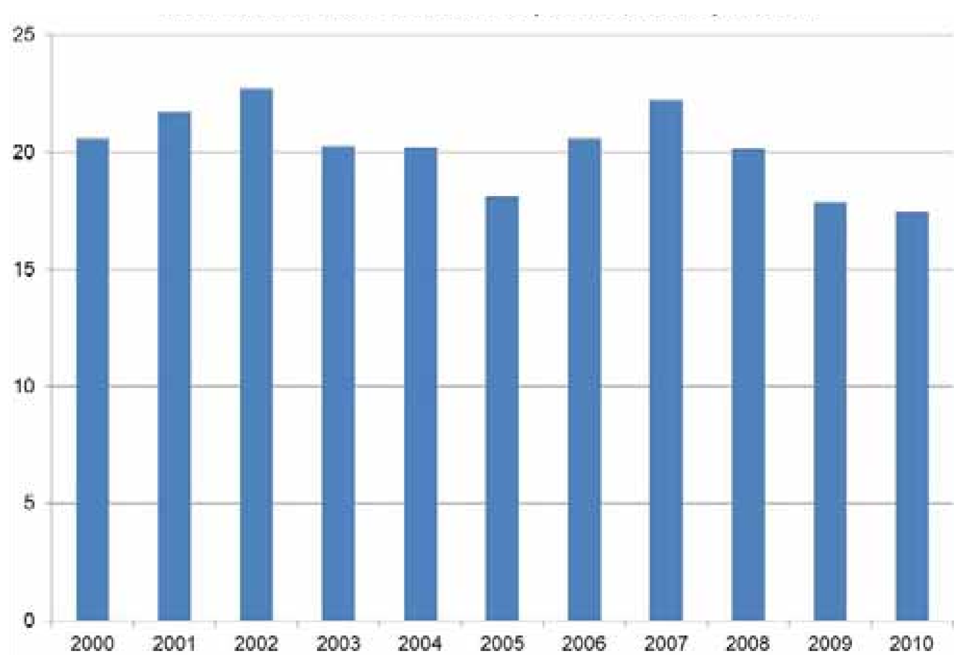
The latter consideration is likely to be of particular concern in the Southern California region, much of which consists on an extremely complex airspace environment, with a large number of commercial service airports and their associated flight arrival and departure routes, even more GA airports, often challenging visibility conditions in the central part of the Los Angeles basin, and high surrounding terrain. Apart from the difficulties that these factors pose to those learning to fly, they also restrict the ease with which GA pilots can take advantages of their ability to exercise their flying privileges. It is increasingly common for those who are seeking a future career as a professional pilot to attend one of the universities and colleges that offer an aviation curriculum that includes flight training. For understandable reasons, these tend not to be located in dense urban areas with complex airspace. Thus someone growing up in Southern California who decides to attend a college or university aviation program with the goal of pursuing a career as a professional pilot is quite likely to enroll in a program elsewhere in the country. Of the 97 U.S. member institutions of the University Aviation Association (the industry association of collegiate aviation), only one is located in the SCAG region, Mount San Antonio College in Walnut, a two-year college with approximately 600 students enrolled in aeronautics courses (http://www.mtsac.edu/instruction/tech-health/aeronautics/). However, not all these students are learning to fly as part of their program.

At a national level, the changes in the number of new student pilot certificates issued per 100,000 population are shown in Table 4-10 and Figure 4-10.

Table 4-10. Number of Student Pilot Certificates Issued per 100,000 Population and Gross Domestic Product per Capita – U.S. Totals

Year	Student Pilot Certificates Issued	U.S. Population (000)	New Student Pilots per 100,000 Population	Real Gross Domestic Product (b 2005$)	GDP per Capita (2005$)
2000	58,042	282,166	20.6	11,226.0	39,785
2001	61,897	285,050	21.7	11,347.2	39,808
2002	65,421	287,746	22.7	11,553.0	40,150
2003	58,842	290,242	20.3	11,840.7	40,796
2004	59,202	292,936	20.2	12,263.8	41,865
2005	53,576	295,618	18.1	12,638.4	42,752
2006	61,448	298,432	20.6	12,976.2	43,481
2007	66,953	301,394	22.2	13,228.9	43,892
2008	61,194	304,177	20.1	13,228.8	43,490
2009	54,876	306,656	17.9	12,880.6	42,003
2010	54,064	309,051	17.5	13,248.2	42,867

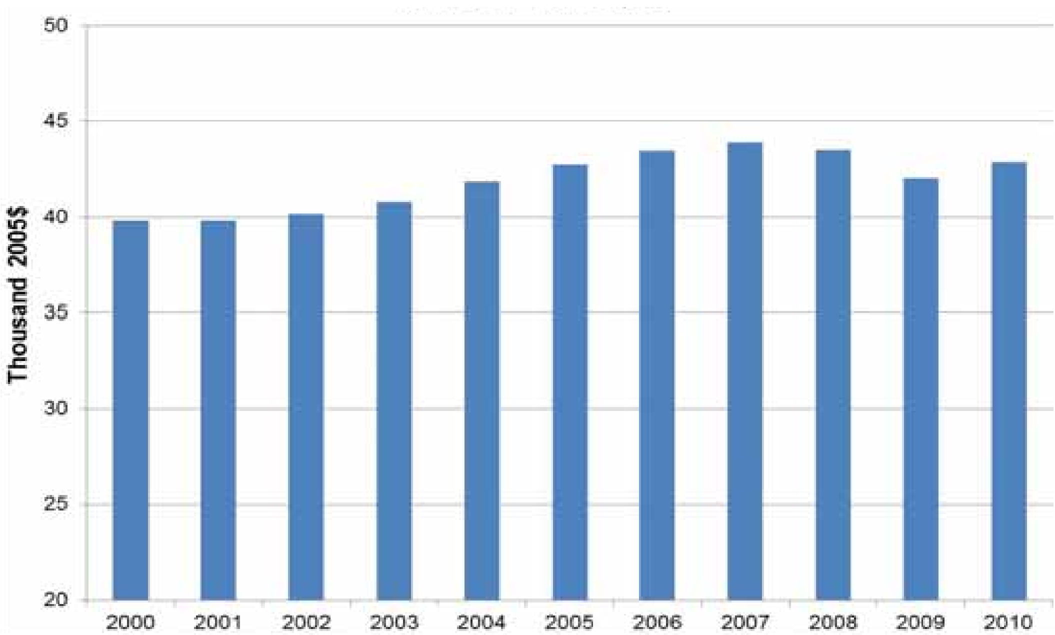
Sources: FAA, *U.S. Civil Airmen Statistics*, various years; U.S. Census Bureau, *Preliminary Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2000 to July 1, 2010*, February 2011. U.S. Bureau of Economic Analysis, *National Economic Accounts: Current-Dollar and "Real" GDP*, (http://www.bea.gov/national/)



Source: See Table 4-10

Figure 4-10. U.S. Student Pilot Certificates Issued per 100,000 Population

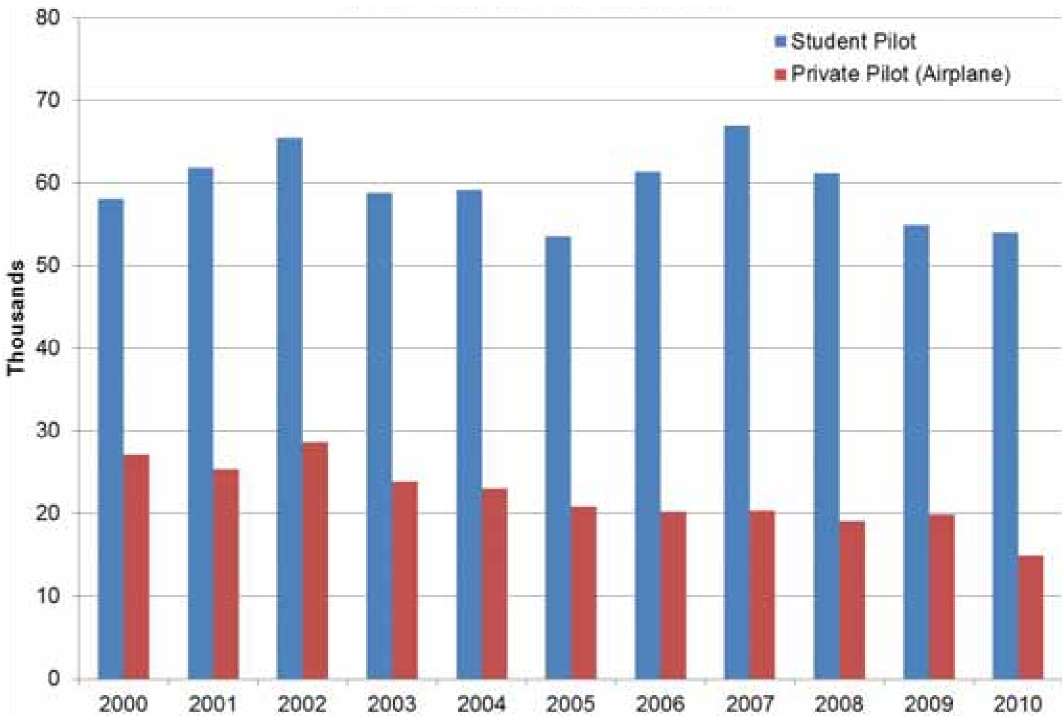
The number of new pilot starts shows both a cyclical fluctuation with a slowly declining overall trend. The cyclical changes do not appear to be particularly correlated with the overall level of the economy, which grew steadily from 2002 to 2007 as shown in Figure 4-11, suggesting that the fluctuations in the number of new pilot starts appear to be mainly driven by other factors.



Source: See Table 4-10

Figure 4-11. Gross Domestic Product per Capita

Figure 4-12 shows the number of new student pilot certificates issued each year compared to the number of new private pilot certificates issued with an airplane rating (this does not count those private pilot certificates issued with only a glider or rotorcraft rating). It can be seen that the cyclical fluctuation in new student pilot certificates does not appear to be reflected in the number of new private pilot certificates, which shows a generally declining trend from 2000 to 2010, apart from a short-lived increase from 2001 to 2002 and a small increase from 2008 to 2009. Those fluctuations do not appear to be related to the cyclical fluctuations in the number of new student pilot certificates issued in any obvious way. While the number of new student pilot certificates issued also increased from 2001 to 2002, it increased by approximately the same amount from 2000 to 2001, when the number of new private pilot certificates issued declined.



Source: FAA, *U.S. Civil Airmen Statistics*, various years

Figure 4-12. New Student Pilot and Private Pilot Certificates Issued per Year

Similarly, the small increase from 2008 to 2009 in new private pilot certificates issued occurred during a period when the number of new student pilot certificates issued was declining steeply.

The data on new student pilot and private pilot certificates issued each year shown in Figure 4-12 indicate that by 2010 only about a third of new student pilots progress to earn a private pilot certificate with an airplane rating. While some student pilots take longer than a year to obtain their private pilot certificates, those obtaining their private pilot certificates in subsequent years are offset by those obtaining their private pilot certificate in the current year who received their student pilot certificate in prior years. For the three-year period from 2008 to 2010 the number of private pilot certificates with an airplane rating that were issued was about 32% of the number of student pilot certificates issued.

Some student pilots progress to obtain a private pilot certificate with only a glider rating or only a rotorcraft rating. The count of new certificates issues with only a glider or rotorcraft rating in the *U.S. Civil Airman Statistics* does not distinguish between whether those certificates were for private, commercial or airline transport pilots. Presumably the majority of new certificates with only a glider rating were for private pilots (the only reason for someone who only flies gliders to obtain a commercial pilot certificate would be if they planned to work as a flight instructor and such a pilot would first have to obtain a private pilot certificate). The number of new certificates issued with only a glider rating in the period from 2008 to 2010 was only about 0.4% of new student pilot certificates issued in the same period.

Considerably more new certificates are issued each year with only a rotorcraft rating. Presumably, the majority of these pilot intend to progress to a commercial pilot certificate, since there are relatively few helicopters used for private flying, although some pilots undoubtedly obtain their private pilot certificate but them give up flying before obtaining their commercial pilot certificate. There are relatively few situations in which FAA regulations require a pilot who is only flying rotorcraft to obtain an airline transport pilot certificate, since there are very few, if any, helicopters flown in scheduled airline service (which requires an airline transport pilot certificate). However, a helicopter operator may require its pilots to hold an airline transport pilot certificate because of the greater level of training and experience required for such a certificate. If 20% of pilots who obtain their private pilot certificate with only a rotorcraft rating do not progress to obtain their commercial pilot certificate, and 10% of those obtaining a commercial pilot certificate with only a rotorcraft rating subsequently obtain an airline transport pilot certificate, then about 53% of the new pilot certificates with only a rotorcraft rating are private pilot certificates and the remainder are either commercial pilot certificates or airline transport pilot certificates. During the three-year period from 2008 to 2010, the number of new pilot certificates issued with only a rotorcraft rating was about 5.9% of the number of new student pilot certificates issued. This suggests that about 3% of student pilots progress to holding a private pilot certificate with only a rotorcraft rating. Thus in total, only about 35% of all student pilots eventually obtain a private pilot certificate.

California Data on New Pilot Starts

In addition to national statistics, data on the number of new pilot certificates issued to California pilots for the past three years were obtained from the FAA Airmen Certification Branch staff, as shown in Table 4-11.

Table 4-11. Number of New Pilot Certificates Issued per 100,000 Population -- California

	Original Certificates Issued			per 100,000 Population		
Type of Certificate	2008	2009	2010	2008	2009	2010
Student pilot	191	205	176	0.52	0.55	0.47
Recreational pilot	2	0	1			
Sport pilot	49	53	42	0.13	0.14	0.11
Airplane						
Private pilot	1,834	1,788	1,496	4.98	4.82	4.00
Commercial pilot	824	763	611	2.24	2.06	1.63
Airline transport pilot	349	207	209	0.95	0.56	0.56
Rotorcraft (only)	405	318	237	1.10	0.86	0.63
Glider (only)	15	37	33	0.04	0.10	0.09
	3,669	3,371	2,805			
Calif. Population (000)	36,856	37,077	37,371			

Source: FAA, *Original Airmen Certificates Issued by Category -- California*, Airmen Certification Branch, Oklahoma City, OK, Personal communication.

California Department of Finance, *Population Estimates and Components of Change by County - July 1, 1999 - 2010*, Series E-6, August 2011

Unfortunately, the data on new student pilot starts are not comparable to the national data because the California data excludes student pilot certificates issued by the Civil Aerospace Medical Institute as part of issuing the initial medical certificate, which accounts for the majority of new student pilot certificates issued in a given year. However, the data for new private pilot, commercial pilot, and airline transport pilot certificates with an airplane rating, new sport pilot certificates, as well as new pilot certificates with only a rotorcraft or glider rating, can be compared to the national data when adjusted for the difference in population.

The number of pilot certificates issued in California relative to population is generally lower than for the U.S. in total. The difference varies from year to year and also by type of pilot certificate, as shown in Table 4-12. The ratios for new student pilot certificates are omitted due to the missing data and those for new recreational pilot certificates have not been calculation due to the small number of such certificates.

Table 4-12. New Pilot Certificates Issued per 100,000 Population -- California Relative to the U.S. in Total

	Percent of U.S. Ratio			
Type of Certificate	2008	2009	2010	Average
Sport pilot	64%	64%	67%	65%
Airplane				
Private pilot	79%	74%	83%	79%
Commercial pilot	64%	56%	63%	61%
Airline transport pilot	55%	55%	56%	56%
Rotorcraft (only)	92%	72%	73%	79%
Glider (only)	61%	123%	123%	102%

Source: Author calculations from Tables 4-10 and 4-11 and FAA, *U.S. Civil Airmen Statistics, 2010.*

On average across the three years, the number of new private pilot certificates issued per 100,000 population is about 79% of the national ratio. This proportion declines for new commercial pilot certificates to 61% of the national ratio and decreases further for new airline transport pilot certificates to 56% of the national ratio. The number of new pilot certificates with only a rotorcraft rating per 100,000 population relative to the national ratio is similar to that for private pilots, although the variation from year to year is greater.

Therefore it appears that not only is California producing fewer new private pilots relative to its population than the national ratio but fewer of those pilots progress to holding a commercial pilot certificate and even fewer progress to holding an airline transport pilot certificate. Thus transition rates between categories of pilot certificate calculated from national data will have to be adjusted to reflect the lower transition rates in California.

Unfortunately, the missing data for new student pilot certificates issued to California pilots mentioned above prevents calculation of the corresponding proportion of the national ratio for new student pilot certificates per 100,000 population. However, it seems reasonable to assume that the California proportion of the national ratio for new student pilot certificates would be similar to that for new private pilot certificates. This is somewhat higher than the California proportion of the national ratio for new sport pilot certificates, which seems reasonable given that the complex airspace environment in the larger metropolitan regions in the state is likely to make flying with a sport pilot certificate rather more limiting than in many other areas of the country.

Projecting Future Student Pilot Starts

It is clear from the trend shown on Figure 4-10 that the number of new student pilot starts per 100,000 population has been tending to decline for the past ten years. In order to quantify this trend and provide a basis for forecasting future new student pilot starts, the following regression model was estimated from the data shown in Table 4-10:

$$S = \underset{(28.2)}{(0.542} - \underset{(-3.7)}{0.01192} * Y) * GDP/Cap$$

where S = New student pilot certificates issued per 100,000 population
GDP/Cap = U.S. Gross Domestic Product per capita (000 2005 $)
Y = Years after 2000

t-statistics shown in parentheses
Adjusted R square = 0.88

The coefficients of the regression model are highly statistically significant and the fit of the model to the data (as measured by the adjusted R square) is quite good, although the model does not fully reflect the cyclical variation in the data, as would be expected from Figures 4-10 and 4-11. The signs of the terms are intuitively reasonable, with the number of new student pilot certificates issued increasing with real Gross Domestic Product (GDP) per capita, as would be expected, and a decreasing trend with time, as the data shows.

An initial version of this model included a term that expressed the new student pilot rate as a constant times the real GDP per capita and a second term that decreased the new student pilot rate linearly by year. This model fitted the general trend in new student pilot starts for the period from 2000 to 2010 fairly well. However, it became apparent that reducing the new student pilot rate by a constant amount per year, irrespective of the value of predicted new student pilot rate, would tend to overestimate the reduction for areas with lower student pilot rates and underestimate the reduction for areas with higher rates. Therefore the model was modified to reduce the coefficient of the GDP per capita term by a constant rate per year, rather than the new student pilot rate itself, as shown above. This resulted in a reduction that was proportional to the value of the new student pilot rate, which resolved the problem.

A comparison was made between the number of active student pilots in California per 100,000 population and the national data for the years 2008 to 2010. The new student pilot model was applied to California population and GDP and the projected new student pilot rate given by the model was compared to the number of new student pilots in California per 100,000 population, assuming that the California rate of new student pilots relative to the national rate is proportional to the ratio of active student pilots per 100,000 population in California to the active student pilots per 100,000 population for the United States. This suggested that the new student pilot rate in California, after controlling for differences in real GDP per capita, is about 80% of the national rate, and this adjustment was applied to the model in developing the forecast.

If the GDP per capita remains constant in real terms at the 2010 level, the annual number of new student pilot certificates issued per 100,000 population would decline from 17.5 in 2010 to 5.4 in 2035. However, if the real GDP per capita grows at an average rate of 1.5% per year over the period, the predicted annual number of new student pilot certificates issued per 100,000 population would only decline to 7.8 in 2035. Even if the real GDP per capita grows at an average rate of 3% per year over the period, the predicted annual number of new student pilot certificates issued per 100,000 population given by the relationship would still decline significantly to 11.2 in 2035. Thus while the future strength of the economy will have a major influence on the number of new pilot starts, assuming that the relationship between the changes in the economy over the past ten years and the changes in the number of student pilot certificates issued continue into the future, the effect of the declining trend in new pilot starts per 100,000 population is not likely to be reversed by any plausible future growth in the strength of the economy. Of course, there are undoubtedly other factors not included in the model such as the cost of flying or the demand for commercial pilots that will also have an important influence.

The AOPA Member Survey

In order to provide more detailed information on the characteristics and flying activity of general aviation pilots in Southern California, an online survey of California members of the Aircraft Owners and Pilots Association (AOPA) was performed by SCAG and the California Department of Transportation (Caltrans) Division of Aeronautics with the assistance of the AOPA. The AOPA agreed to invite its California members to participate in the survey and provide them with the web address of the survey website where they can complete the survey. Survey respondents were not asked to provide identifying information, but they were asked to provide their zip code of residence and (if they are an aircraft owner) the airport where they base their aircraft. They were also asked to provide the following information:

- Whether they have flown general aviation aircraft in the past six months
- How long ago they last flew as general aviation pilot (if no longer active)
- The highest level of pilot certificate that they currently hold (or have held)
- Their total flight hours in all types of aircraft
- Their flight hours in general aviation aircraft in the past year
- Whether they are a current or former aircraft owner
- The type(s) or aircraft that they own (or owned), if any
- Their zip code of residence
- Their age range (in ten year intervals)

In addition, the survey asked a number of questions about services that respondents have used or would like to see at airports that they use, as well as issues that they believe should be addressed at the airport where they base their aircraft or use most frequently, or that should be considered in developing a general aviation demand forecast. Since these issues are not germane to the analysis of the composition and activity levels of the pilot community, they are not addressed further in this working paper, but will be reported in a separate document.

It should be noted that the definition of an active GA pilot used in the survey is considerably narrower than the definition of an active pilot used by the FAA. The FAA defines an active pilot by whether a pilot has a valid medical certificate, not by when they have last flown. Since medical certificates can be valid for as long as five years (in the case of a student pilot under age 40), pilots can be counted as active by the FAA long after they have in fact stopped flying. In addition, the FAA does not distinguish between the types of flying performed. In the case of active pilots holding an airline transport pilot certificate, they may or may not engage in general aviation flying.

In invitation to participate in the survey was distributed by e-mail to potential respondents on June 6, 2011 and 1,991 responses were obtained by June 19, at which point the survey website was closed to further responses. Of the 1,991 responses, 1,901 reported GA flight activity in the past six months.

An analysis was preformed of the zip code of residence reported by survey respondents in order to identify those respondents resident in Southern California. A certain amount of data cleaning of the reported zip codes was required to resolve invalid zip codes or zip codes outside of California that on examination of the responses to other questions were most likely typographic errors. After correcting the errors in the data 1,831 responses (96%) had valid zip codes, of which 764 (42%) were residents of the six-county Southern California region.

Findings from the AOPA Member Survey

The distribution of the type of pilot certificate held by active GA pilot respondents in the six Southern California counties is shown in Table 4-13, together with the corresponding distribution of active pilots holding each type of certificate in the region.

Table 4-13. Southern California AOPA Survey Respondents by Pilot Certificate -- Active General Aviation Pilots

	Highest Level of Pilot Certificate Held					
County	Student	Sport or Recreational	Private	Commercial	Airline Transport	Total
Imperial	0	0	3	0	0	3
Los Angeles	15	2	198	82	45	342
Orange	10	1	80	44	20	155
Riverside	2	0	53	18	10	83
San Bernardino	3	0	44	21	8	76
Ventura	0	0	31	25	11	67
Total	**30**	**3**	**409**	**190**	**94**	**726**
Percent of region	4.1%	0.4%	56.3%	26.2%	12.9%	100 %
Active pilots (as of 12/31/10)	5,093	70	9,970	5,119	4,439	24,691
Percent of region	20.6%	0.3%	40.4%	20.7%	18.0%	100 %
Sampling ratio	0.20	1.46	1.40	1.26	0.72	

Source: Author analysis of AOPA member survey results

It can be seen that the survey tended to oversample pilots holding private pilot and commercial pilot certificates, under-sample those holding airline transport pilot certificates and significantly under-sample student pilots. This is entirely to be expected, since student pilots are much less likely to be AOPA members until they obtain at least their private pilot certificate.

Similarly, not all airline transport pilots are involved in general aviation flying and are thus less likely to be AOPA members than private or commercial pilots. It follows that if student and airline transport pilots are under-sampled, the other categories must be oversampled. It also seems reasonable that private pilots would be oversampled to a greater extent than commercial pilots, since many pilots holding commercial pilot certificates are flying for firms or other organizations that own the aircraft and thus may be less inclined to be members of the AOPA.

It is also possible that AOPA members who hold private pilot certificates had a greater interest in the issues addressed by the survey and thus the high response rate of these pilots relative to the pilot population as a whole is more a reflection of their willingness to participate in the survey rather than a reflection of the composition of the AOPA membership.

Respondents holding sport pilot or recreational pilot certificates were also oversampled by about the same amount as those holding private pilot certificates. However, due to the small number of respondents in this category, this result is quite possibly coincidental.

The number of active GA pilot survey respondents in Southern California by county compared to the population of active pilots in each county from FAA pilot certificate data is shown in Table 4-14. Generally the geographic distribution of survey respondents corresponds to the distribution of active pilots. Pilots in Riverside County are somewhat oversampled while those in Los Angeles County are under-sampled by a similar amount, although the difference in each case is only about 3% of regional pilots. Other differences are well within normal sampling error.

Table 4-14. Southern California AOPA Survey Respondents by County

County	Survey Respondents	Percent	Active Pilots (12/31/10)	Percent
Imperial	3	0.4%	183	0.7%
Los Angeles	342	47.1%	10,878	44.1%
Orange	155	21.3%	5,303	21.5%
Riverside	83	11.4%	3,447	14.0%
San Bernardino	76	10.5%	2,632	10.7%
Ventura	67	9.2%	2,248	9.1%
Total	**726**	100 %	**24,691**	100 %

Source: Author analysis of AOPA member survey results

The age distribution of the Southern California survey respondents who are active GA pilots compared to the age distribution of active pilots in the six Southern California counties from FAA pilot certificate data is shown in Table 4-15.

Table 4-15. Age Distribution of Southern California AOPA Survey Respondents by Pilot Certificate – Active General Aviation Pilots

	Highest Level of Pilot Certificate Held					
Age Group	Student	Sport or Recreational	Private	Commercial	Airline Transport	Total
Under 20	1	0	3	0	0	4
20-29	8	0	26	10	1	45
30-39	5	0	50	16	8	79
40-49	7	0	57	34	21	119
50-59	6	3	130	54	22	215
60-69	3	0	101	49	27	180
70+	0	0	42	27	15	84
Total	**30**	**3**	**409**	**190**	**94**	**726**
Under 20	3.3%		0.7%	0.0%	0.0%	0.6%
20-29	26.7%		6.4%	5.3%	1.1%	6.2%
30-39	16.7%		12.2%	8.4%	8.5%	10.9%
40-49	23.3%		13.9%	17.9%	22.3%	16.4%
50-59	20.0%	100%	31.8%	28.4%	23.4%	29.6%
60-69	10.0%		24.7%	25.8%	28.7%	24.8%
70+	0.0%		10.3%	14.2%	16.0%	11.6%
	100 %		100 %	100 %	100 %	100 %
	Active Pilots (as of December 31, 2010)					
Under 20	8.0%	0.0%	1.3%	0.2%	0.0%	2.2%
20-29	37.4%	5.7%	12.7%	17.5%	2.5%	16.9%
30-39	27.3%	2.9%	14.7%	19.8%	15.3%	18.4%
40-49	16.2%	27.1%	19.1%	18.3%	31.3%	20.5%
50-59	7.8%	37.1%	26.8%	18.6%	29.4%	21.7%
60-69	2.6%	21.4%	18.4%	17.6%	16.6%	14.6%
70+	0.7%	5.7%	7.1%	8.0%	5.0%	5.6%
	100 %	100 %	100 %	100 %	100 %	100 %

Source: Author analysis of AOPA member survey results

Perhaps not surprisingly, survey respondents are somewhat older than the active pilot community in general. This could reflect a number of factors. It is likely that the AOPA membership tends to be somewhat older than the pilot community in general, since younger pilots are less likely to be able to afford to own an aircraft. While the AOPA membership includes pilots who do not own aircraft, aircraft owners are more likely to perceive a benefit in being a member of the association. In addition, older pilots have generally been flying longer and thus have had greater opportunity to decide to join the AOPA. It is also possible that older members had greater opportunity to respond to the survey, although the level of survey participation was not noticeably higher for those respondents in an age rage where they are likely to be retired.

The most applicable findings from the survey for the pilot cohort analysis relate to the average hours flown per year in general aviation activity, and how this varies by type of pilot certificate and age, since this information is not readily available from data published by the FAA. Table 4-16 shows the average number of GA flight hours in the past year reported by survey respondents.

Table 4-16. Average GA Flight Hours per Year by Southern California AOPA Survey Respondents by Pilot Certificate and Age Range

	Highest Level of Pilot Certificate Held					
Age Group	Student	Sport or Recreational	Private	Commercial	Airline Transport	All Pilots
Under 20	40.0		81.7			71.3
20-29	24.8		52.2	196.0	800.0	95.9
30-39	20.2		63.4	335.3	227.8	132.4
40-49	31.9		62.1	134.6	256.4	115.3
50-59	47.5	33.3	66.1	120.8	131.5	85.6
60-69	25.0		64.7	96.7	116.6	80.5
70+			60.0	98.5	64.1	73.1
Average	**30.7**	**33.3**	**63.5**	**135.9**	**159.7**	**93.4**

Source: Author analysis of AOPA member survey results

Some caution is warranted for the data for student and sport or recreational pilots, private pilots below age 20, and airline transport pilots below age 30, due to the small sample size in those categories as shown in Table 4-15. In other categories, the change in average flight hours between different categories of pilot certificate and age ranges seems reasonable. On average student pilots fly about 30 hours per year, which suggest that it would take between one and two years to obtain a private pilot certificate. On average private pilots fly slightly more than twice the number of hours per year than student pilots, while commercial pilots and airline transport pilots fly between two and three times the number of GA hours per year than private pilots, not surprisingly since many of the pilots holding commercial or airline transport certificates are flying professionally.

The survey also asked in which year respondents holding a student or sport/recreational pilot certificate were issued their student pilot certificate or respondents holding higher levels of pilot certificate obtained their private pilot certificate. The average number of years since respondents obtained their student or private pilot certificate (as the case may be) is shown in Table 4-17. As expected, older respondents holding private, commercial or airline transport pilot certificates have been flying longer. However, the interesting finding is the average number of years that older pilots holding a student pilot certificate have been flying since obtaining that certificate. This suggests that many older student pilots remain student pilots for a long time before finally obtaining their private pilot certificate, if they ever do.

Table 4-17. Average Years Since Obtaining a Student/Private Pilot Certificate -- Southern California AOPA Survey Respondents

	Highest Level of Pilot Certificate Held					
Age Group	Student	Sport or Recreational	Private	Commercial	Airline Transport	All Pilots
Under 20	5.0		1.7			2.5
20-29	2.1		2.7	4.4	7.0	3.1
30-39	5.0		3.6	9.1	15.8	6.1
40-49	5.4		10.0	17.6	22.5	14.1
50-59	7.8	11.7	18.2	24.1	33.9	20.9
60-69	3.0		23.8	37.5	40.4	29.7
70+			34.5	46.9	53.3	41.9
Average	**4.7**	**11.7**	**17.2**	**27.3**	**34.5**	**21.5**

Source: Author analysis of AOPA member survey results

Analysis of Pilot Cohort Characteristics

An analysis of pilot age cohort attrition and transition to higher levels of pilot certificate was performed using two different data sources: statistical data on national totals of active pilots by age group and number of original pilot certificates issued each year from the annual *U.S. Civil Airmen Statistics* (FAA, 2011e) and detailed data from the Airmen Registration Database (FAA, 2011d) for selected years. While the *U.S. Civil Airmen Statistics* provide data on totals by age group, the Airmen Registration Database does not provide the age of the individual pilots, although since this is disaggregate data, it allows more detailed analysis.

In the course of this analysis it became clear that there are a number of apparent inconsistencies in the *U.S. Civil Airmen Statistics* data that will require further research to resolve. Some of these inconsistencies may arise from the way that the FAA Airmen Registry staff accounted for the change in the validity of third-class medical certificates that occurred in July 2008. Because the only way that the FAA knows when pilots are no longer active is when they fail to renew their medical certificate, this change distorted the way that active student pilots were counted.

Based on data for California pilots for 2004 and 2010 from the Airmen Registration Database, the six-year attrition and transition rates shown in Table 4-16 were calculated. These rates express the percent of active pilots holding a given pilot certificate at the start of the period who were either no longer active at the end of the period (attrition) or had progressed to a higher level of pilot certificate (transition).

Table 4-18. California Pilot Attrition and Transition Rates – 2004 to 2010

	Pilot Certificate Held at Start of Period			
Pilot Certificate Held at End of Period	Student	Private	Commercial	Airline Transport
Student	5.1%	0.0%	0.0%	0.0%
Private	14.9%	47.5%	0.0%	0.0%
Commercial	4.0%	3.8%	50.1%	0.0%
Airline Transport	0.1%	0.3%	6.9%	66.9%
Recreational	0.0%	0.0%	0.0%	0.0%
Sport	0.1%	0.0%	0.0%	0.0%
Attrition	75.8%	48.5%	43.0%	33.0%
	100%	100%	100%	100%

Source: Author analysis of FAA Airman Registration Database records.

The above transition and attrition rates suggest that of the pilots holding student pilot certificates at the start of the six-year period, about 5 percent were still active student pilots (or at least still holding a valid medical certificate) at the end of the period. Some 15% had progressed to hold a private pilot certificate by the end of the six year period, while only about 4 percent held a commercial pilot certificate at the end of the period. About 76 percent had become inactive.

The attrition rates shown in Table 4-18 are surprisingly high, particularly for pilots holding a private, commercial, or airline transport certificate. It would be surprising if a third of those holding an airline transport certificate became inactive every six years. Therefore more detailed analysis of the underlying data was undertaken to determine the reason for these apparently high attrition rates. One factor that affects the apparent attrition rates is pilots who move from California during the six-year period and change their registered address. These would be counted as becoming inactive, since they would have been dropped from the California records. However, on the other hand, those who move to California during the period would appear in the data at the end of the period but not the beginning. Therefore an analysis of individual pilot data for California was undertaken to quantify the extent of these effects on the attrition and transition rates.

Summary and Conclusions

The trends in the size and composition of the pilot community over the past decade, as indicated by previous studies and the analysis undertaken as part of the current study, suggest that not only is pilot community getting steadily older on average, but the number of new student pilots to are taking up flying is not enough to maintain the size of the overall pilot community as the older pilots reach an age where they no longer fly or significantly reduce the amount of flying that they do. This in turn has important implications for the number of hours that are flown each year and the associated number of aircraft operations.

The detailed attrition and transition rates for pilots in a given age cohort is not a straightforward issue, since these rates not only vary by age, but also by the time that a given pilot has held his or her current pilot certificate. Many student pilots obtain their private pilot certificate within a year of taking up flying. Others take many years to do so. The transition rate from student to private pilot for student pilots in their first year since starting flying is likely to be significantly different from that for pilots who have been learning to fly for several years.

Similarly, when looking at transition rates over a period as long as six years, these will include pilots who have progressed through several levels of pilot certificate, such as from student pilot to commercial pilot or even airline transport pilot. While this does not matter from the perspective of performing a pilot cohort analysis over a comparable period of time (say in five year steps), it does make it difficult to compare the resulting transition and attrition rates with those obtained from annual data, such as the *U.S. Civil Airmen Statistics*.

Therefore more detailed analysis of the registered airmen data should be undertaken in the future to better understand and quantify the pilot attrition and transition rates for use in improving the use of applying the pilot cohort model to general aviation demand forecasts.

5. Forecasts of Active Pilots, Hours Flown and Aircraft Operations

The FAA Terminal Area Forecast for future general aviation activity at airports in the Southern California region described in Chapter 3 represents a fairly optimistic scenario of likely future trends in general aviation demand in the region in the light of recent trends. For some purposes, such as determining whether the current airport system provides sufficient capacity to handle potential future demand, it may be appropriate to consider a forecast based on fairly optimistic assumptions regarding the factors that will shape future demand for GA activity. However, for other purposes, such as considering whether there will be sufficient future demand for GA activity to allow the large number of airports in the region to remain financially viable, it is necessary to consider a number of alternate scenarios that are based on less optimistic assumptions. These assumptions include such factors as the number of new student pilots who decide to take up flying, the rate at which they transition to higher levels of pilot certificate, the attrition rates of pilots holding different types of certificate in different age groups, the average number of GA flight hours per year by pilots holding different types of certificate in different age groups, the attrition rates of the current based aircraft fleet, and the rate at which new aircraft are purchased. The forecast approach described in Chapter 2 provides a framework to consider these factors in a structured way and work through their implications for the resulting forecasts of regional GA activity.

This chapter presents three alternative forecasts of active pilots, hours flown and aircraft operations by county and for the Southern California region as a whole. These forecasts differ in the assumed relationship between new student pilot starts and the change in the economy, expressed in terms of real Gross Domestic Product (GDP) per capita.

- The Baseline Forecast assumes a continuation of the relationship observed over the past ten years, in which this relationship has shown a steady decline in the number of new student pilots per 100,000 population after accounting for the change in the real GDP per capita.
- The Reduced Decline Forecast assumes that the decline in this relationship observed over the past ten years slows between 2010 and 2025, with the relationship remaining constant thereafter.

- The Arrested Decline Forecast assumes that the decline in the relationship observed over the past ten years ceases after 2010.

Baseline Forecast

Applying the pilot cohort model with the baseline assumptions discussed below gives the forecast for active pilots by county shown in Table 5-1.

Table 5-1. Baseline Forecast of Active Pilots by County

	2010	2015	2020	2025	2030	2035
Imperial County						
Student	33	37	38	36	31	25
Private /1	89	69	53	48	41	36
Commercial	48	34	26	20	16	15
Airline Transport	13	11	8	7	7	6
	183	151	125	111	95	82
Los Angeles County						
Student	2,419	4,392	4,222	3,962	3,500	2,806
Private /1	4,513	5,283	4,925	4,520	3,998	3,320
Commercial	2,263	2,295	2,002	1,736	1,460	1,167
Airline Transport	1,683	1,483	1,189	945	714	521
	10,878	13,453	12,338	11,163	9,672	7,814
Orange County						
Student	1,009	1,659	1,580	1,460	1,270	1,002
Private /1	2,042	2,161	1,931	1,716	1,482	1,205
Commercial	1,072	985	819	688	560	434
Airline Transport	1,180	944	707	526	382	261
	5,303	5,749	5,037	4,390	3,694	2,902
Riverside County						
Student	674	522	450	428	392	330
Private /1	1,413	1,039	752	600	498	413
Commercial	683	503	368	274	212	163
Airline Transport	677	510	375	270	191	128
	3,447	2,574	1,945	1,572	1,293	1,034
San Bernardino County						
Student	593	480	412	382	341	286
Private /1	1,092	860	643	518	430	355
Commercial	606	446	325	241	185	139
Airline Transport	341	283	219	160	117	80
	2,632	2,069	1,599	1,301	1,073	860

(continued)

Table 5-1. Baseline Forecast of Active Pilots by County (cont.)

	2010	2015	2020	2025	2030	2035
Ventura County						
Student	365	431	397	370	326	262
Private /1	891	736	580	481	405	329
Commercial	447	352	264	204	157	121
Airline Transport	545	412	296	211	147	94
	2,248	1,931	1,537	1,266	1,035	806
Regional Total						
Student	5,093	7,521	7,099	6,638	5,860	4,711
Private /1	10,040	10,148	8,884	7,883	6,854	5,658
Commercial	5,119	4,615	3,804	3,163	2,590	2,039
Airline Transport	4,439	3,643	2,794	2,119	1,558	1,090
	24,691	25,927	22,581	19,803	16,862	13,498

Note 1. Includes pilots holding a Sport Pilot certificate

The pilot cohort model is based on the model of new student pilot starts each year described in Chapter 4 together with five-year transition relationships between different classes of pilot certificate derived from the analysis of a large sample of individual pilot data for California obtained from the Federal Aviation Administration (FAA) Airmen Registry.

The new student pilot starts model was developed from national data on student pilot certificates issued each year obtained from the FAA *U.S. Civil Airmen Statistics* for various years. The new pilot starts model predicts the number of student pilot certificates issued per 100,000 population on the basis of the real GDP per capita in 2005 constant dollars. The model was estimated on data for 2000 to 2010. Since the model predicts the number of new student pilots in terms of population and GDP per capita, it can be applied to smaller geographic areas, such as counties.

In order to apply the model to generate a forecast of future new student pilots, it was necessary to make assumptions about the future growth in real GDP per capita in each of the six counties in the Southern California region. An analysis was undertaken of the trend in real GDP per capita in the Los Angeles-Long Beach-Santa Ana and Riverside-San Bernardino-Ontario Standard Metropolitan Statistical Areas (SMSAs), using data from the U.S, Bureau of Economic Analysis for the period 2001 to 2010. Based on this trend the future growth in real GDP per capita in each of the two SMSAs was assumed. The GDP for each SMSA in 2009 was allocated to the two counties that comprise each SMSA on the basis of the total personal income of the counties, and the ratio of the real GDP per capita in each county to the real GDP per capita for the SMSA was estimated. This allowed different values of future real GDP per capita to be projected for each county. Since Imperial County and Ventura County are not included in the two SMSAs, the GDP for those counties was estimated on the basis of the total personal income in each county relative to that in the closest SMSA (Riverside-San Bernardino-Ontario in the case of Imperial County and Los Angeles-Long Beach-Santa Ana in the case of Ventura County).

The trend in the real GDP per capita for the two SMSAs over the past ten years is shown in Figure 5-1. It is clear than the real GDP per capita in the Riverside-San Bernardino-Ontario SMSA is not only significantly lower than in the Los Angeles-Long Beach-Santa Ana, but that the decline during the recent recession started earlier and the recovery had not yet begun by the end of 2010, although the rate of decline had slowed.

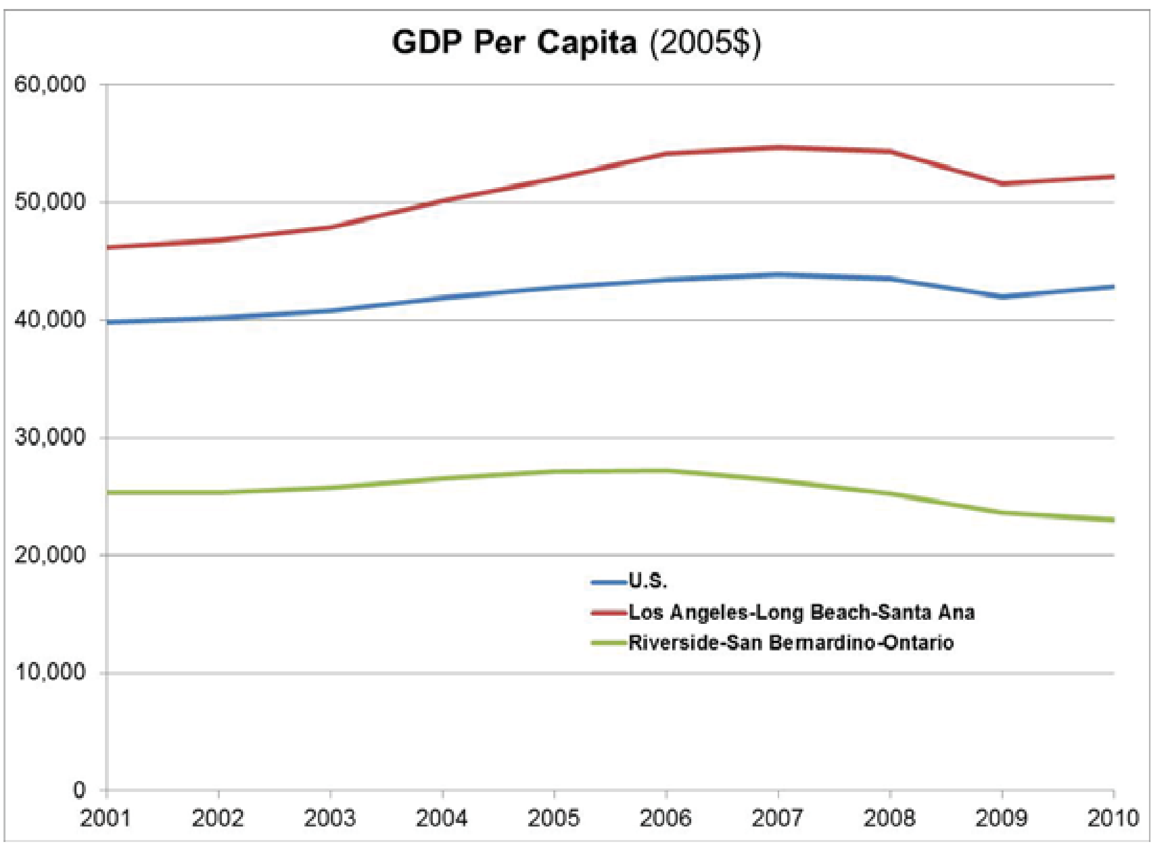


Figure 5-1. Recent Trends in the Southern California Economy

The assumed growth in real GDP per capita in each of the two SMSAs is shown in Figure 5-2, compared to two assumptions for the U.S. economy overall. The first assumption for the future growth in the U.S. real GDP per capita for the U.S. was based on the average of the relatively high average annual growth rate experienced during the period from 2001 to 2007 and the lower average annual growth rate experienced from 2001 to 2010, which included the latest recession. This avoids biasing the assumed growth rate by choosing a period that ends in the immediate aftermath of a fairly deep recession. This gave an assumed average annual growth in real GDP per capita of 1.2 percent. Figure 5-2 also shows the assumed future growth implied by the economic assumptions in the latest national *FAA Aerospace Forecast*. This assumed an average annual growth in real GDP per capita of about 1.9 percent, somewhat higher than the average annual growth during the most recent expansion period from 2001 to 2007.

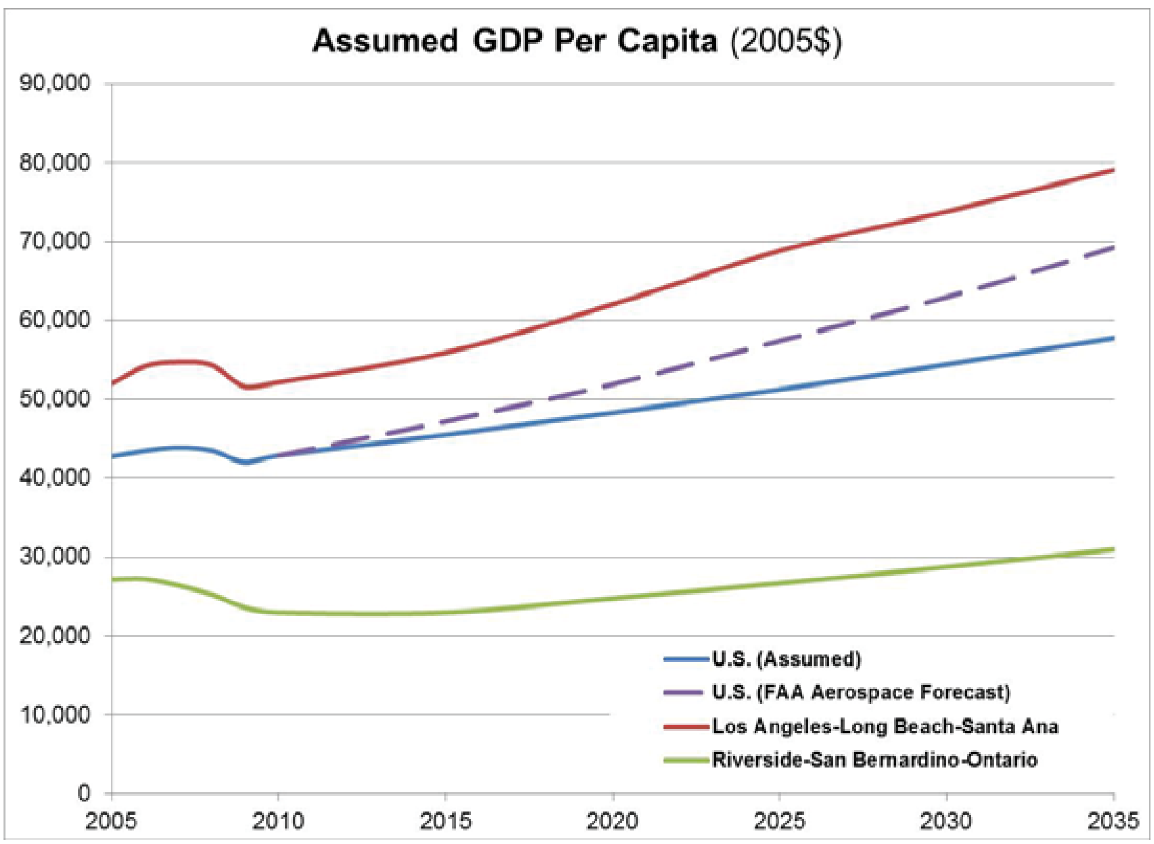


Figure 5-2. Assumed Future Growth in the Southern California Economy

It was assumed that the annual growth rate of real GDP per capita for the Los Angeles-Long Beach-Santa Ana SMSA would continue the average annual growth rate of 1.4 percent experienced from 2001 to 2010 until 2015, then would increase to the average of the relatively high average annual growth rate experienced from 2001 to 2007 and the average over the period 2001 to 2010, which gave an annual growth rate of 2.1 percent. From 2025 to 2035 it was assumed that the annual growth rate would drop back to the average annual growth rate experienced from 2001 to 2010.

In the case of the Riverside-San Bernardino-Ontario SMSA, it was assumed that the decline in the real GDP per capita would end in 2010 and the real GDP per capita would remain constant until 2015, when the annual growth rate would increase to the average annual growth rate of 1.5 percent experienced during the last expansion period from 2001 to 2006.

The transition relationships between different categories of pilot certificate that form the second key component of the pilot cohort model were estimated from the disaggregate data for individual California pilots from the FAA Airman Registry for May 2010 and May 2011. This gave one-year transition percentages, from which five-year transition rates were calculated assuming that the one-year transition rates apply to each year of the five-year period. Unfortunately, the individual pilot data does not include the pilot's age, due to privacy reasons. However, it is possible to classify each pilot as either under age 40 or age 40 and over on the basis of the validity of the pilot's medical certificate, which is included in the data, since medical certificates have different validity periods for pilots under age 40 from those for pilots age 40 and over. It was determined that pilots in the two age groups have different transition rates. The corresponding rate was then applied to each of the five-year age ranges used in the cohort analysis.

Although of course these transition rates and the relationship incorporated in the new student pilot model could change in the future, it was assumed that the current relationships would remain in effect for the entire forecast period.

Pilot Hours Flown

Once the number of active student pilots in each age range have been projected for each future year, it is fairly straightforward to calculate the number of hours flown per year by those pilots from data on the average number of hours flown per year by pilots holding a given certificate in a given age range, obtained from the survey of Aircraft Owners and Pilots Association members performed earlier this year as part of the current project. The results of this calculation are shown in Table 5-2

Table 5-2. Baseline Forecast of Hours Flown by Pilots in each County

	2010	2015	2020	2025	2030	2035
Imperial County	16,459	12,100	9,321	7,661	6,382	5,655
Los Angeles County	1,047,596	1,090,087	937,680	814,885	691,948	555,120
Orange County	549,943	495,865	396,978	327,876	267,401	207,685
Riverside County	342,418	234,899	163,751	121,288	94,621	73,458
San Bernardino County	254,018	185,154	132,030	98,733	78,155	61,396
Ventura County	230,658	176,000	125,738	96,223	75,213	57,684
Regional Total	2,441,092	2,194,105	1,765,498	1,466,666	1,213,720	960,998

It should be noted that the number of hours flown for each county is the total flight time for pilots resident in that county, which is not necessarily the county in which the flying takes place. Obviously many of the flight hours in question involve flights to and from airports outside the county in which the flight originates, and in many cases outside Southern California.

It should also be noted that the flight hours by pilots holding an airline transport pilot certificate only includes general aviation flight hours and not flight time in airline operations.

Aircraft Operations

Finally, the forecast of general aviation aircraft operations for each county was projected from the number of aircraft operations at airports in each county for 2010 on the basis of the change in flight hours by pilots resident in the county. Separate forecasts were made for local and itinerant operations, with local operations being projected on the basis of the change in flight hours by student and private pilots, while itinerant operations were projected on the basis of the change in flight hours by commercial and airline transport pilots. While student and private pilots also make itinerant flights, and pilots holding commercial and airline transport pilot certificates also make local flights, the majority of local aircraft operations are made by student and private pilots, while a high proportion of itinerant flights involve the use of professional pilots and are thus are most likely made by pilots holding a commercial or airline transport pilot certificate. Unfortunately, there is very little information readily available on the composition of the general aviation activity at each aircraft in terms of the pilot certificate held by the pilot operating the aircraft.

The resulting forecast of general aviation operations is shown in Table 5-3. With the exception of Los Angeles County from 2010 to 2015, the number of aircraft operations in each county shows a steady decline, with the total number of general aviation operations in the region in 2035 projected to have declined to only 42 percent of the 2010 level.

Table 5-3. Baseline Forecast of General Aviation Aircraft Operations by County

	2010	2015	2020	2025	2030	2035
Imperial County						
Local	53,134	43,208	35,584	32,564	27,669	23,841
Itinerant	48,230	32,951	23,993	17,715	14,430	13,195
	101,364	76,159	59,577	50,279	42,099	37,036
Los Angeles County						
Local	600,192	770,713	724,023	668,487	590,561	484,914
Itinerant	745,066	682,654	548,514	451,792	369,104	289,062
	1,345,258	1,453,367	1,272,537	1,120,278	959,666	773,976
Orange County						
Local	100,807	115,656	105,098	94,347	81,594	65,744
Itinerant	154,510	123,905	91,412	70,805	54,852	41,126
	255,317	239,561	196,509	165,152	136,446	106,870
Riverside County						
Local	297,905	217,263	162,541	134,564	114,243	94,770
Itinerant	266,043	177,193	118,959	82,274	60,370	44,364
	563,948	394,456	281,500	216,839	174,612	139,134
San Bernardino County						
Local	336,048	260,498	200,601	166,809	140,790	116,444
Itinerant	217,701	153,510	104,528	72,580	54,544	40,904
	553,749	414,008	305,129	239,389	195,333	157,348
Ventura County						
Local	183,858	159,474	129,864	110,729	94,152	76,019
Itinerant	119,658	86,255	57,429	40,962	30,018	22,019
	303,516	245,729	187,293	151,691	124,170	98,039
Regional Total						
Local	1,571,944	1,566,812	1,357,710	1,207,499	1,049,009	861,731
Itinerant	1,551,208	1,256,467	944,835	736,128	583,318	450,671
	3,123,152	2,823,279	2,302,545	1,943,627	1,632,327	1,312,402

Reduced Decline Forecast

This forecast assumes that the annual decline in the coefficient of the new student pilot relationship remains the same as that observed over the past ten years until 2015, then slows to half the annual rate of decline until 2025, then remains constant until 2035.

The resulting forecast of active pilots by county is shown in Table 5-4.

Table 5-4. Reduced Decline Forecast of Active Pilots by County

	2010	2015	2020	2025	2030	2035
Imperial County						
Student	33	37	39	41	46	52
Private /1	89	69	54	54	53	56
Commercial	48	34	26	23	21	22
Airline Transport	13	11	8	7	7	8
	183	151	127	125	127	138
Los Angeles County						
Student	2,419	4,392	4,403	4,571	4,879	5,367
Private /1	4,513	5,283	5,055	4,989	5,118	5,471
Commercial	2,263	2,295	2,042	1,888	1,817	1,846
Airline Transport	1,683	1,483	1,198	985	814	708
	10,878	13,453	12,698	12,433	12,628	13,392
Orange County						
Student	1,009	1,659	1,650	1,685	1,772	1,912
Private /1	2,042	2,161	1,981	1,887	1,891	1,973
Commercial	1,072	985	834	743	687	677
Airline Transport	1,180	944	712	541	417	327
	5,303	5,749	5,177	4,856	4,767	4,889
Riverside County						
Student	674	522	466	490	545	631
Private /1	1,413	1,039	766	650	624	664
Commercial	683	503	371	291	248	240
Airline Transport	677	510	376	273	202	150
	3,447	2,574	1,979	1,704	1,619	1,685
San Bernardino County						
Student	593	480	425	435	476	541
Private /1	1,092	860	653	558	538	569
Commercial	606	446	326	256	221	203
Airline Transport	341	283	219	165	124	99
	2,632	2,069	1,623	1,414	1,359	1,412

(continued)

Table 5-4. Reduced Decline Forecast of Active Pilots by County (cont.)

	2010	2015	2020	2025	2030	2035
Ventura County						
Student	365	431	414	428	454	499

	2010	2015	2020	2025	2030	2035
Private /1	891	736	594	527	506	527
Commercial	447	352	268	217	189	182
Airline Transport	545	412	298	215	155	109
	2,248	1,931	1,574	1,387	1,304	1,317
Regional Total						
Student	5,093	7,521	7,397	7,650	8,172	9,002
Private /1	10,040	10,148	9,103	8,665	8,730	9,260
Commercial	5,119	4,615	3,867	3,418	3,183	3,170
Airline Transport	4,439	3,643	2,811	2,186	1,719	1,401
	24,691	25,927	23,178	21,919	21,804	22,833

Note 1. Includes pilots holding a Sport Pilot certificate

The revised assumptions result in a doubling in the number of active student pilots in Los Angeles and Orange Counties by 2035, with a more modest growth in Ventura County. Active student pilots in Riverside and San Bernardino Counties decline from 2010 to 2020, then increase to levels in 2035 slightly below those of 2010. There is a modest increase in active private pilots in Los Angeles County from 2010 to 2035, but otherwise active private, commercial and airline transport pilots decline in all counties.

The effect of this is to give an increase in total active pilots in Los Angeles County from 2010 to 2035, with a decline in all the other counties. For the region as a whole, total active pilots decline by about 7.5% from 2010 to 2035.

Pilot Hours Flown

The corresponding forecast for pilot hours flown is shown in Table 5-5.

Aircraft Operations

The resulting forecast of aircraft operations is shown in Table 5-6. The revised assumptions result in a decline in the number of aircraft operations in all counties from 2010 to 2035 by about 30%. The decline is obviously less in Los Angeles County, due to the greater increase in active student pilots, where aircraft operations decline by only about 3% from 2010 to 2035.

Table 5-5. Reduced Decline Forecast of Hours Flown by Pilots in each County

	2010	2015	2020	2025	2030	2035
Imperial County	16,459	12,100	9,403	8,645	8,647	9,437

	2010	2015	2020	2025	2030	2035
Los Angeles County	1,047,596	1,090,087	961,154	900,321	891,849	932,932
Orange County	549,943	495,865	406,359	358,818	339,702	342,200
Riverside County	342,418	234,899	165,919	130,217	116,415	117,188
San Bernardino County	254,018	185,154	133,375	106,843	97,058	98,424
Ventura County	230,658	176,000	128,142	104,189	93,090	91,265
Regional Total	2,441,092	2,194,105	1,804,352	1,609,033	1,546,761	1,591,446

Table 5-6. Reduced Decline Forecast of General Aviation Aircraft Operations by County

	2010	2015	2020	2025	2030	2035
Imperial County						
Local	53,134	43,208	36,246	36,739	37,418	40,495
Itinerant	48,230	32,951	23,993	19,995	19,595	21,591
	101,364	76,159	60,239	56,734	57,012	62,086
Los Angeles County	600,192	770,713	746,729	748,009	776,743	838,158
Local	745,066	682,654	559,343	493,180	465,870	471,086
Itinerant	1,345,258	1,453,367	1,306,072	1,241,189	1,242,613	1,309,244
	600,192	770,713	746,729	748,009	776,743	838,158
Orange County						
Local	100,807	115,656	108,385	105,289	107,026	112,875
Itinerant	154,510	123,905	93,072	76,218	67,585	64,932
	255,317	239,561	201,457	181,507	174,611	177,807
Riverside County						
Local	297,905	217,263	166,180	148,232	148,163	161,973
Itinerant	266,043	177,193	119,921	86,782	71,142	66,332
	563,948	394,456	286,101	235,014	219,305	228,306
San Bernardino County						
Local	336,048	260,498	204,540	182,463	182,284	197,411
Itinerant	217,701	153,510	104,963	77,893	65,261	62,001
	553,749	414,008	309,502	260,356	247,544	259,412
Ventura County						
Local	183,858	159,474	133,679	123,289	121,813	129,150
Itinerant	119,658	86,255	58,177	43,460	35,762	32,502
	303,516	245,729	191,855	166,749	157,576	161,652

(continued)

Table 5-6. Reduced Decline Forecast of General Aviation Aircraft Operations (cont.)

	2010	2015	2020	2025	2030	2035
Regional Total						

Local	1,571,944	1,566,812	1,395,758	1,344,021	1,373,446	1,480,062
Itinerant	1,551,208	1,256,467	959,468	797,528	725,215	718,444
	3,123,152	2,823,279	2,355,227	2,141,549	2,098,662	2,198,506

Arrested Decline Forecast

This forecast assumes that the annual decline in the coefficient of the new student pilot relationship ends in 2010 and the relationship between new student pilots per 100,000 population and real GDP per capita remains constant until 2035. While this is obviously a more optimistic scenario than the other two, since it will generate more student pilots, and eventually other categories of pilot as those student pilots transition to higher levels of certificate, it begs the question what would cause the decline in the new student pilot relationship to suddenly flatten out. The resulting forecast of active pilots by county is shown in Table 5-7.

Table 5-7. Arrested Decline Forecast of Active Pilots by County

	2010	2015	2020	2025	2030	2035
Imperial County						
Student	33	41	48	54	61	70
Private /1	89	70	63	65	68	74
Commercial	48	34	29	26	25	26
Airline Transport	13	11	8	10	12	12
	183	156	148	155	166	182
Los Angeles County						
Student	2,419	4,715	5,294	6,019	6,753	7,457
Private /1	4,513	5,516	5,757	6,222	6,816	7,472
Commercial	2,263	2,368	2,266	2,277	2,350	2,480
Airline Transport	1,683	1,502	1,265	1,092	960	877
	10,878	14,101	14,582	15,610	16,879	18,286
Orange County						
Student	1,009	1,775	1,976	2,219	2,451	2,659
Private /1	2,042	2,247	2,239	2,343	2,508	2,692
Commercial	1,072	1,009	916	885	884	901
Airline Transport	1,180	949	736	581	469	390
	5,303	5,980	5,867	6,028	6,312	6,642

(continued)

Table 5-7. Arrested Decline Forecast of Active Pilots by County (cont.)

	2010	2015	2020	2025	2030	2035
Riverside County						
Student	674	557	560	648	753	879
Private /1	1,413	1,063	838	781	811	897
Commercial	683	513	394	337	310	313
Airline Transport	677	513	383	284	216	166
	3,447	2,646	2,175	2,050	2,090	2,255
San Bernardino County						
Student	593	514	511	574	658	756
Private /1	1,092	884	720	679	704	772
Commercial	606	453	347	293	275	267
Airline Transport	341	287	225	176	142	113
	2,632	2,138	1,803	1,722	1,779	1,908
Ventura County						
Student	365	458	496	562	628	694
Private /1	891	755	657	642	667	713
Commercial	447	360	290	254	241	242
Airline Transport	545	414	304	227	167	126
	2,248	1,987	1,747	1,685	1,703	1,775
Regional Total						
Student	5,093	8,060	8,885	10,076	11,304	12,515
Private /1	10,040	10,535	10,274	10,732	11,574	12,620
Commercial	5,119	4,737	4,242	4,072	4,085	4,229
Airline Transport	4,439	3,676	2,921	2,370	1,966	1,684
	24,691	27,008	26,322	27,250	28,929	31,048

Note 1. Includes pilots holding a Sport Pilot certificate

This forecast gives an increase in active student pilots in all counties, with a higher growth of active private pilots in Los Angeles County, and a growth of active private pilots in Orange County and active commercial pilots in Los Angeles and Orange Counties. Active private and commercial pilots decline in all other counties and active airline transport pilots decline in all counties. The net effect gives an overall increase in total active pilots in the region of about 26% from 2010 to 2035.

Pilot Hours Flown

The corresponding forecast for pilot hours flown is shown in Table 5-8.

Table 5-8. Arrested Decline Forecast of Hours Flown by Pilots in each County

	2010	2015	2020	2025	2030	2035
Imperial County	16,459	12,301	10,960	10,961	11,896	12,739
Los Angeles County	1,047,596	1,132,893	1,088,037	1,116,095	1,183,260	1,271,978
Orange County	549,943	510,538	452,813	438,495	445,749	463,442
Riverside County	342,418	240,160	178,957	154,403	148,532	156,065
San Bernardino County	254,018	189,488	145,204	127,722	126,444	132,218
Ventura County	230,658	179,717	140,044	124,953	120,541	123,514
Regional Total	2,441,092	2,265,097	2,016,015	1,972,629	2,036,422	2,159,956

Aircraft Operations

The resulting forecast of aircraft operations is shown in Table 5-9. Aircraft operations increase from 2010 to 2035 in Los Angeles County from 2010 to 2035 by about 33%. For the region as a whole, aircraft operations decline from 2010 to 2025 then increase thereafter to reach a level on 2035 about 4% below the level in 2010.

Table 5-9. Arrested Decline Forecast of General Aviation Aircraft Operations by County

	2010	2015	2020	2025	2030	2035
Imperial County						
Local	53,134	44,832	42,950	45,324	48,531	53,756
Itinerant	48,230	32,951	27,542	26,112	28,738	29,695
	101,364	77,782	70,492	71,436	77,268	83,451
Los Angeles County						
Local	600,192	811,277	864,797	949,485	1,048,187	1,152,198
Itinerant	745,066	702,934	620,830	597,306	606,912	636,307
	1,345,258	1,514,211	1,485,627	1,546,790	1,655,099	1,788,506
Orange County						
Local	100,807	121,237	124,584	133,134	143,915	155,055
Itinerant	154,510	126,228	101,341	90,363	86,519	86,575
	255,317	247,465	225,925	223,497	230,434	241,630
Riverside County						
Local	297,905	224,146	186,218	183,315	196,847	221,820
Itinerant	266,043	180,331	126,471	99,791	87,553	85,821
	563,948	404,477	312,688	283,106	284,401	307,641

(continued)

Table 5-9. Arrested Decline Forecast of General Aviation Aircraft Operations (cont.)

	2010	2015	2020	2025	2030	2035
San Bernardino County						
Local	336,048	270,189	230,575	227,735	243,245	270,992
Itinerant	217,701	155,908	111,646	89,916	83,100	81,361
	553,749	426,097	342,221	317,651	326,345	352,353
Ventura County						
Local	183,858	164,961	151,219	153,932	163,555	176,887
Itinerant	119,658	87,519	62,232	50,523	44,777	43,434
	303,516	252,480	213,451	204,455	208,332	220,321
Regional Total						
Local	1,571,944	1,636,642	1,600,342	1,692,926	1,844,279	2,030,708
Itinerant	1,551,208	1,285,870	1,050,062	954,011	937,599	963,192
	3,123,152	2,922,512	2,650,404	2,646,937	2,781,878	2,993,901

Summary

The total numbers of forecast aircraft operations for the region as a whole for each of the three forecast scenarios are shown in Table 5-10. For comparison, the regional total from the latest FAA Terminal Area Forecast is also shown.

Table 5-10. Comparison of Alternative Forecasts of General Aviation Aircraft Operations for the Southern California Region

	2010	2015	2020	2025	2030	2035
Baseline Forecast						
Local	1,571,944	1,566,812	1,357,710	1,207,499	1,049,009	861,731
Itinerant	1,551,208	1,256,467	944,835	736,128	583,318	450,671
	3,123,152	2,823,279	2,302,545	1,943,627	1,632,327	1,312,402
Reduced Decline Forecast						
Local	1,571,944	1,566,812	1,395,758	1,344,021	1,373,446	1,480,062
Itinerant	1,551,208	1,256,467	959,468	797,528	725,215	718,444
	3,123,152	2,823,279	2,355,227	2,141,549	2,098,662	2,198,506
Arrested Decline Forecast						
Local	1,571,944	1,636,642	1,600,342	1,692,926	1,844,279	2,030,708
Itinerant	1,551,208	1,285,870	1,050,062	954,011	937,599	963,192
	3,123,152	2,922,512	2,650,404	2,646,937	2,781,878	2,993,901

(continued)

Table 5-10. Comparison of Alternative Forecasts of General Aviation Aircraft Operations for the Southern California Region (cont.)

	2010	2015	2020	2025	2030	2035
FAA Terminal Area Forecast /1						
Local	1,423,344	1,425,724	1,469,893	1,516,718	1,566,376	/2
Itinerant	1,439,626	1,448,200	1,517,703	1,592,170	1,671,980	/2
	2,862,970	2,873,924	2,987,596	3,108,888	3,238,356	/2

Note: 1. Excludes non-TAF airports
2. Latest Terminal Area Forecast only extends to 2030

Under the Baseline Forecast, total aircraft operations decline to 42% of 2010 levels by 2035. However, the projected decline is greater for itinerant operations, which are projected to decline to only 29% of 2010 levels by 2035. Local operations are projected to decline to 55% of 2010 levels by 2035, reflecting the larger share of student and private pilots in the pilot community by 2035, as the inflow of new student pilots transitioning to higher levels of certificate are not sufficient to replace the numbers of older commercial and airline transport pilots becoming inactive. The number of total aircraft operations in the Baseline Forecast for 2030 is only 50% of that projected in the FAA Terminal Area Forecast (TAF) for that year. However, the TAF projects a slight increase in the proportion of itinerant operations from 50% 2010 to 52% in 2030. Because of the slower decline in local operations than itinerant operations in the Baseline Forecast the number of local operations in 2030 only declines to 67% of the number forecast in the TAF while the number of itinerant operations declines to 35% of the number forecast in the TAF.

Under the Reduced Decline Forecast, total aircraft operations decline to 70% of 2010 levels by 2035. Itinerant operations are projected to decline to 46% of 2010 levels by 2035, while due to the assumed greater inflow of student pilots than in the Baseline Forecast local operations are projected to decline to only 70% of 2010 levels by 2035. The number of total aircraft operations in the Reduced Decline Forecast for 2030 is 65% of that projected in the TAF for that year, with the number of local operations only declining to 94% of the number forecast in the TAF while the number of itinerant operations is projected to decline to 46% of the number forecast in the TAF.

Under the more aggressive Arrested Decline Forecast, total aircraft operations only decline to 96% of 2010 levels by 2035. Itinerant operations are projected to decline to 62% of 2010 levels by 2035, while the even greater assumed inflow of student pilots compared to the Baseline Forecast results in an increase in local operations to 129% of 2010 levels by 2035. The number of total aircraft operations in the Arrested Decline Forecast for 2030 is 86% of that projected in the TAF for that year, with the number of local operations 18% higher than the number forecast in the TAF and the number of itinerant operations projected to decline to 56% of the number forecast in the TAF.

It should be noted that the greater decline in forecast itinerant operations compared to local operations in all three forecast scenarios is a consequence of the interaction of two effects:

1 The more rapid forecast decline in the number of active commercial and airline transport pilots compared to student and private pilots

2 The assumption that the change in the number of local operations is proportional to the change in hours flown by student and private pilots, while the change in the number of itinerant operations is proportional to the change in the hours flown by commercial and airline transport pilots.

However the first result could change if the demand for commercial pilots in the general aviation sector (some of whom are required by their employers to hold an airline transport pilot certificate) causes a higher proportion of student and private pilots to transition to higher levels of pilot certificate. A shortage of commercial pilots could also cause those commercial pilots who are active to fly more, leading to an increase in flight hours by commercial and airline transport pilots and the associated aircraft operations.

Since student and private pilots do perform itinerant operation as well as local operations, although typically not as many, an increase in the proportion of student and private pilots relative to commercial and airline transport pilots should contribute to an increase in the number of itinerant operations, rather than these being determined solely by the change in the number of flight hours by commercial and airline transport pilots. Further research is needed to better understand the relative proportions of local and itinerant operations flown by pilots holding different levels of pilot certificate, as well as any trends in these proportions over time.

6. Forecasts of Based Aircraft and Associated Aircraft Operations

The forecasts of active pilots in Southern California and the hours flown by those pilots provides one perspective on the future levels of general aviation activity in the region. However, the size and composition of the based aircraft is only indirectly related to the level of flying activity. Aircraft do not disappear when the amount of flying declines; rather they tend to be flown less and the percentage of the fleet that is inactive increases. Even so, some new aircraft will be added to the fleet each year and some aircraft will be sold and relocated outside the region, or even outside the country. Eventually older aircraft that are no longer airworthy or no longer economic to maintain and operate will be sold or scrapped. From the perspective of the Southern California based aircraft fleet, it does not matter whether an aircraft is sold to a new owner located outside the region or scrapped. In any year there will of course be some used aircraft that are purchased by new owners in Southern California and imported into the region. Therefore what matters is the net attrition of aircraft of a given age due to the balance between those aircraft that are sold and exported from the region or scrapped and the addition of used aircraft that are imported in to the region from elsewhere.

Thus a forecast of the potential size and composition of the future based aircraft fleet in the region can be developed by considering the net attrition rate of the current aircraft fleet and the future addition of newly manufactured aircraft to the fleet.

Approach

The based aircraft forecast is based on the list of registered aircraft in each county for 2010 prepared by the County Assessor and obtained from the California Department of Transportation, Division of Aeronautics. The County Assessor record for each aircraft includes the Federal Aviation Administration (FAA) aircraft registration number (tail number) and in principle includes the year of manufacture and the aircraft make and model. However, the year of manufacture is missing for many records and the terminology used for the aircraft make and model are not standardized, making it extremely difficult to classify each aircraft into a consistent set of aircraft categories. Therefore additional data for each aircraft was obtained from the FAA Aircraft Registration Database using the aircraft tail number to search for the aircraft in the FAA data. The additional data included the aircraft type (fixed-wing, rotorcraft, etc.), number of engines, and type of engines, as well as the year of manufacture.

This allowed each aircraft in the County Assessor data to be classified into the following categories:

- Single-engine piston (SEP)
- Single-engine turboprop (SET)
- Multi-engine piston (MEP)
- Multi-engine turboprop (MET)
- Jet aircraft (JET)
- Helicopter (HELI)
- Glider (GLI)
- Balloon (BAL)
- Other (OTH)

In addition missing data on the year of manufacture in the County Assessor records was filled in where possible from the FAA aircraft registration data. Many of the FAA records are also missing the year of manufacture, but with some effort this could be determined in many cases from other data in the FAA aircraft registration record, such as the airworthiness date, the date when the aircraft was first certificated, or the serial number of the aircraft. Aircraft manufacturers generally assign serial numbers for each aircraft model sequentially, so the year of manufacture can be determined from that for other aircraft of the same model with adjacent serial numbers for which the year of manufacture is given.

A number of aircraft records in the County Assessor data turned out to be duplicate entries for the same aircraft, such as cases where an aircraft had been assigned a new tail number after a sale. Quite a few of the aircraft in the County Assessor data did not appear in the FAA database of currently registered aircraft. Further investigation established that these were often explained by the following situations:

- The aircraft had been exported or sold to a new owner who had registered the aircraft under a different tail number
- The aircraft owner had cancelled the registration, presumably because the aircraft was no longer being used

- The aircraft tail number had been issued to an owner who was building a homebuilt aircraft which had not yet been registered (presumably because it was still under construction)

Based Aircraft Forecast Methodology

The forecast of based aircraft needs to consider two effects. The first is the attrition of the current (2010) based aircraft fleet over time. The second is the addition of new aircraft to the fleet in the future. Those aircraft will also experience attrition over the period of the forecast. Therefore the forecast requires two sets of assumptions:

1. An attrition function that predicts the percentage of aircraft in the based aircraft fleet in a given year that will remain in the fleet one year later.
2. The number of aircraft of each type that will enter the fleet in each future year.

Given these two sets of assumptions, it is a fairly simple matter to calculate the change in the size of the based aircraft fleet over time. However, neither assumption is a simple matter, since both the attrition rate and the rate of new aircraft entering the fleet are likely to change over time in response to changing conditions in the general aviation sector.

For the purposes of the current forecasts, the aircraft fleet attrition relationship developed in a study for the FAA by Optimum Computer Systems, Inc. (OCS) in the mid 1970s (Rocks, 1976) has been adopted. While this study is now somewhat dated, the underlying factors that determine the rate at which aircraft are withdrawn from the aircraft fleet may not have changed that much over the past 35 years, although this is a subject that is deserving of future research. The attrition relationship developed in the OCS report expresses the attrition rate per year as a function of the age of the aircraft. This attrition rate initially increases as the aircraft becomes older, reaching a maximum of 2.7% per year at 18 years, then declining in subsequent years to a rate of 1.75% per year at 25 years. Unfortunately, the OCS study did not analyze the change in attrition rates for aircraft older than 25 years, but simply grouped all aircraft older than 25 years into a single category for which they suggested an attrition rate of 1.0% per year.

This is potentially problematical for developing forecasts of the based aircraft fleet from 2010 to 2035, since a large proportion of the aircraft fleet is already well over 30 years old, and by 2035 the majority of these aircraft (if they are still in service) will be over 60 years old. However, the annual FAA *General Aviation and Part 135 Activity Survey* (FAA, 2011c) provides estimates of the number of registered and active aircraft in five-year age ranges for aircraft 60 years old or less, with older aircraft grouped into a single category. It is apparent from these data that attrition of older aircraft from the fleet does indeed occur at about 1% per year. However, the percent of the registered aircraft fleet that was reported as being actively flown reduces steadily with age, as shown in Figure 6-1. The trend shown in Figure 6-1 points out the need to distinguish between registered aircraft and active aircraft in forecasting based aircraft, since registered aircraft determine the size of the based aircraft fleet, while the number of active aircraft determines how much flying those aircraft do.

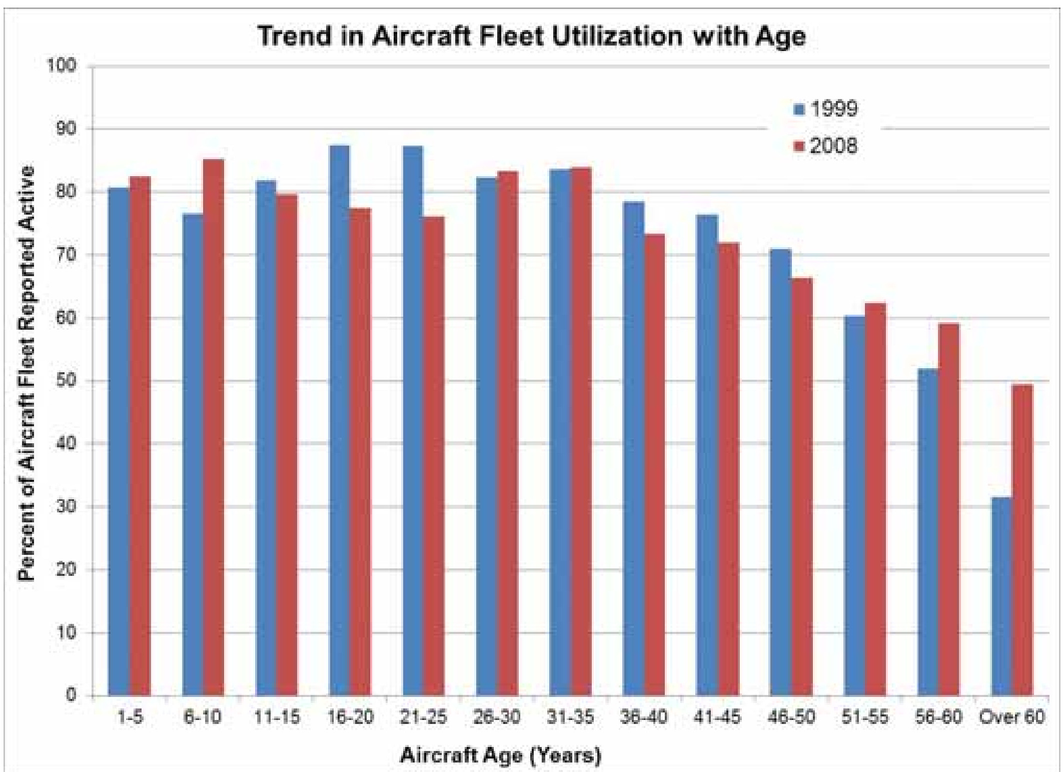


Figure 6-1. Change in Aircraft Utilization with Age – 1999 and 2008

The analysis of the FAA survey data shown in Figure 6-1 used the data from the 1999 and 2008 surveys because the aircraft age ranges used in those two surveys gave the number of registered and active aircraft grouped by aircraft manufactured in the same five-year periods. This therefore allowed a direct measure of the attrition of aircraft by age. For example, the aircraft in the age range 36 to 40 years old in the 1999 survey are the same aircraft in the age range 46 to 50 years old in 2008. Therefore the change in the number of aircraft in this cohort from 1999 to 2008 measures the net attrition over the nine-year period, from which the annual attrition rate can be derived.

It was found that for aircraft over about 25 years old, the attrition rate of registered aircraft was around 1% per year, which is consistent with the value estimated in the earlier OCS study. An attrition rate of 1% per year is relatively slow and implies that about 78% of the aircraft that was more than 25 years old in 2010 will still be in the fleet in 2035. However, the percentage of this fleet that is actively flown also declines with the age of the aircraft, as shown in Figure 6-1, which indicates than less than half the aircraft in the fleet that are over 60 years old are still actively flown.

Obviously aircraft cannot continue to be flown forever, although many of the older aircraft that are still in the based aircraft fleet have been restored and in effect given a new lease of life. This is particularly true for what have come to be viewed as vintage aircraft dating from the 1930’s and 1940’s. It remains to be seen what percentage of aircraft built between the late 1960’s and the early 1980’s, that forms by far the largest proportion of the current aircraft fleet, will eventually be restored. The number of such aircraft and their relative lack of historic interest to collectors suggests that the majority will probably be scrapped when they reach an age where it is no longer economic to continue to keep them in flying condition.

Furthermore, it is unclear from the FAA aircraft activity survey data whether the attrition rates observed for aircraft aged between 25 and 60 years continue to apply to aircraft significantly older than 60 years, since the results of the aircraft activity surveys group aircraft over 60 years old into a single age group. While this was less important in the past, since a relatively small proportion of the aircraft fleet was over 60 years old, this will change over the coming 25 years. By 2035 aircraft built between 1965 and 1975 that are still in the aircraft fleet will be between 60 and 70 years old. In the absence of more detailed information about the attrition rates of aircraft older than 60 years, it was assumed that the average attrition rate for aircraft over 60 years old calculated from the results of the FAA activity survey remains constant for all aircraft older than 60 years.

Examination of changes in the composition of the based aircraft fleet in Southern California over the past ten years has shown that the rates at which different aircraft types have been entering the fleet has varied widely, with the numbers of jet aircraft and helicopters growing significantly over the period, while the number of single-engine propeller aircraft has remained fairly static and the number of multi-engine propeller aircraft has declined. In the absence of any formal models of the rates at which different aircraft types are likely to be added to the based aircraft fleet in the future, assumed values for these rates can be based on an analysis of recent trends in the fleet composition and size, as discussed in the next section.

Current Composition of the Based Aircraft Fleet

Los Angeles County contains the largest number of based aircraft of any of the six counties in the Southern California region, accounting for about 46% of the total based aircraft in the region. The next two counties with the largest numbers of based aircraft are Riverside County with 17 % of the total based aircraft in the region and San Bernardino County with 15% of the regional based aircraft fleet. The following discussion compares the composition of Los Angeles County aircraft fleet given by the County Assessor data to that given by the based aircraft counts in the FAA Form 5010 *Airport Master Record* data for the same year. While these comparisons differ somewhat from county to county, the pattern observed in Los Angeles County is generally true for the other counties.

After the data cleaning, the 4,370 aircraft records in the County Assessor database for Los Angeles County were classified as follows:

- 4,296 valid records with a year of manufacture and aircraft type
- 28 records missing the year of manufacture, mostly homebuilt single-engine piston aircraft (possibly still under construction)
- 28 aircraft destroyed, exported or transferred out of the county
- 6 records with an invalid tail number and insufficient information to identify the aircraft
- 2 tail numbers reserved with no aircraft information
- 10 duplicate entries

The number of aircraft of each type in the valid records with year of manufacture and aircraft type, together with the corresponding FAA Form 5010 based aircraft data for Los Angeles County airports for 2010 are shown in Table 6-1. Compared to the County Assessor data, the FAA Form 5010 counts overstate single-engine propeller aircraft by about 6.5%, or some 200 aircraft. For the other aircraft types, the Form 5010 counts are considerably less than the County Assessor data. Jet aircraft are understated by about 9%, the multi-engine propeller aircraft are understated by about 12%, and helicopters are understated by about 35%. The low number of helicopters in the Form 5010 data could be due to a large number of helicopters being kept at locations other than the airports included in the FAA 5010 data.

Table 6-1. Comparison of County Assessor Data with FAA 5010 Based Aircraft Counts for Los Angeles County

Aircraft Type	County Assessor Data	FAA Form 5010 Counts	Percent Difference
Single-engine Piston	3,011		
Single-engine Turboprop	59		
	3,070	3,269	106.5%
Multi-engine Piston	362		
Multi-engine Turboprop	67		
	429	376	87.6%
Jet Aircraft	418	381	91.1%
Helicopter	284	185	65.1%
Glider	70	7	10.0%
Balloon	17		0.0%
Other	8		0.0%
	4,296	4,218	98.2%

The low number of gliders and the absence of balloons and other aircraft in the FAA Form 5010 counts is not surprising, since many gliders, balloons and ultralight aircraft are typically stored at locations other than airports. In addition some of the gliders and ultralight aircraft in the county may be stored at private airports that are not included in the FAA Form 5010 data.

The lower number of single-engine propeller aircraft in the County Assessor data may partly be accounted for by those aircraft that did not have a year of manufacture identified, and were omitted from the data shown in Table 6-1. However, this would only account for about 25 of the 199 aircraft difference. It is clear from the FAA Form 5010 data for individual airports that these data are not always updated on an annual basis, particularly at smaller airports. Therefore the counts may tend to lag behind the decline in the actual number of single-engine propeller aircraft. Conversely, in the case of jet aircraft and helicopters, where the fleet has been growing in recent years, the counts may lag behind this growth.

However, notwithstanding these differences, the County Assessor data and the FAA Form 5010 data are broadly consistent, and it appears that the County Assessor data provides a reasonable basis for developing forecasts of based aircraft, particularly given the inherent uncertainty involved in such forecasts over more than a few years.

Age Profile of the Current Aircraft Fleet

Figure 6-2 shows the age profile of the current aircraft fleet in Los Angeles County, distinguishing between single-engine propeller aircraft and other aircraft types. Single-engine propeller aircraft constitute the largest fraction of the fleet, but this proportion has been dropping over time, largely due to the high proportion of single-engine aircraft among aircraft older than 30 years.

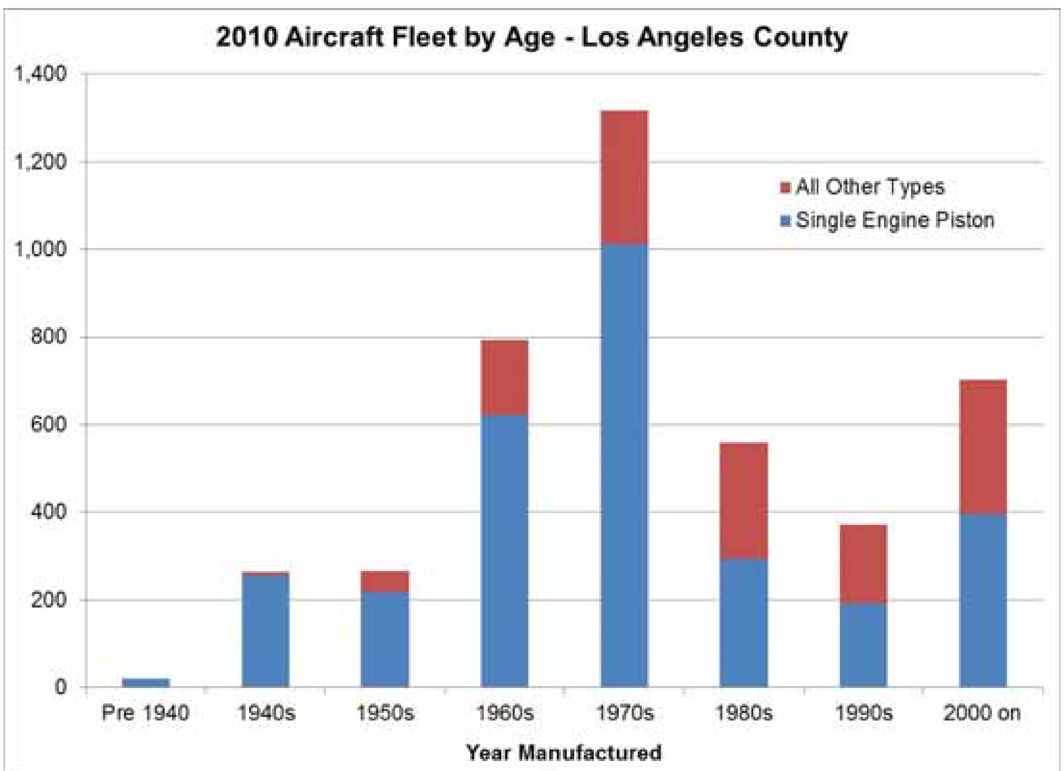


Figure 6-2. Age Profile of 2010 Based Aircraft Fleet in Los Angeles County

Aircraft manufactured during the 1970's constitute the largest age cohort of the fleet, accounting for 31% of all aircraft, followed by those manufactured during the 1960s, which account for 19% of the fleet. The newest aircraft, those manufactured during the past 10 years, form the third highest age cohort, accounting for 16% of the fleet. Of these relatively new aircraft, single-engine piston aircraft comprise 56% of the aircraft in this age cohort, due in large part to the growing number of homebuilt aircraft.

The age profile of aircraft manufactured since 2000 is shown in Figure 6-3. Since there has been relatively low attrition of these aircraft (the OCS study cited above found that 93% of the aircraft manufactured in a given year are still registered 10 years later, with correspondingly higher proportions for newer aircraft), the number of the aircraft manufactured in each year gives a good indication of the rate at which new aircraft have been added to the fleet. As can be seen, this was fairly constant from 2000 to 2003 then rose steadily to 2006, since when it has declined sharply.

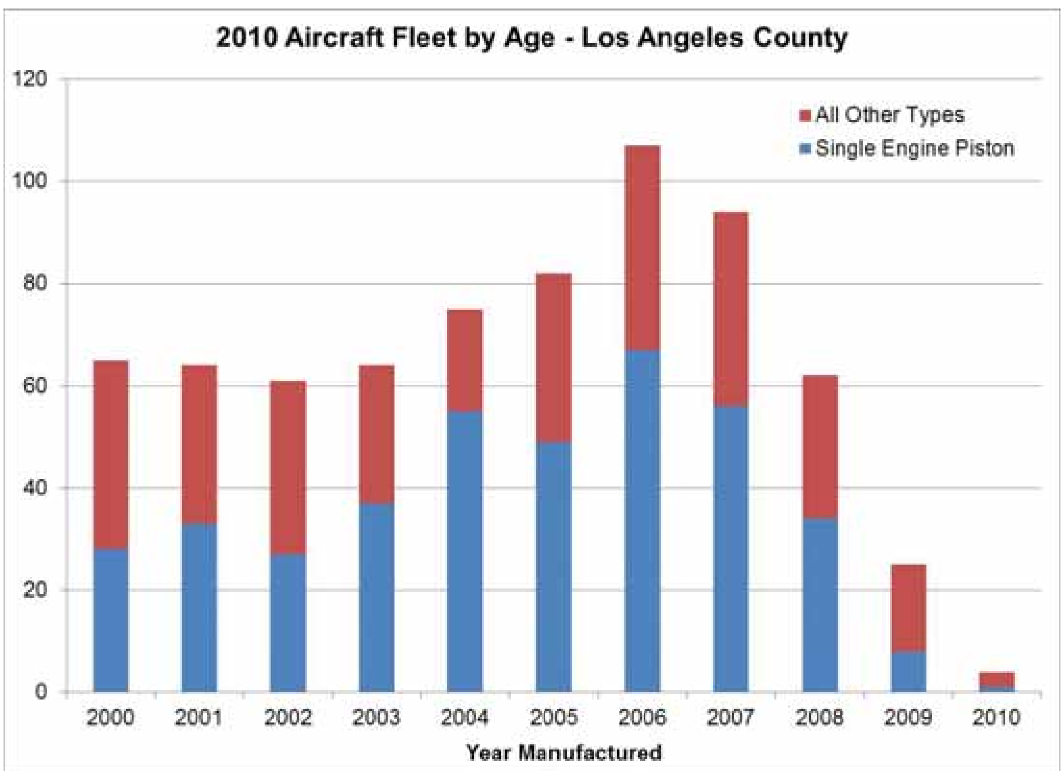


Figure 6-3. Age Profile of 2010 Based Aircraft Fleet Manufactured Since 2000

The data for 2010 should be viewed with caution, since the County Assessor data was assembled during the year and so almost certainly have missed aircraft added to the fleet later in the year. Even so, the decline in new aircraft being added to the fleet since 2006 is dramatic.

The age profile of the single-engine turboprop and multi-engine piston and turboprop aircraft in the fleet is shown in Figure 6-4. This shows that the great majority of these aircraft is over 30 years old, while the proportion of turboprop aircraft relative to multi-engine piston aircraft has increased steadily over time, as has the proportion of single-engine turboprop aircraft. Indeed, over the past 10 years more single-engine turboprop aircraft were added to the fleet than multi-engine turboprop and piston aircraft combined. The decline in the numbers of multi-engine turboprop and piston aircraft added to the fleet over the past 30 years in part reflects a shift to jet aircraft for corporate and business flying.

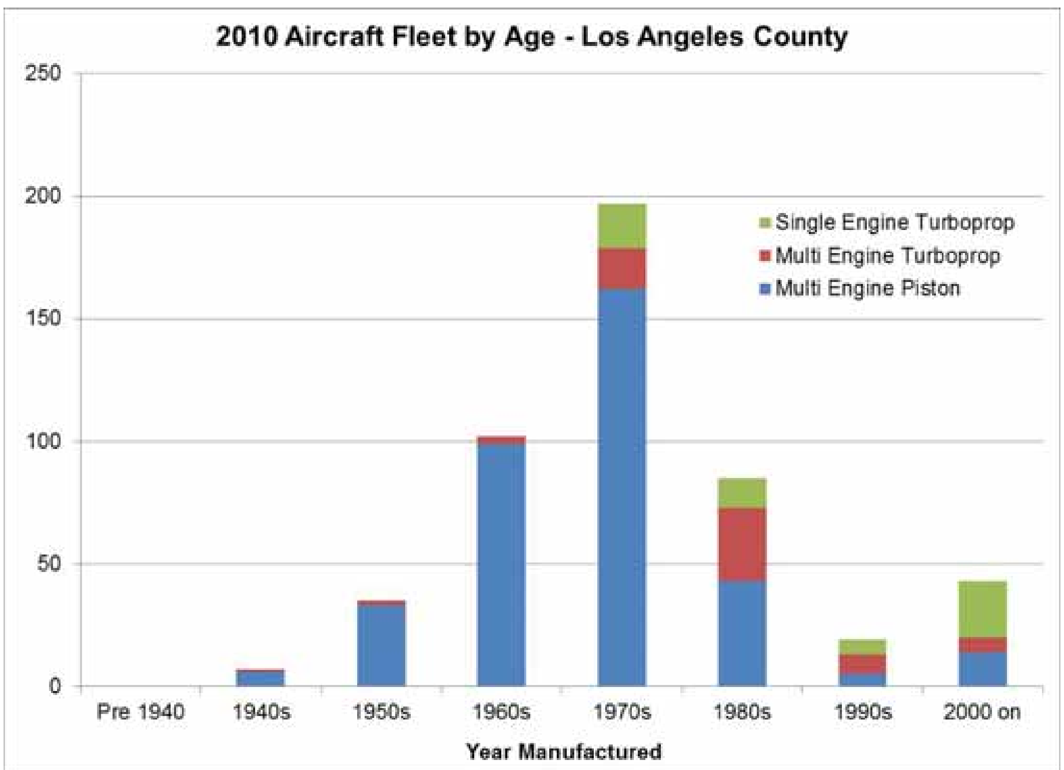


Figure 6-4. Age Profile of 2010 Based Aircraft Fleet – Turboprop and Multi-Engine Piston Aircraft in Los Angeles County

The corresponding age profile for rotorcraft and jet aircraft is shown in Figure 6-5. In contrast to the age profile of piston and turboprop aircraft shown in the Figures 6-2 and 6-4, the number of both rotorcraft and jet aircraft added to the fleet has increased steadily over time, with those manufactured over the past 10 years comprising the largest age cohort and accounting for 42% of the rotorcraft fleet and 31% of the jet aircraft fleet.

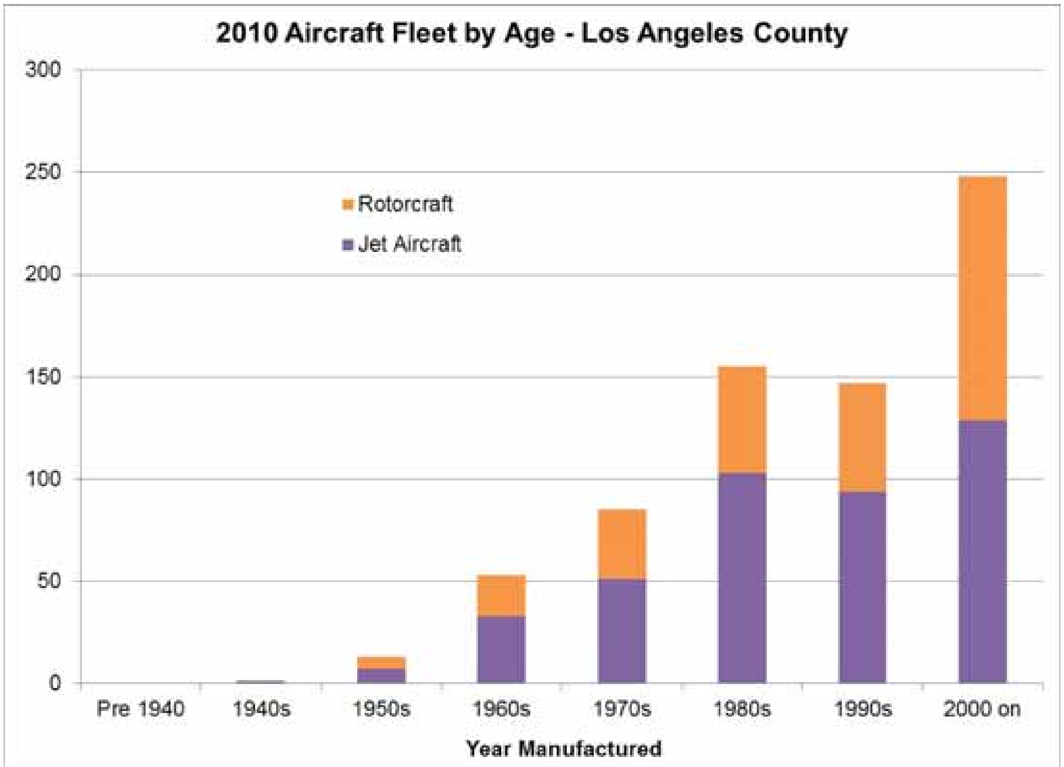


Figure 6-5. Age Profile of 2010 Based Aircraft Fleet – Rotorcraft and Jet Aircraft in Los Angeles County

The age profile for rotorcraft and jet aircraft manufactured since 2000 is shown in Figure 6-6. The steady increase in the number of such aircraft added to the fleet in each decade shown in Figure 6-5 appears to have leveled out, with marked fluctuations over the decade. Following a sharp decline in the number of both types of aircraft added to the fleet from 2002 to 2004, there was a strong growth to 2006 in rotorcraft added to the fleet and to 2007 in jet aircraft added to the fleet. This was followed by a steady decline in the number of rotorcraft added to the fleet from 2006 to 2009 and a similar decline in jet aircraft added to the fleet from 2007 to 2008, followed by a modest growth to 2009. However, it should be noted that the differences from year to year are typically less than five aircraft and never more than seven aircraft, so year to year fluctuations are likely to be heavily influenced by the timing on individual owner decisions on aircraft acquisition.

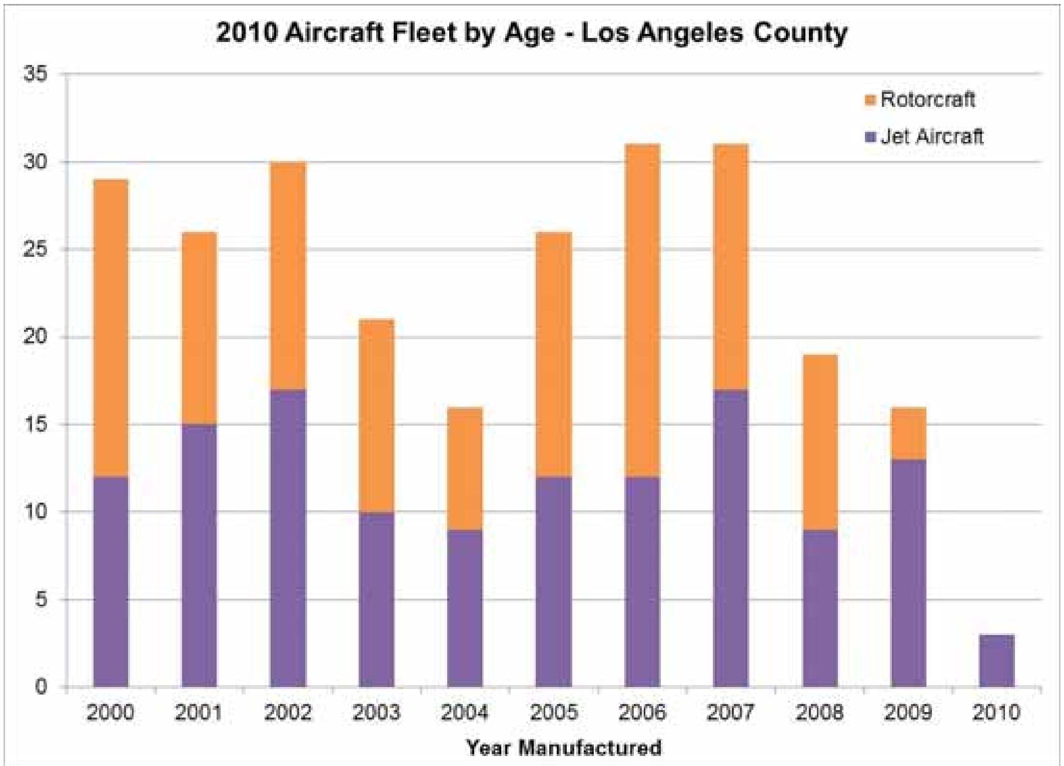


Figure 6-6. Age Profile of 2010 Based Aircraft Fleet – Rotorcraft and Jet Aircraft Manufactured Since 2000

It is very likely that the decline in the addition of new rotorcraft and jet aircraft to the fleet from 2007 to 2009 was heavily influenced by the recession that started in 2007 as well as subsequent restrictions on the availability of business credit that occurred. As the economy recovers from the recession, it is seems likely that acquisition of new rotorcraft and jet aircraft will return to pre-recession levels.

Forecast Assumptions for Future Additions to the Fleet

Based on the previous analysis, it seems reasonable to assume as a baseline case that over the next 25 years, additions of rotorcraft and jet aircraft to the fleet will correspond to the average rate experienced during the period from 2000 to 2009. In the case of Los Angeles County this implies net additions of about 12 new rotorcraft and 13 new jet aircraft per year. These additions do not count imports to and exports from the region of older aircraft. It is assumed that the net effect of these imports and exports is accounted for in the assumed attrition rates for aircraft of a given age and the current age profile of aircraft of a given type. Of course, attrition rates calculated on national data (as rates estimated in the OCS study were) do not consider movement of aircraft between different regions of the country, although they do account for exports from and imports to the United States. Thus the use of national fleet attrition data assumes that for a given region, such as Southern California, sales of aircraft to new owners outside the region are balanced by purchases of aircraft of a similar age that are moved to the region (although not generally by the same owners).

The number of single-engine piston aircraft added to the fleet each year during the past decade in Los Angeles County showed an increasing trend from 2000 to 2006, followed by a rapid decline to 2009, as shown in Figure 6-3. It is assumed that these trends reflect the general economic growth prior to 2006 and the effect of the 2007 recession, although the decline from 2006 to 2009 is so great that there may be other factors involved. Therefore as a baseline case it seems reasonable to assume that future additions of new single-engine piston aircraft to the aircraft fleet each year will correspond to the average rate in each county over the period from 2000 to 2009, or about 39 aircraft per year in the case of Los Angeles County. This implicitly assumes that future changes in various factors that are likely to influence aircraft owner decisions to purchase a new aircraft or construct a homebuilt aircraft offset each other. These factors are likely to include:

- An increase in real disposable income due to improvement in the economy, which would tend to increase the rate at which new aircraft are acquired or older aircraft are replaced by new aircraft
- A decline in the number of active private pilots as the private pilot community ages, which would reduce the overall demand for aircraft and put more used aircraft on the market, reducing the demand for new aircraft
- Increases in the cost of flying, particularly fuel costs, which would discourage potential new aircraft owners from acquiring new or used aircraft
- Changes in the number of new student pilots, which would affect aircraft acquisition decisions by flying schools and other flight training programs

The combined effect of these factors is likely to be quite complex and difficult to predict, although developing a better understanding of their influence on aircraft purchase decisions would be a very useful topic for future research.

Recent trends in the addition of other aircraft types to the based aircraft fleet are less clear, due to the relatively small number of such aircraft that have been added to the fleet over the past decade. The average numbers of aircraft added to the fleet in Los Angeles County each year from 200 to 2009 are as follows:

- 2.3 single-engine turboprop
- 0.6 multi-engine turboprop
- 1.4 multi-engine piston
- 1.2 gliders
- 0.5 balloons and other aircraft

Given the small number of aircraft involved, the number of each type of aircraft added to the fleet in each year varied widely (in an extreme case, six of the 14 multi-engine piston aircraft added to the fleet from 2000 to 2009 were manufactured in 2007). Therefore as a baseline case it seems reasonable to assume that future additions of each of these aircraft types in a given year in each county will correspond to the average rate over the period 2000 to 2009 for that county.

The resulting assumptions for annual additions to the based aircraft fleet in each county are shown in Table 6-2.

Table 6-2. Assumed Annual Additions to the Based Aircraft Fleet by County

Aircraft Type	Imperial County	Los Angeles County	Orange County	Riverside County	San Bernardino County	Ventura County
Single-engine Piston	0.4	39.3	11.8	16.4	9.9	8.4
Single-engine Turboprop		2.3	0.4	0.7	0.4	0.4
	0.4	41.6	12.2	17.1	10.3	8.8
Multi-engine Piston		1.4	0.2		0.1	0.5
Multi-engine Turboprop	0.1	0.6	0.2	0.2	0.1	0.4
	0.1	2.0	0.4	0.2	0.2	0.9
Jet Aircraft		12.6	3.0	0.8	1.4	1.2
Helicopter	0.2	11.9	1.2	1.0	1.1	0.9
Glider		1.2		0.3	0.1	0.1
Balloon		0.1		1.8	0.2	
Other		0.4		0.6	0.2	
	0.7	69.8	16.8	21.8	13.5	11.9

Baseline Forecast

Using the assumptions discussed above for fleet attrition rates and addition of new aircraft to the fleet, the attrition of the current (2010) aircraft fleet was projected to 2035. To this was added the projected number of new aircraft that are assumed would be added to the fleet each year from 2011 through 2035, with appropriate adjustments for attrition between the year they are added to the fleet and 2035. This gave the based aircraft forecasts for each county presented in the following sections.

It should be noted that the Balloon/Other category are not strictly based aircraft, since they are typically not stored at airports, as noted above.

In addition to the forecast of based aircraft for each county, forecasts were prepared of active aircraft and hours flown by the active aircraft, based on national data for average utilization for aircraft of a given category and age obtained from the FAA *General Aviation and Part 135 Activity Survey* (FAA, 2011c).

One important caveat that should be noted when considering the forecast based aircraft fleet for different aircraft types is that the same attrition relationship was assumed for each aircraft type. The OCS study for the FAA from which this relationship was obtained did not develop separate relationships for different aircraft types. At the time the relationship was developed, single-engine piston aircraft accounted for the great majority of the aircraft fleet, so it would have been difficult to develop attrition relationships for different aircraft types. In addition, the factors that influence future changes in the number of new aircraft added to the fleet per year for different aircraft types are also likely to differ by aircraft type. Thus while future additions of some aircraft types may continue at the average rate observed during the period from 2000 to 2009, the rates for other aircraft types may change.

However, in the absence of any basis for projecting different attrition rates for different aircraft types, applying the same rate to each aircraft type seems reasonable. Since the assumed rates at which new aircraft are added to the fleet are based on the average observed rates over the period from 2000 to 2009, alternative scenarios could easily be defined if there was any agreed basis for doing so.

Imperial County

The forecast of based aircraft in Imperial County in 2035 is shown in Table 6-3.

Table 6-3. Baseline Forecast of Based Aircraft in 2035 – Imperial County

Aircraft Type	Current (2010) Fleet	Remaining Aircraft from Current Fleet (2035)	New Aircraft Additions to Fleet (2035)	Forecast Based Aircraft Fleet (2035)
Single-engine Piston	116	89	9	98
Single-engine Turboprop	1	1	0	1
	117	90	9	99
Multi-engine Piston	6	5	0	5
Multi-engine Turboprop	2	1	2	3
	8	6	2	8
Jet Aircraft	0	0	0	0
Helicopter	4	3	4	7
Glider	1	1	0	1
Balloon/Other				
	130	100	15	115

The total based aircraft fleet is forecast to decline by 12% from 2010 levels. The number of single-engine piston aircraft is projected to decline by 15%, with the number of single-engine turboprop and multi-engine propeller aircraft projected to remain unchanged from 2010 levels. The number of helicopters is projected to increase from 4 to 7 aircraft. The one glider in the 2010 County Assessor data is projected to remain in the based aircraft fleet with no additions. There were no jet aircraft in the 2010 Count Assessor data, so the forecast approach did not generate any additions of jet aircraft to the 2035 based aircraft fleet.

The associated forecast of active aircraft in Imperial County in 2035 and the hours flown by those aircraft is shown in Table 6-4. By 2035 only 44% of the based aircraft fleet is projected to be actively flown and these aircraft are projected to be flown for a total of about 4,900 hours per year. The relatively low percentage of active aircraft is a consequence of increase in the average age of the aircraft fleet as new aircraft additions have not kept up with attrition. The low number of flight hours by the active aircraft fleet is partly a result of the average age of the fleet and partly due to the low proportion of higher-end aircraft in the fleet, in particular the absence of jet aircraft, which are flown significantly more hours per year than single-engine piston aircraft.

Table 6-4. Baseline Forecast of Based Aircraft Activity in 2035 – Imperial County

Aircraft Type	Forecast Based Aircraft Fleet (2035)	Forecast Active Aircraft (2035)	Percent of Aircraft Fleet Active (2035)	Forecast Hours Flown (2035)
Single-engine Piston	98	43	43.5%	2,368
Single-engine Turboprop	1	0	0.0%	72
	99	43	43.1%	2,439
Multi-engine Piston	5	0	0.0%	42
Multi-engine Turboprop	3	3	88.5%	701
	8	3	37.4%	743
Jet Aircraft	0	0		
Helicopter	7	5	76.4%	1,719
Glider	1	0	0.0%	6
Balloon/Other				
	115	51	44.4%	4,907

Los Angeles County

The forecast of based aircraft in Los Angeles County in 2035 is shown in Table 6-5. The total based aircraft fleet is forecast to increase by 10% from 2010 levels, due principally to the additions of higher-end aircraft to the fleet between 2010 and 2035. The number of single-engine turboprop aircraft is projected to increase by 56%, with the number of helicopters increasing by 61%, and the number of jet aircraft increasing by 36%. The number of single-engine piston aircraft is projected to increase by just 4%, with the number of multi-engine turboprop aircraft projected to decline by 5% and the number of multi-engine piston aircraft projected to decline by 14%. The number of gliders is projected to increase by 11%, with the number of balloons and other aircraft types projected to increase by 17%.

The associated forecast of active aircraft in Los Angeles County in 2035 and the hours flown by those aircraft are shown in Table 6-6. By 2035 61% of the based aircraft fleet is projected to be actively flown and these aircraft will be flown for a total of about 394,000 hours per year. Jet aircraft and helicopters are projected to account for the majority of the hours flown, 28% and 27% respectively. However, single-engine propeller aircraft are projected to account for 39% of the hours flown, the majority of which (34% of the total hours flown) is accounted for by single-engine piston aircraft.

Table 6-5. Baseline Forecast of Based Aircraft in 2035 – Los Angeles County

Aircraft Type	Current (2010) Fleet	Remaining Aircraft from Current Fleet (2035)	New Aircraft Additions to Fleet (2035)	Forecast Based Aircraft Fleet (2035)
Single-engine Piston	3,011	2,265	854	3,119
Single-engine Turboprop	59	42	50	92
	3,070	2,307	904	3,211
Multi-engine Piston	362	280	30	310
Multi-engine Turboprop	67	50	13	63
	429	330	43	373
Jet Aircraft	418	296	274	570
Helicopter	284	198	259	457
Glider	70	52	26	78
Balloon/Other	25	18	11	29
	4,296	3,200	1,517	4,717

Table 6-6. Baseline Forecast of Based Aircraft Activity in 2035 – Los Angeles County

Aircraft Type	Forecast Based Aircraft Fleet (2035)	Forecast Active Aircraft (2035)	Percent of Aircraft Fleet Active (2035)	Forecast Hours Flown (2035)
Single-engine Piston	3,119	1,814	58.1%	134,687
Single-engine Turboprop	92	76	82.9%	19,791
	3,211	1,890	58.8%	154,477
Multi-engine Piston	310	117	37.7%	11,980
Multi-engine Turboprop	63	39	61.5%	8,153
	373	156	41.8%	20,134
Jet Aircraft	570	432	75.8%	111,823
Helicopter	457	340	74.4%	106,159
Glider	78	35	45.1%	1,153
Balloon/Other	29	14	49.4%	476
	4,717	2,867	60.8%	394,223

Orange County

The forecast of based aircraft in Orange County in 2035 is shown in Table 6-7.

Table 6-7. Baseline Forecast of Based Aircraft in 2035 – Orange County

Aircraft Type	Current (2010) Fleet	Remaining Aircraft from Current Fleet (2035)	New Aircraft Additions to Fleet (2035)	Forecast Based Aircraft Fleet (2035)
Single-engine Piston	655	488	256	744
Single-engine Turboprop	16	11	9	20
	671	499	265	764
Multi-engine Piston	67	52	4	56
Multi-engine Turboprop	43	32	4	36
	110	84	8	92
Jet Aircraft	64	44	65	109
Helicopter	35	24	26	50
Glider	8	6	0	6
Balloon/Other				
	888	657	364	1,021

The total based aircraft fleet is forecast to increase by 15% from 2010 levels, due principally to the additions of higher-end aircraft to the fleet between 2010 and 2035. The number of jet aircraft is projected to increase by 70%, while the number of helicopters is projected to increase by 44%. The number of single-engine piston aircraft is projected to increase by 14%, with a small increase in the number of single-engine turboprop aircraft from 16 to 20 aircraft. The number of multi-engine piston and turboprop aircraft is projected to decline by 17% and 16% respectively. The number of gliders is projected to decrease slightly due to attrition from the fleet, with no additions of new aircraft. There were no balloons or other aircraft types in the 2010 County Assessor data, and no additions of these aircraft types have been projected.

The associated forecast of active aircraft in Orange County in 2035 and the hours flown by those aircraft are shown in Table 6-8. By 2035 65% of the based aircraft fleet is projected to be actively flown and these aircraft will be flown for a total of about 83,400 hours per year. Jet aircraft and helicopters combined are projected to account for slightly less flight activity than single-engine piston aircraft, which are projected to account for 45% of the hours flown. Jet aircraft and helicopters are projected to account for 30% and 14% of the total hours flown respectively.

Table 6-8. Baseline Forecast of Based Aircraft Activity in 2035 – Orange County

Aircraft Type	Forecast Based Aircraft Fleet (2035)	Forecast Active Aircraft (2035)	Percent of Aircraft Fleet Active (2035)	Forecast Hours Flown (2035)
Single-engine Piston	744	471	63.3%	37,140
Single-engine Turboprop	20	16	78.8%	3,884
	764	487	63.7%	41,024
Multi-engine Piston	56	21	37.6%	1,966
Multi-engine Turboprop	36	21	57.9%	4,274
	92	42	45.6%	6,240
Jet Aircraft	109	93	85.5%	24,788
Helicopter	50	37	74.3%	11,269
Glider	6	2	34.5%	67
Balloon/Other				
	1,021	661	64.7%	83,389

Riverside County

The forecast of based aircraft in Riverside County in 2035 is shown in Table 6-9. The total based aircraft fleet is forecast to increase by 6% from 2010 levels, due principally to the additions of jet aircraft and helicopters to the fleet between 2010 and 2035, the numbers of which are projected to increase by 33% and 25% respectively.. The number of single-engine piston aircraft is projected to increase by 5%, with a small increase in the number of single-engine turboprop aircraft from 13 to 24 aircraft. The numbers of multi-engine piston and turboprop aircraft are projected to decline by 21% and 6% respectively. The number of gliders is projected to decrease by about 6 aircraft, while the number of balloons and other aircraft types is projected to increase by 75%.

The associated forecast of active aircraft in Riverside County in 2035 and the hours flown by those aircraft are shown in Table 6-10. By 2035 54% of the based aircraft fleet is projected to be actively flown and these aircraft will be flown for a total of about 81,500 hours per year.

Single-engine piston aircraft are projected to account for 65% of the hours flown, with helicopters and jet aircraft accounting for 12% and 8% of the total hours flown respectively and single-engine turboprop aircraft accounting for 7% of the hours flown.

Table 6-9. Baseline Forecast of Based Aircraft in 2035 – Riverside County

Aircraft Type	Current (2010) Fleet	Remaining Aircraft from Current Fleet (2035)	New Aircraft Additions to Fleet (2035)	Forecast Based Aircraft Fleet (2035)
Single-engine Piston	1,226	926	356	1,282
Single-engine Turboprop	13	9	15	24
	1,239	935	371	1,306
Multi-engine Piston	140	111	0	111
Multi-engine Turboprop	22	17	4	21
	162	127	4	131
Jet Aircraft	29	21	17	38
Helicopter	42	31	22	53
Glider	50	37	7	44
Balloon/Other	48	32	52	84
	1,570	1,184	473	1,657

Table 6-10. Baseline Forecast of Based Aircraft Activity in 2035 – Riverside County

Aircraft Type	Forecast Based Aircraft Fleet (2035)	Forecast Active Aircraft (2035)	Percent of Aircraft Fleet Active (2035)	Forecast Hours Flown (2035)
Single-engine Piston	1,282	712	55.5%	53,272
Single-engine Turboprop	24	21	88.8%	5,714
	1,306	733	56.1%	58,986
Multi-engine Piston	111	25	22.8%	1,493
Multi-engine Turboprop	21	11	54.1%	2,358
	131	36	27.8%	3,851
Jet Aircraft	38	26	68.0%	6,861
Helicopter	53	32	61.0%	9,612
Glider	44	16	37.1%	544
Balloon/Other	84	49	58.9%	1,629
	1,657	894	53.9%	81,484

San Bernardino County

The forecast of based aircraft in San Bernardino County in 2035 is shown in Table 6-11.

Table 6-11. Baseline Forecast of Based Aircraft in 2035 – San Bernardino County

Aircraft Type	Current (2010) Fleet	Remaining Aircraft from Current Fleet (2035)	New Aircraft Additions to Fleet (2035)	Forecast Based Aircraft Fleet (2035)
Single-engine Piston	1,202	934	215	1,149
Single-engine Turboprop	10	7	9	16
	1,212	941	224	1,165
Multi-engine Piston	76	63	2	65
Multi-engine Turboprop	14	11	2	13
	90	74	4	78
Jet Aircraft	58	45	30	75
Helicopter	40	31	24	55
Glider	36	27	2	29
Balloon/Other	12	8	8	16
	1,448	1,127	292	1,419

The total based aircraft fleet is forecast to decline by 2% from 2010 levels, due to a 4% decline in single-engine piston aircraft, which accounted for 83% of the total aircraft fleet in 2010, despite an increase in the jet aircraft and helicopter fleets between 2010 and 2035, the numbers of which are projected to increase by 30% and 38% respectively.. The number of single-engine turboprop aircraft is projected to increase slightly from 10 to 16 aircraft, while the numbers of multi-engine piston and turboprop aircraft are projected to decline by 11 and one aircraft respectively. The number of gliders is projected to decrease by about 7 aircraft, while the number of balloons and other aircraft types is projected to increase by about 4 aircraft.

The associated forecast of active aircraft in San Bernardino County in 2035 and the hours flown by those aircraft are shown in Table 6-12. By 2035 only 48% of the based aircraft fleet is projected to be actively flown and these aircraft will be flown for a total of about 66,500 hours per year. Single-engine piston aircraft are projected to account for 57% of the hours flown, with jet aircraft and helicopters accounting for 18% and 15% of the total hours flown respectively and single-engine turboprop aircraft accounting for 5% of the hours flown.

Table 6-12. Baseline Forecast of Based Aircraft Activity in 2035 – San Bernardino County

Aircraft Type	Forecast Based Aircraft Fleet (2035)	Forecast Active Aircraft (2035)	Percent of Aircraft Fleet Active (2035)	Forecast Hours Flown (2035)
Single-engine Piston	1,149	554	48.3%	37,817
Single-engine Turboprop	16	13	80.5%	3,403
	1,165	567	48.7%	41,220
Multi-engine Piston	65	13	20.6%	1,123
Multi-engine Turboprop	13	6	42.8%	1,185
	78	19	24.4%	2,308
Jet Aircraft	75	47	62.5%	12,277
Helicopter	55	32	58.4%	10,045
Glider	29	10	33.6%	324
Balloon/Other	16	9	55.3%	298
	1,419	684	48.2%	66,472

Ventura County

The forecast of based aircraft in Ventura County in 2035 is shown in Table 6-13.

Table 6-13. Baseline Forecast of Based Aircraft in 2035 – Ventura County

Aircraft Type	Current (2010) Fleet	Remaining Aircraft from Current Fleet (2035)	New Aircraft Additions to Fleet (2035)	Forecast Based Aircraft Fleet (2035)
Single-engine Piston	827	625	183	808
Single-engine Turboprop	17	12	9	21
	844	638	192	830
Multi-engine Piston	80	62	11	73
Multi-engine Turboprop	15	11	9	20
	95	73	20	93
Jet Aircraft	23	16	26	42
Helicopter	37	27	20	47
Glider	8	6	2	8
Balloon/Other	6	4	0	4
	1,013	763	260	1,023

The total based aircraft fleet is forecast to increase by 1% from 2010 levels, due primarily to increasing numbers of jet aircraft and helicopters, which are projected to increase by 81% and 27% respectively and largely offset a projected decline in the number of single-engine piston aircraft of 2%. The number of single-engine turboprop aircraft is projected to increase slightly from 17 to 21 aircraft, with the number of multi-engine turboprop aircraft projected to increase from 15 to 20 aircraft. These increases almost exactly offset a projected decline in the number of multi-engine piston aircraft from 80 to 73 aircraft. The number of gliders is projected to remain constant, while the number of balloons and other aircraft types is projected to decline slightly from 6 to 4 aircraft.

The associated forecast of active aircraft in Ventura County in 2035 and the hours flown by those aircraft are shown in Table 6-14. By 2035 55% of the based aircraft fleet is projected to be actively flown and these aircraft will be flown for a total of about 60,300 hours per year. Single-engine piston aircraft are projected to account for 51% of the hours flown, with jet aircraft and helicopters accounting for 16% and 14% of the total hours flown respectively. Single-engine and multi-engine turboprop aircraft and multi-engine piston aircraft each account for a similar proportion of the hours flown, about 6% of the total hours flown.

Table 6-14. Baseline Forecast of Based Aircraft Activity in 2035 – Ventura County

Aircraft Type	Forecast Based Aircraft Fleet (2035)	Forecast Active Aircraft (2035)	Percent of Aircraft Fleet Active (2035)	Forecast Hours Flown (2035)
Single-engine Piston	808	431	53.4%	30,926
Single-engine Turboprop	21	16	75.0%	3,906
	830	447	53.9%	34,832
Multi-engine Piston	73	31	41.9%	3,589
Multi-engine Turboprop	20	15	78.0%	3,446
	93	46	49.5%	7,034
Jet Aircraft	42	36	85.5%	9,604
Helicopter	47	29	62.1%	8,658
Glider	8	3	40.8%	104
Balloon/Other	4	2	36.8%	53
	1,023	563	55.0%	60,286

Regional Total

The forecast regional total of based aircraft in 2035 is shown in Table 6-15.

Table 6-15. Baseline Forecast of Based Aircraft in 2035 – Southern California

Aircraft Type	Current (2010) Fleet	Remaining Aircraft from Current Fleet (2035)	New Aircraft Additions to Fleet (2035)	Forecast Based Aircraft Fleet (2035)
Single-engine Piston	7,037	5,328	1,873	7,201
Single-engine Turboprop	116	82	92	174
	7,153	5,410	1,965	7,375
Multi-engine Piston	731	572	47	619
Multi-engine Turboprop	163	123	34	157
	894	694	81	775
Jet Aircraft	592	422	412	834
Helicopter	442	313	355	668
Glider	173	129	37	166
Balloon/Other	91	63	71	134
	9,345	7,031	2,921	9,952

The total based aircraft fleet in the region is forecast to increase by about 7% from 2010 levels, due primarily to increasing numbers of jet aircraft and helicopters, which are projected to increase by 41% and 51% respectively. The size of the based single-engine piston aircraft fleet is projected to increase slightly by about 2%, as new additions to the fleet offset attrition, while the number of single-engine turboprop aircraft is projected to increase by 50%. However, the number of multi-engine piston aircraft is projected to decline by 15%, with the number of multi-engine turboprop aircraft declining by 4%. The number of gliders is projected to decline slightly by about 7 aircraft, while the number of balloons and other aircraft types is projected to increase by 86%.

The associated regional forecast of active aircraft in 2035 and the hours flown by those aircraft are shown in Table 6-16. By 2035 58% of the based aircraft fleet is projected to be actively flown and these aircraft will be flown for a total of about 691,000 hours per year. Single-engine piston aircraft are projected to account for 43% of the hours flown, with jet aircraft and helicopters accounting for 24% and 21% of the total hours flown respectively. Single-engine turboprop aircraft are projected to account for about 5% of the total hours flown, while multi-engine turboprop aircraft and multi-engine piston aircraft each account for a similar proportion of the hours flown, about 3% of the total hours flown.

Table 6-16. Baseline Forecast of Based Aircraft Activity in 2035 – Southern California

Aircraft Type	Forecast Based Aircraft Fleet (2035)	Forecast Active Aircraft (2035)	Percent of Aircraft Fleet Active (2035)	Forecast Hours Flown (2035)
Single-engine Piston	7,201	4,025	55.9%	296,209
Single-engine Turboprop	174	142	81.7%	36,770
	7,375	4,167	56.5%	332,979
Multi-engine Piston	619	207	33.5%	20,193
Multi-engine Turboprop	157	95	60.8%	20,117
	775	302	39.0%	40,310
Jet Aircraft	834	634	76.0%	165,354
Helicopter	668	476	71.2%	147,463
Glider	166	66	40.1%	2,198
Balloon/Other	134	74	55.7%	2,456
	9,952	5,720	57.5%	690,761

The Baseline forecast of the total hours flown in 2035 by the based aircraft fleet is broadly consistent with the Baseline forecast of annual hours flown by active pilots in Southern California presented in Chapter 5 and shown in Table 5-2, which gave a regional total of about 961,000 hours per year. While this is some 39% higher than the forecast of aircraft hours flown, many commercial flight operations require two pilots and of course dual instructional flying involves two pilots (the student and the instructor). In these cases both pilots will count the flight time. The higher number of pilot flight hours implies that about 39% of the flights involve two pilots, which does not appear an unreasonable amount given the proportion of total pilot flight hours accounted for by student pilots and the proportion of the higher-end aircraft flight hours flown by jet aircraft, which typically require two pilots..

7. Summary and Conclusions

This report has presented a review of recent trends in the size and composition of the pilot community in Southern California, as well as changes in the size and composition of the based aircraft fleet and aircraft operations at airports in the region, together with alternative forecasts of how these measures of general aviation activity may evolve in the future. The size of the active pilot community has been slowly declining over the past ten years, and if current trends continue it appears that the number of new student pilots who progress to higher levels of pilot certificate and continue as active pilots will not be sufficient to offset the natural attrition of the existing active pilot community, which is largely comprised of older pilots. At the same time, the size of the based aircraft fleet at airports in the region, which has been fairly stable for most of the past decade, has recently also started to show signs of declining. However, the apparent stability in the size of the aircraft fleet for most of the decade concealed a pattern of changes in the composition of the fleet, in which the number of jet aircraft and helicopters has been increasing, while the number of single-engine propeller aircraft, which comprise the majority of the based aircraft fleet, has been steadily declining. In recent years the number of multi-engine propeller aircraft, which had grown somewhat during the first part of the past decade has also begun to decrease.

While the total size of the based aircraft fleet has been fairly stable until the past few years, the number of total aircraft operations across all airports in the Southern California region has been declining steadily throughout the past decade. This decline has been greatest for air taxi and itinerant general aviation operations, but has also occurred for general aviation local operations and even air carrier operations. The fact that the decline in general aviation aircraft operations has been greater than that for the number of active pilots in the region or for the number of based aircraft suggests that not only is the number of active pilots declining, but that those pilot are flying less and the average utilization of the based aircraft fleet is also declining. Since the composition of the based aircraft fleet has also been changing, with the number of jet aircraft and helicopters, which are generally used more intensively than single-engine propeller aircraft, increasing and the number of single-engine propeller aircraft declining more slowly that general aviation aircraft operations, this suggests that the average utilization of single-engine propeller aircraft has been declining quite steeply.

These findings are broadly consistent with the results of recent FAA surveys of general aviation aircraft owners that have collected data on aircraft utilization. These data show quite clearly that average aircraft utilization declines with the age of the aircraft, both in terms of the percent of the registered aircraft fleet that is actively flown and the average number of hours flown per year by active aircraft. Furthermore there is some evidence from the survey data that in addition to the decline in average utilization as the average age of the aircraft fleet is increasing, the average utilization of aircraft of a given age is also declining.

In contrast to the recent decline in the size of the pilot community and general aviation aircraft operations in the Southern California region, the most recent FAA forecast for general aviation activity at the airports in the region projects that this decline in GA activity will reverse in 2012 and be followed by a steady growth to 2030, increasing the number of GA itinerant operations by 16 percent above 2010 levels and the number of GA local operations by 10 percent above 2010 levels. The FAA forecast also projects that based aircraft in the region will increase by 21 percent from 2010 to 2030. Surprisingly, the forecast projects that the number of single-engine and multi-engine propeller aircraft based in the region will increase more rapidly than the number of jet aircraft and helicopters, whereas the trend over the past decade has been quite the reverse, with the numbers of jet aircraft and helicopters increasing, while the numbers of propeller aircraft have declined.

This fairly rosy view of the future of general aviation activity in the Southern California region is not supported by recent studies of the demographics of the pilot community, or the pilot cohort analysis undertaken as part of the current study. Of course, the future is inherently unknown, and there may well be factors that cause the recent trends in new student pilot starts to reverse and the size of the pilot community to begin to grow again, and with it the number of aircraft operations and new aircraft purchases. However, against this has to be set possible future trends in such factors as the cost of flying and the potential demand for airline and commercial pilots, which is likely to influence the number of people who decide to take up flying as a career.

In order to provide a counterpoint to the FAA forecast of future GA activity in Southern California, this study has prepared a set of alternative forecasts based on the application of the forecast approach described in this report, using a range of assumptions addressing such factors as the number of new pilot starts, the rate at which pilots transition to higher levels of pilot certificates, the average number of flight hours per year by pilots with different levels of pilot certificate in different age ranges, the number of new aircraft purchases and the average attrition rates of the current general aviation aircraft fleet.

Forecast Results

The application of the pilot cohort analysis described in Chapter 4 to the Baseline Forecast assumptions regarding future trends in new pilot starts and rates of pilot attrition and transition to higher levels of certificate gave the results shown in Figure 7-1 for pilots resident in each of the six counties within the Southern California region.

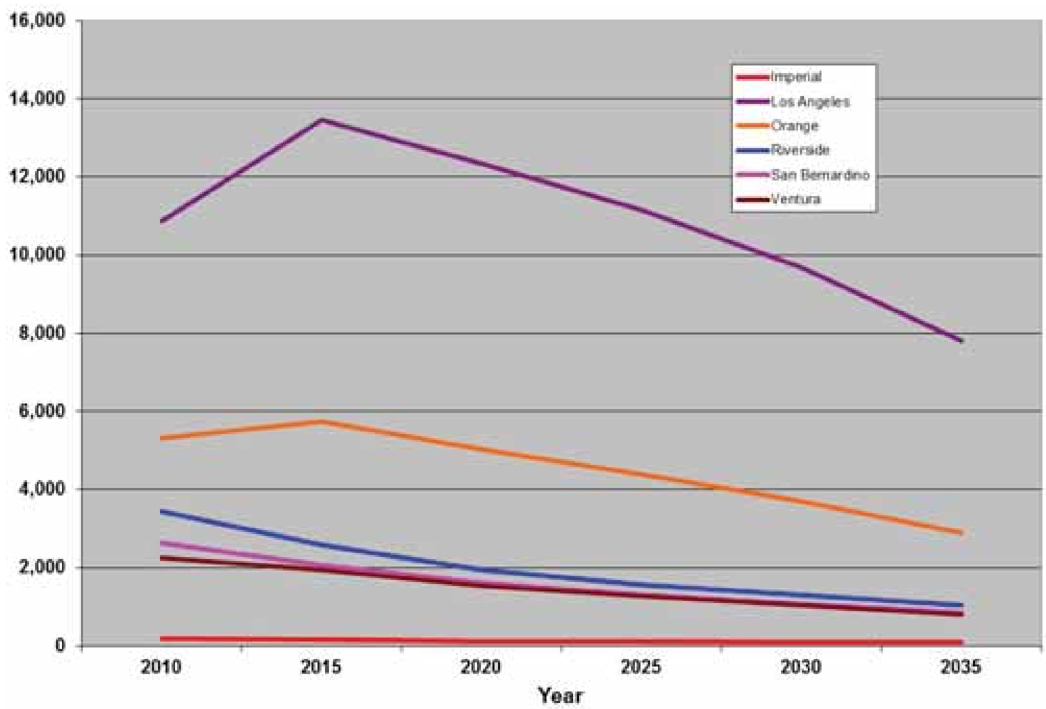


Figure 7-1. Baseline Forecast of Active Pilots

The increase in projected active pilots in Los Angeles and Orange Counties from 2010 to 2015 results from a transition from the FAA data for active pilots in 2010 to a forecast of active pilots in 2015 based on the trend in the relationship between new pilot starts and socioeconomic factors over the period from 2000 to 2010. The number of active student pilots in 2010 in both counties appeared to be depressed below the long-term trend by the current economic conditions, which it was assumed would have improved by 2015. However, beyond 2015, the assumed growth in population and the economy were not enough to offset the declining trend in the historical relationship between new pilot starts and socioeconomic factors. With an insufficient number of new student pilots taking up flying to replace the attrition of older pilots as they age, the size of the total pilot community is projected to steadily decline in the future. This effect is apparent in all six counties, as shown in Figure 7-1.

A more detailed perspective on the changes in the pilot community is provided by Figure 7-2, which shows the forecast trend in the number of pilots holding different levels of pilot certificate for the Baseline Forecast scenario. The increase in student pilots from 2010 to 2015 leads to an initial increase in private pilots and even a slight increase in commercial pilots as some of those student pilots transition to higher levels of pilot certificate. However, although the number of active student pilots each year remains above 4,000 until almost 2025, this is not sufficient to prevent the number of pilots holding other categories of pilot certificate from declining steadily.

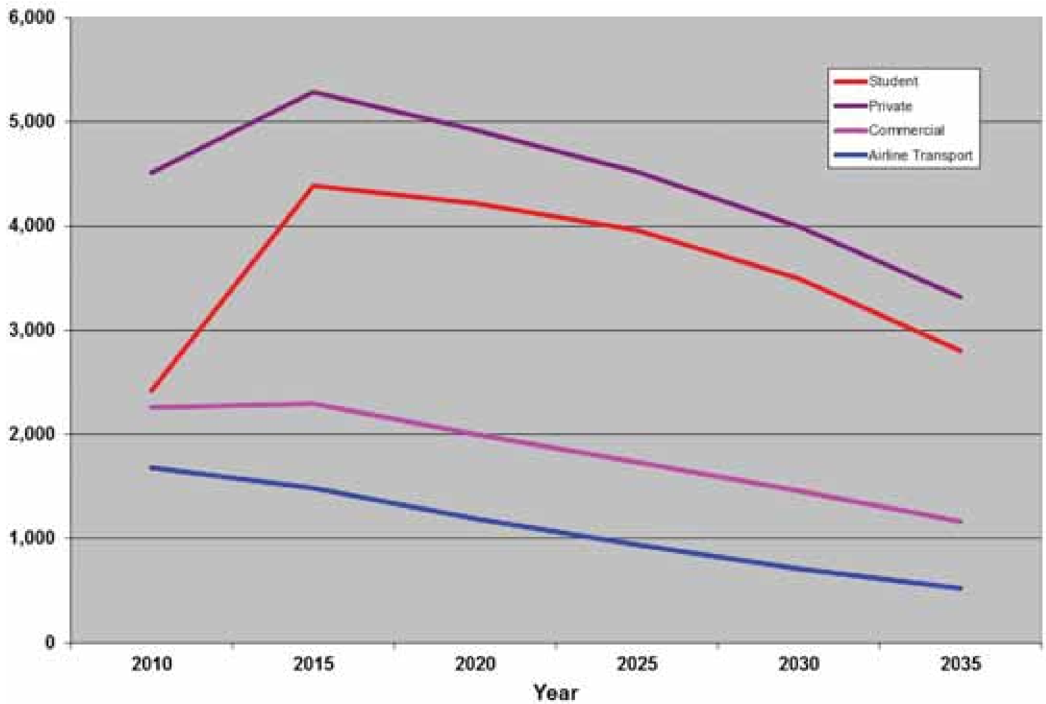


Figure 7-2. Baseline Forecast of Active Pilots – Los Angeles County

In order to explore the potential effect of factors that might cause a change in the historical declining trend in the number of new pilot starts, two additional forecast scenarios were defined. The Reduced Decline Forecast scenario assumed that the declining relationship between the number of new student pilot starts and the underlying socioeconomic factors observed over the past ten years reduces to half the historical rate of decline from 2015 to 2025 then remains constant thereafter. This results in a higher number of new student pilots each year that in turn reduces the rate of decline of the number of pilots holding higher categories of pilot certificate. A more aggressive Arrested Decline Forecast scenario assumes that the decline in the relationship between the number of new student pilot starts and the underlying socioeconomic factors ceases after 2010 and the relationship remains constant thereafter. It is unclear what policies or actions could cause this to occur, but the purpose of the scenario is to provide a more optimistic forecast scenario that might correspond more closely to the expectations of the FAA regarding future growth of the general aviation sector.

The projected number of active pilots in Southern California under each of the three forecast scenarios is shown in Figure 7-3. The Reduced Decline scenario results in the historical decline in the number of active pilots in the region being forecast to stabilize around 2025 with a modest growth after 2030. The Arrested Decline scenario results in a progressively increasing number of active pilots in the region forecast for the period from 2020 to 2035.

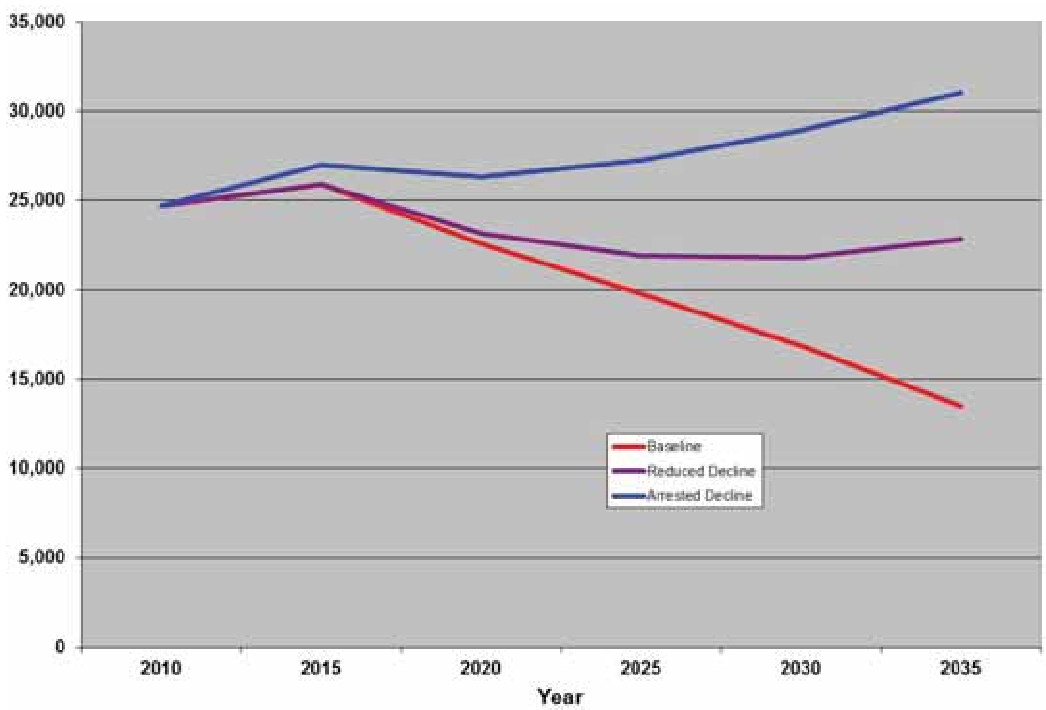


Figure 7-3. Alternative Forecasts of Active Pilots in Southern California

In addition to projecting the number of active pilots, the cohort analysis also estimates the number of annual hours flown by those pilots and the resulting change in aircraft operations in the region. The estimated number of aircraft operations for each of the three alternative forecast scenarios is shown in Figure 7-4. Not surprisingly, this broadly reflects the number of active pilots in the region, with some minor differences from the pattern shown in Figure 7-3 due to the changing composition of the pilot community and the implications for the average number of hours flown per pilot across the pilot community.

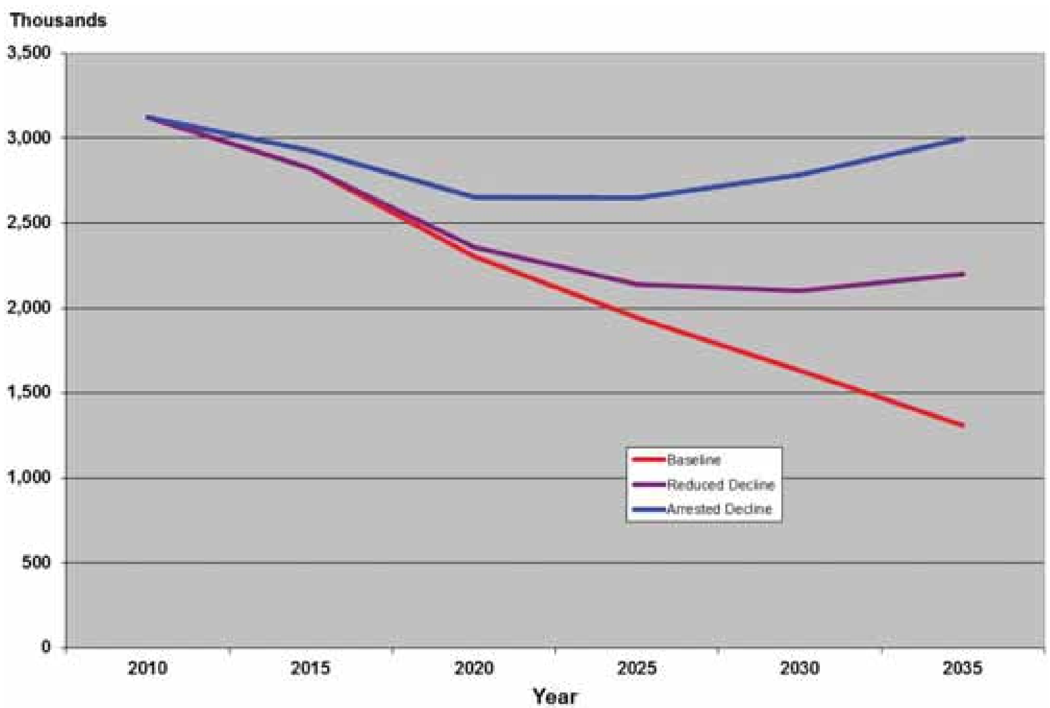


Figure 7-4. Alternative Forecasts of Aircraft Operations in Southern California

Under the Arrested Decline Forecast scenario aircraft operations decline from 2010 to 2020, remain relatively constant until 2025, then grow to a level just below the level in 2020. The other two scenarios project a significant decline in the number of aircraft operations in the region from 2010 to 2035, particularly in the Baseline Forecast, with the Reduced Decline Forecast showing the decline in the number of aircraft operations ending by 2030 with a modest growth in operations from 2030 to 2035.

Forecast of Based Aircraft

In addition to the forecast of active pilots and pilot flight activity developed using the pilot cohort analysis, a separate forecast of based aircraft in the region was prepared by applying an aircraft attrition model to the existing aircraft fleet and making assumptions about the number of new aircraft added to the fleet each year in the future. For the based aircraft forecast described in this report, termed the Baseline Forecast since the underlying assumptions reflect those adopted in the Baseline Forecast of active pilots and pilot activity, the average rate at which new aircraft have been added to the aircraft fleet over the past ten years was assumed to continue in the future. The attrition rates at which existing aircraft leave the fleet in any year were based on an the findings of an aircraft fleet attrition study prepared for the FAA in the mid 1970s, supplemented with an analysis of recent data from a survey of aircraft owners performed every year by the FAA.

This analysis suggested that the region's based aircraft fleet might grow by about 7% between 2010 and 2035, as newer aircraft are added to the fleet somewhat faster than older aircraft are retired. While the number of single-engine piston aircraft is projected to grow by about 2%, the numbers of jet aircraft and helicopters are projected to grow by 41% and 51% respectively. However, while the number of based aircraft may increase over time, assuming that the recent rate at which new aircraft have been added to the fleet continues unabated until 2035, the number of active aircraft will tend to drop as much of the current fleet grows progressively older. By 2035 the forecast suggests that only about 58% of the based aircraft fleet will still be actively flown.

The based aircraft forecast also used data on the average utilization of the current aircraft fleet given by FAA surveys of general aviation aircraft owners to make estimates of the number of hours flown per year in 2035 by the based aircraft fleet. These projections are broadly consistent with the estimates of annual flight hours by the region's pilot community, after making an allowance for the proportion of flight activity that is performed with two pilots on board.

Implications of the Forecast Results

Two of the three alternative forecasts for active pilots and pilot flight activity imply a significant reduction in general aviation activity in the region by 2035, while the third scenario is based on a premise that there is no obvious way to implement. Any such reduction in general aviation activity is likely to have significant consequences for the region's general aviation airports that derive the majority of their operating revenue from activity-related fees. The combination of declining flight activity and a slowing growing based aircraft fleet will result in a significant reduction in average aircraft utilization, particularly for single-engine piston aircraft.

As average aircraft utilization reduces, some aircraft owners may decide that it is simply too expensive to maintain their aircraft in an airworthy conditions if it is not being flown much, or at all. However, whether they are able to sell their aircraft on the used aircraft market will depend on the overall demand for used aircraft nationally and abroad. Since the decline in the number of active pilots and associated general aviation activity is a national phenomenon, other regions are likely to also experience a growing pool of underutilized aircraft, reducing the opportunities to sell aircraft that are no longer needed by their current owners. In any case, from the perspective of the size of the regional based aircraft fleet it does not really matter whether an unused aircraft is scrapped or sold and exported outside the region. In either case it disappears from the fleet.

The other important implication for regional airport system planning is the increasing role in regional general aviation activity of higher-end aircraft, particularly jet aircraft and helicopters. These aircraft tend to be based at a limited number of airports in the region and consume much larger quantities of fuel than single-engine piston aircraft, both because they burn more fuel per flight hour and tend to fly more hours per year. Therefore those airports where these aircraft are based are likely to be in fairly good shape financially, and may even find that demand for aircraft storage facilities exceeds the available resources. However, those airports that predominantly serve smaller general aviation aircraft and support flight training activity may find that they become the home to an increasing pool of inactive aircraft and experience a steady decline in airport revenues that derive from flight activity.

Sources of Uncertainty in the Forecasts

As with any forecast, there are many aspects that can influence future levels of general aviation activity and the likely size of the based aircraft fleet that are cannot be known with any certainty or may change in unexpected ways due to unforeseen occurrences or factors. One example of such factors is the future availability of leaded aviation gasoline (avgas). At present the majority of general aviation aircraft engines use leaded avgas. However, there are growing concerns about the air quality impacts of continued use of leaded fuel for aircraft and the U.S.

Environmental Protection Agency has begun moves to prohibit the use of this fuel in the future. In response the FAA has convened a national working group to examine options to replace leaded avgas. If any replacement fuel requires relatively expensive modifications to aircraft engines or costs more per gallon, this may cause a large number of owners of older aircraft to decide that these aircraft are not worth modifying or continuing to operate, with implications for the aircraft fleet attrition rates.

In the other direction, a growing demand for airline pilots as many current airline pilots approach retirement could stimulate a renewed interest in careers as a professional pilot, leading to a surge in new student pilots taking up flying. Continued growth in business aviation could exacerbate the demand for commercial pilots as many of the current commercial pilots also approach retirement or are unable to maintain their medical certificate as they grow older.

Beyond these larger trends that may affect the underlying dynamics of the industry, there are other sources of uncertainty that arise from limitations of current data sources and a lack of recent studies that have examined underlying issues in any detail. A good example of this is that fact that most recent formal study of aircraft attrition rates was performed in the mid-1970s when the general aviation sector was very different. There have been no studies that have looked at how aircraft attrition rates vary across different categories of aircraft, such as between single-engine piston aircraft, jet aircraft, and helicopters. Similar, data on the average number of hours flown per year by pilots of difference ages and holding different types of pilot certificate, or even the type of flying that they do, is extremely limited. For example, while the FAA provides detailed data on the certificates held by individual pilots on its website, the data contain no information on the number of hours those pilots fly or the type of flying that they do. While the FAA knows the age of every pilot, for privacy reasons this information is not made public.

It is thus unclear how many pilots holding a commercial pilot or airline transport pilot certificate are in fact working as a profession pilot or flight instructor, or obtained the certificate with an intention of working as a professional pilot but are not currently doing so. Similarly it is not clear how many individuals holding a student pilot certificate are actively progressing to obtaining a private pilot certificate and how many have long since given up learning to fly or are keeping the medical certificate valid in the hope of one day resuming their flight training but are not currently actively doing so.

Next Steps

The regional general aviation demand forecasts presented in this report complete the first phase of a two-phase study for the Southern California Association of Governments. The second phase, not currently funded, will develop a based airport choice model that can be used to examine how the forecast regional demand is likely to be distributed among the airports in each county and how this allocation of general aviation activity may be influenced by actions that SCAG or others could take.

As part of this modeling work, the second phase of the study could revisit some of the issues identified in the analysis performed to date and refine the assumptions used in the pilot cohort analysis and the based aircraft forecast. These issues could include a more detailed study of general aviation aircraft attrition rates using the data from the FAA general aviation aircraft activity surveys and further analysis of pilot attrition rates and transition to higher levels of pilot certificate.

A large amount of data has been assembled in the course of the current phase of the study and a number of extremely complex spreadsheet models have been developed to implement the pilot cohort analysis and the based aircraft forecast model. It would be highly desirable for SCAG to devote some resources to organizing and documenting these data and models so that they can be easily updated and reused in the future without having to invest a large amount of money and time reinventing this particular wheel.

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Appendix A

AIRCRAFT USE CATEGORIES

The following categories of aircraft use are defined for the FAA General Aviation and Part 135 Activity Surveys (see Appendix B to the 2009 FAA *General Aviation and Part 135 Activity Survey*, "Documents Used to Conduct the 2009 General Aviation and Part 135 Activity Survey," Figure B.1: Single-Aircraft Questionnaire).

<u>General Use</u>

Personal/Recreation – Flying for personal reasons (excludes business transportation)

Business Transportation – Individual or group use for, or in the furtherance of, a business <u>*without*</u> a paid flight crew

Corporate/Executive Transportation – Individual or group business transportation <u>*with*</u> a paid flight crew (includes fractional ownership)

Instructional – Flying under the supervision of a flight instructor, including student pilot solo (excludes positioning flights, proficiency flights, training, ferrying, sales demos)

Aerial Application in Agriculture and Forestry – Crop and timber production, including fertilizer and pesticide application

Aerial Observation – Aerial mapping/photography, patrol, search and rescue, hunting, traffic advisory, ranching, surveillance, oil and mineral exploration, etc.

Other Aerial Application – Public health sprayings, cloud seeding, fire fighting, including forest fires, etc.

External Load – Operation under FAR Part 133, rotorcraft external load operations, examples include: helicopter hoist, hauling logs, etc.

Other Work Use – Construction work (excluding FAR Part 135 operation), parachuting, aerial advertising, towing gliders, etc.

Sight-seeing – Commercial sight-seeing conducted under FAR Part 91

Air Medical Services – Air ambulance services, rescue, human organ transportation, emergency medical services (excludes AMS conducted under FAR Part 135)

Other – Positioning flights, proficiency flights, training, ferrying, sales demos, etc.

FAR Part 135

Air Taxi – FAR Part 135 on-demand passenger and all cargo operations (excluding air tours, air medical services, or scheduled passenger service)

Air Tours – Commercial sight-seeing conducted under FAR Part 135

Air Medical Services – Air ambulance services, rescue, human organ transportation, emergency medical services conducted under FAR Part 135