PHOENIX SKY HARBOR
INTERNATIONAL AIRPORT

Chapter Four
NOISE ABATEMENT ALTERNATIVES

Chapter Four

NOISE ABATEMENT ALTERNATIVES

The DOT/FAA Aviation Noise Abatement Policy of 1976, the Airport Safety and Noise Abatement Act of 1979, and the Airport Noise and Capacity Act of 1990 outline the framework for a coordinated approach to noise abatement and mitigation of noise impacts. Responsibilities are shared among airport users, aircraft manufacturers, airport proprietors, federal, state, and local governments, and residents of communities near the airport.

- The federal government has the authority and responsibility to control aircraft noise at the source, implement and enforce operational flight procedures, and manage the air traffic control system in ways that minimize noise impacts on populated areas.

- Aircraft manufacturers are responsible for incorporating quiet engine technology into new aircraft designs to meet federal noise standards.

- Airport proprietors are responsible for planning and implementing airport development actions designed to reduce noise. These include noise abatement ground procedures and improvements in airport design. Proprietors may also enact restrictions on airport use that do not unjustly discriminate against any user, impede the federal interest in safety and management of the air navigation system, unreasonably interfere with interstate commerce, or otherwise conflict with federal law.

- Local governments are responsible for land use planning, zoning, and building regulations to encourage development that is compatible with present and projected airport noise levels.

- Air carriers, all-cargo carriers, and commuter operators are responsible for retirement, replacement, or retrofitting of older aircraft to meet federal noise standards. They are also responsible for operating aircraft in ways that minimize the impact of noise on people.

- General aviation operators are responsible to use proper aircraft maintenance and flying techniques to minimize noise output.

- Air travelers and shippers generally should bear the cost of noise reduction, consistent with established federal economic and environmental policy which states that the adverse environmental consequences of a service or product should be reflected in its price.

- Residents of areas surrounding airports should seek to understand the aircraft noise problem and what steps can and cannot be taken to minimize its effect on people.

- Prospective residents of areas impacted by aircraft noise should be aware of the affect of noise and make their locational decisions with that in mind.

An airport noise abatement program has three primary objectives:

1. To reduce the noise-impacted population in the study area, within practical cost and legal constraints.

2. To minimize, where practical, the exposure of the local population to very loud noise events. These loud single events can occur even outside of the DNL contours. They can annoy airport neighbors and warrant attention.

3. To ensure maximum compatibility of existing and future land uses with aircraft noise at the airport.

This chapter discusses and analyzes measures which may potentially abate noise in the Phoenix Sky Harbor International Airport area. It begins by screening the full range of potential noise abatement measures for possible use at Sky Harbor. The screening criteria include the probable noise reduction over noise-sensitive areas, the potential for compromising safety margins and the ability of the airport to perform its intended function, and the potential for implementation considering the legal, political and financial climate of the area. Measures which merit further consideration are analyzed in a following section where detailed noise analyses are presented. The last section summarizes the results of the analysis by comparing the various alternatives.

STATUS OF PREVIOUS NOISE COMPATIBILITY PROGRAM AVIATION NOISE ABATEMENT RECOMMENDATIONS

The previous Noise Compatibility Program for Phoenix Sky Harbor International Airport was completed in 1989. This study recommended eleven potential noise abatement options. These recommendations focused on methods to reduce aircraft operation impacts on the surrounding airport environs. These recommendations and their current implementation status are summarized in **Table 4A**.

As part of the analysis leading to the preparation of this chapter, the consultant held a special technical conference to brainstorm potential noise abatement measures and troubleshoot preliminary ideas identified by the Consultant. This conference was held on September 22, 1999. Those attending the conference included aviation professionals responsible for the administration, control, and operation of aircraft and facilities at the airport. They included professional pilots, representatives of airlines and flight departments of companies using the airport, air traffic controllers, representatives of national aviation organizations, and airport administrators.

In order to judge the effectiveness and appropriateness of a particular technique, it is important to consider the magnitude of the noise impacts around Phoenix Sky Harbor International Airport. Chapter Three of the Noise Exposure Maps document evaluated the impact of noise on the population around the airport. Based on the current conditions (1999), 13,023 persons are exposed to aircraft noise above 65 DNL. In the immediate future, the existing population exposed to aircraft noise above 65 DNL is expected to decrease. This is primarily due to the mandatory phase-out of Stage II turbojet aircraft in excess of 75,000 pounds after December 31, 1999. When considering the future growth of population, however, the number of people exposed to noise above 65 DNL could increase to as many as 22,128 persons by the year 2004. These increases are primarily due to the potential for residential growth around the airport, as the five-year noise contours are actually smaller than the current contours. In 2015, due to a projected increase in aircraft operations, the noise contours are slightly larger than those in 2004, however, they remain smaller than the current condition (1999) contours. Given the potential for continued future residential growth, the total potential population exposed to aircraft noise above 65 DNL could increase to 24,363 by 2015.

The FAA is most concerned with noise impacts at the 65 DNL level and higher in evaluating the acceptability of any proposed noise abatement measures. The FAA only considers the current and five-year noise contours when evaluating noise abatement recommendations.

TABLE 4A
Previous Noise Compatibility Program Aviation Noise Abatement Recommendations
Phoenix Sky Harbor International Airport

NOISE ABATEMENT ALTERNATIVE (1989)	CURRENT STATUS
NA-1: Continue the runway use program calling for the equalization of departure operations to the east and west for both the daytime and nighttime.	Runway use is determined by the direction of the wind. During periods of calm winds (less than 5 knots), the airport can operate in either direction. Aircraft operations data between November 1, 1997 and November 1, 1998: Arrivals: West: 35% (From) East: 65% Departures: West: 60% (To) East: 40%
NA-2: Request airlines adopt the use of FAA Advisory Circular (AC) 91-53 or equivalent replacement noise abatement departure procedures by jet air carrier aircraft. Request that low bypass ratio aircraft reduce power to 1.7 EPR or less during the thrust reduction mode and that high bypass ratio aircraft reduce power to normal climb thrust.	AC 91-53 was superceded in 1993 by AC 91-53A. FAA developed AC 91-53A to provide procedures for establishing noise abatement departure profiles (NADP). Two types of NADPs are described in AC 91-53A, close-in and distant. The close-in NADP provides noise reduction for noise-sensitive areas in close proximately to the airport. The distant NADP is intended to provide noise reduction over all other areas. Most air carriers, including the predominant carriers at Sky Harbor- America West and Southwest Airlines, uses one of these NADPs as part of their standard operating procedures for departures.
NA-3: Request the use of NBAA "close in" or comparable departure procedures by general aviation business jet aircraft when departing from all runways.	The Aviation Department recommends the use of NBAA procedures for business jet aircraft. However, dissemination of this information is limited.
NA-4: Implement a left turn by all jets and large propeller aircraft departing Runway 26L to a heading of 245 degrees upon crossing the middle marker for Runway 8R approaches. Maintain that heading until reaching 13 DME from the SRP VORTAC. To enhance traffic separation, assign Runway 26R/L departures based on the SID procedure selected. Assign Runway 26L to aircraft using left-turning or straight-out SIDs. Assign Runway 26R to aircraft using right-turning SIDs.	The Air Traffic Control published a SID procedure from Runway 26L requiring a turn to a 240-degree heading. The FAA does turn a majority of the departures onto the 240-degree heading; however, approximately five percent of aircraft still depart straight out. These "Straight-Out" departures are only granted when airport traffic volume is low so as not to cause traffic delays.

TABLE 4A (Continued)
Previous Noise Compatibility Program Aviation Noise Abatement Recommendations
Phoenix Sky Harbor International Airport

NOISE ABATEMENT ALTERNATIVE (1989)	CURRENT STATUS
NA-5: Implement a departure route procedure which overflies the Salt River to a position one mile west of the SRP VORTAC for use by all jets and large propeller aircraft departing Runways 8R/L (One DME departure).	This procedure is reflected in SIDs published for Sky Harbor International Airport. Since the VORTAC was moved to allow for the construction of the Price Freeway, the procedure is now called the 4 DME Departure, but the intent of the procedure remains unchanged. In 1996 the City of Phoenix installed a flight track and noise monitoring system to monitor aircraft compliance with this procedure. On June 15, 1998, the Airport implemented a formal compliance program for the 4 DME Departure procedure. The program consists of notifying carriers of their deviation from the 4 DME procedure and requesting an explanation for the deviation. During 1999, over 97 percent of turbojet aircraft departing Runways 8L/R complied with this procedure. Turboprop aircraft routinely depart using a 120-degree heading.
NA-6: Standardize initial departure and final approach routes for helicopter traffic using Sky Harbor.	There are standard departure and approach procedures for helicopters when landing on the helipad. (Refer to Exhibit 1H following page 1-24 of the Noise Exposure Maps document.)
NA-7: Continue existing run-up policy prohibiting run-ups between the hours of 2300 and 0500.	Engine run-ups are prohibited between the hours of 2300 (11 p.m.) and 0500 (5 a.m.) A hush house is being considered that would allow engine run-ups 24-hours a day, while reducing run-up noise at all times.
NA-8: Encourage airlines to utilize Stage 3 aircraft, especially for late night departures.	As of January 1, 2000, all aircraft weighing more than 75,000 pounds operating at Sky Harbor International Airport are Stage 3.
NA-9: Encourage the use of established published visual approaches during VFR conditions, traffic permitting.	There are published visual approaches for Runways 26L and 8R. The FAA utilizes these approaches whenever weather and traffic permit.
NA-10: Implement turns by all jets and large propeller aircraft departing new parallel Runway 25 to a heading of 245 degrees upon crossing the middle marker for Runway 7 approaches. If no middle marker is constructed, the turn location should be defined as 7.1 miles west of the SRP VORTAC. Maintain that heading until reaching 13 DME from the SRP VORTAC.	The FAA is currently developing procedures for Runway 7-25. (Runway 7-25 currently under construction.)
NA-11: Implement a departure route procedure which overflies the Salt River to a position one mile east of the SRP VORTAC for use by all jets and large propeller aircraft departing Runway 7.	The FAA is currently developing procedures for Runway 7-25. (Runway 7-25 currently under construction.)

POTENTIAL NOISE ABATEMENT MEASURES

A comprehensive list of potential noise abatement measures is shown in **Exhibit 4A.** F.A.R. Part 150 specifically requires most of these to be analyzed in noise compatibility studies for possible use at airports undertaking those studies. These techniques either (1) reduce the size of the noise contours or (2) they move the noise to other areas where it is less disruptive.

To reduce the size of the noise contours, the total sound energy emitted by the aircraft must be reduced. This can be done by modifying aircraft operating procedures or restricting the number or type of aircraft allowed to operate at the airport. Measures which can be used to shift the location of noise include runway use programs, special flight routes, and airport facility development. In short, potential noise abatement measures can be assigned to the following four categories:

- Runway Use and Flight Routing
- Airport Facilities
- Aircraft Operational Procedures
- Airport Regulations

RUNWAY USE AND FLIGHT ROUTING

The land use pattern around the airport provides clues to the design of arrival and departure corridors for noise abatement. By redirecting air traffic over compatible land uses, noise impacts may be significantly reduced in noncompatible areas.

Preferential Runway Use

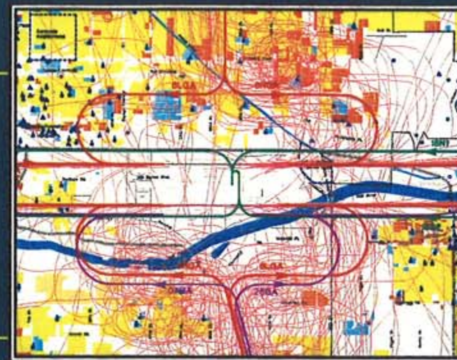
Preferential runway use programs are intended to direct as much noise as possible over the least noise-sensitive areas. They accomplish this by favoring the runway or runways which lead traffic over compatibly developed areas.

FAA Order 8400.9 describes national safety and operational criteria for establishing runway use programs. It defines two classes of programs: *formal* and *informal*. A formal program must be defined and acknowledged in a Letter of Understanding between FAA's Flight Standards Division and Air Traffic Service, the airport proprietor, and the airport users. Once established, participation by aircraft operators is mandatory. Formal programs can be extremely difficult to establish, especially at airports with many different users. An informal program is an approved runway use program which does not require the Letter of Understanding. Informal programs are typically implemented through a Tower Order and publication of the procedure in the Airport/Facility Directory. Participation in the program is voluntary.

98DSP14-4A-3/2/00

RUNWAY USE AND FLIGHT ROUTES

- Preferential Runway Use
- Rotational Runway Use
- Noise - Compatible Corridors
- Departure Turns
- Visual and Offset Instrument Approaches



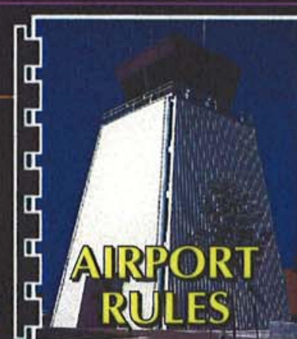
FACILITIES DEVELOPMENT

- Runway Lengthening
- New Runways
- Displaced / Relocated Thresholds
- Terminal Relocation
- Ground Activity Relocation
- Noise Barriers
- Navigational Aids

AIRCRAFT OPERATING PROCEDURES

- Reduced Thrust Takeoffs
- Thrust Cutback Departures
- Maximum Climb Departures
- Minimum Approach Altitude
- Approach Flap Adjustments
- Two-Stage Descents
- Raised Glide Slope Angle
- Limited Reverse Thrust

AIRPORT RESTRICTIONS & REGULATIONS



- Nighttime Curfews
- Aircraft Type Restrictions Based On Noise Level
- Capacity Limitations
- Noise Budget
- Variable Landing Fees Based on Noise Level or Time of Day
- Ground Activity Restrictions
- Training Activity Restrictions

PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Exhibit 4A
POSSIBLE NOISE ABATEMENT TECHNIQUES

Phoenix Sky Harbor International Airport is surrounded by extensive residential development on all sides of the airport. To the east, south, and southwest, the Salt River, interstate highways, and railroads provide narrow undeveloped corridors. All runways are generally aligned with these corridors yet certain directional operations could utilize these corridors for arrivals and departures for noise abatement to a greater extent.

Runway use is often dominated by wind direction. When the airport is in an eastern flow (landing aircraft from the west and departing to the east), Runways 8L and 7 offer the best opportunity to avoid overflights of noise-sensitive land uses west of the airport by arriving aircraft. The approach to Runway 8L is primarily dominated by industrial land uses located along a rail corridor. The approach to Runway 7 also contains a relatively large amount of industrial uses along an interstate corridor and park and open space bordering the Salt River. Although this corridor allows aircraft to fly over the least number of people than other flight routes, planned development in the airport vicinity could significantly reduce the benefits of this corridor.

Aircraft departing to the east could enhance noise abatement efforts by utilizing Runways 8L and 8R. This would allow aircraft departing straight out to follow the Salt River corridor during climb out. The use of Runway 7 for departures would cause aircraft to depart over noise-sensitive uses within the City of Tempe. Potential runway use for east flow operations is depicted on **Exhibit 4B**.

At times when the airport is operating in a western flow, a reciprocal of eastern flow operations should be considered as shown on **Exhibit 4B**. When possible, arriving aircraft should approach to Runways 26L/R, taking advantage of the Salt River corridor. Straight-in approaches to Runway 25 from the east would require aircraft to fly over the northern portion of the Arizona State University Campus and other noise-sensitive land uses within Tempe.

Departures to the west could benefit noise abatement efforts by using Runways 26R and 25 whenever possible. The departure paths from these runways are generally aligned with noise compatible corridors affiliated with the Salt River, interstate highways or railroads. Departures from 26L would overfly concentrated areas of noise-sensitive development approximately one mile west of the airport.

Conclusion: Sky Harbor is fortunate to have noise compatible corridors generally aligned with the approach and departure paths of certain runways. The airport should consider establishing an informal preferential runway use program that would maximize the use of these corridors. The use of a preferential runway use program for noise abatement deserves further consideration.

Rotational Runway Use

Rotational runway use is intended to distribute aircraft noise equally off all runway ends. At best, a rotational runway use program can only provide temporary relief for one group at the expense of another. A rotational runway use program may have merit at Sky Harbor Airport by equalizing aircraft noise exposure on noise-sensitive areas overflown from each runway direction.

A basic consideration in evaluating a runway use program is wind direction and velocity. In general, aircraft should be aligned into the wind during landing and takeoff. Depending on the length of the runway, aircraft load and power, and outside air temperature, aircraft can accept light tailwinds and crosswinds. Weather data at Phoenix indicate that while the prevailing winds are from the south and southwest, winds are light or calm a large proportion of the time. By itself, this situation would lend support to a rotational runway use program.

Phoenix currently utilizes an informal rotational runway use program that was developed as part of the airport's previous Part 150 study (See **Table 4A**). This program focuses on the equalization of approach and departure operations to the east and west during both daytime and nighttime periods. Since runway use is primarily determined by wind direction, during calm wind conditions (less than five knots) the airport can operate in either direction. Runway use data collected between November 1, 1997 and November 1, 1998 is depicted in **Table 4B.**

As shown in **Table 4B**, the airport operates most frequently (approximately 60 percent of the time) with arrivals from the east and departures to the west. This configuration favors the use of Runways 26L/R. According to FAA air traffic officials at Sky Harbor, this is the closest to an equal runway split possible given prevailing wind conditions and capacity limitations at the airport associated with the 4 DME procedure.

TABLE 4B
Runway Use by Direction
Phoenix Sky Harbor International Airport

Direction	Arrivals (From)	Departures (To)
East	65%	40%
West	35%	60%

Source: Phoenix Sky Harbor International Airport Noise and Flight Track Monitoring System (NFTMS)

Conclusion: The continuation of the airport's rotational runway use program is encouraged as a means to distribute aircraft noise impacts off all runway ends. Although weather (winds) and operational factors (4 DME procedure) may not allow for a true 50/50 directional split, this effort should be continued to prevent one area from receiving the bulk of the arrival and/or departure noise. It should be noted that the removal of the 4 DME procedure would assist in achieving an equal operational distribution, however, this

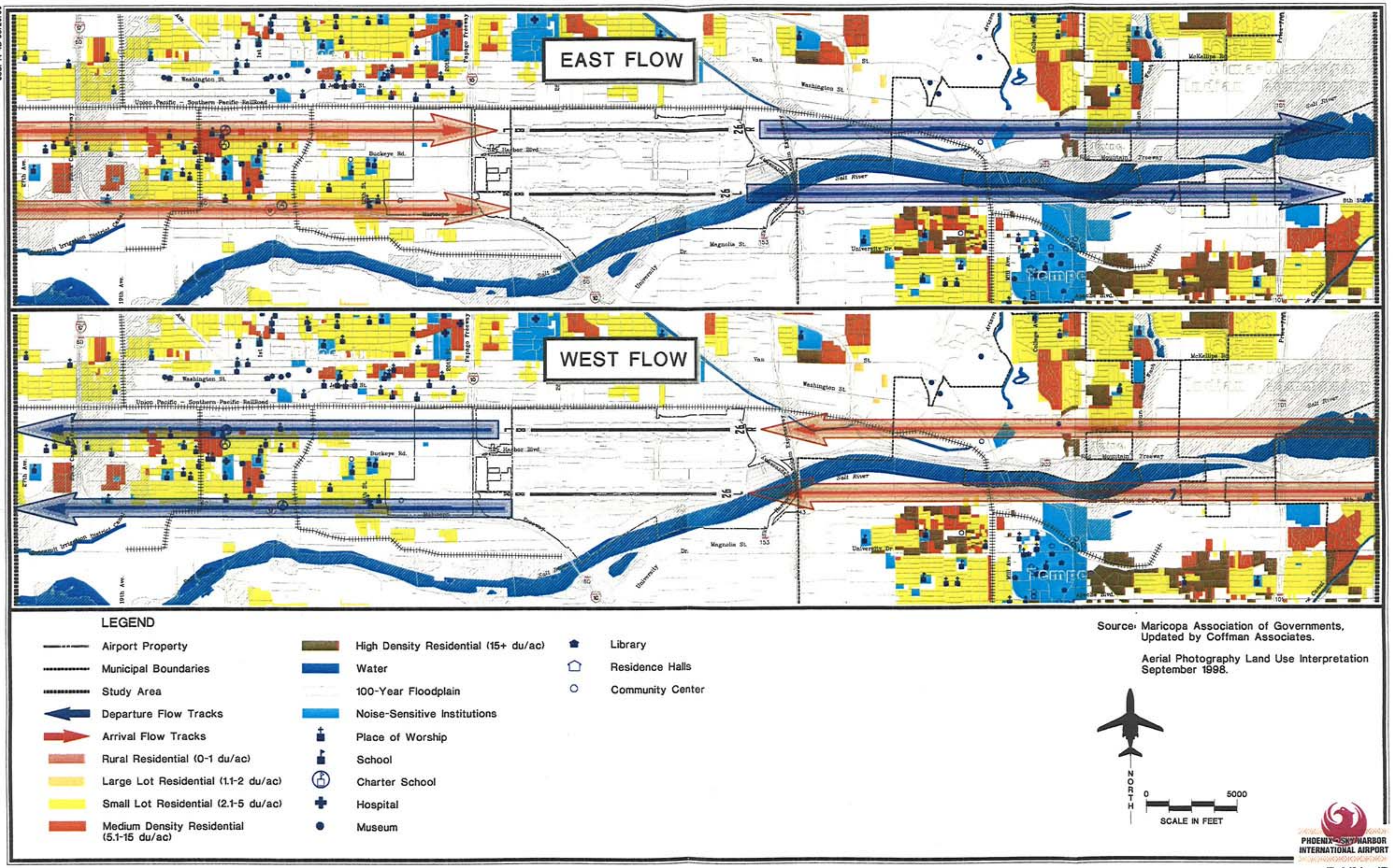


Exhibit 4B

PHOENIX SKY HARBOR INTERNATIONAL AIRPORT
EVALUATION OF RUNWAY USE FOR NOISE ABATEMENT

is prohibited by an Intergovernmental Agreement.

Departure Turns

A common noise abatement technique is to route departing aircraft over noise-compatible areas immediately after takeoff. In order to be fully effective, the compatible corridor must be relatively wide and closely aligned with the runway so that turns over the area are practical.

Several noise-compatible corridors currently exist around Phoenix Sky Harbor International Airport. Corridors along the Salt River, interstate highways, and railroads are available both east, southeast, west and southwest of the airport. These are shown in **Exhibit 4C**. These relatively narrow corridors have limitations in their usefulness for noise abatement for two reasons. First, they are difficult for aircraft to fly over with absolute precision. It is essential in these cases for aircraft to use some kind of electronic navigational aid to be able to fly over the corridor. Even this can be of limited effectiveness since these instruments do not offer perfect resolution. (The width of a VOR radial can vary, depending on its distance from the VOR facility.) Pilot technique also varies. This situation is changing. With the use of modern, computerized flight management systems (FMS) and the global positioning satellite (GPS) system, aircraft can be flown with considerable precision over known navigational fixes.

A particular problem with narrow corridors is that aircraft noise radiates outward over a wide area. Even an aircraft perfectly aligned along a narrow corridor will produce noise well off the sides of the noise-compatible corridor.

It is possible, of course, for a noise-compatible corridor to be widened by purchasing residential or other noise-sensitive property, relocating the residents, and demolishing the homes. This is an expensive solution, but it can be justified where the net noise abatement benefits are substantial. (The potential acquisition of property for noise mitigation is discussed in greater detail in Chapter Five, Land Use Management Alternatives.)

Even without the adjustments, corridors present around Sky Harbor Airport could offer some additional noise abatement benefits. Aircraft departing Runway 25 could be requested to fly a heading of 240-degrees upon reaching the runway end. The original Part 150 study recommended 245-degree departure turn from Runway 25. This departure turn procedure, adjusted to 240-degrees to meet safe separation standard, was incorporated into the 2004 and 2015 noise exposure contours. Aircraft would then be directed over the Salt River alleviating potential aircraft overflights of noise-sensitive development north of I-17, approximately one mile west of the airport. In addition, a Runway 25 departure turn would be similar to the 240-degree departure turn from Runway 26L which is associated with several instrument departure (SID) procedures used at Sky Harbor. Consideration should be given to establishing the 240-degree turn procedure for Runway 25 when Runway 7-25 is opened.

Aircraft departing Runways 8L and 8R under instrument flight rules (IFR) utilize departure procedures that generally follow the Salt River to the east until a position 4DME east of the PXR VORTAC. This allows aircraft to avoid initial climb out over noise-sensitive regions in the City of Tempe. This procedure is required for aircraft departing Runway 7.

The use of the 4DME procedure does pose some operational problems for the airport. Currently, aircraft from both Runways 8L and 8R are required to converge towards the PXR VORTAC. This causes aircraft separation delays. Without the 4DME procedure, aircraft would depart using a minimum 15-degree diverging flight track allowing for simultaneous parallel runway operations. Following the recent phase-out of Stage-2 aircraft, all air carriers are using newer Stage-3 aircraft technology. These aircraft are able to climb more quickly and quietly than their predecessors. In addition, the recent completion of the Rio Salado Town Lake along the Salt River corridor east of the airport has increased residential development pressure in this area. Therefore, the continued use of the 4DME procedure for noise abatement should be evaluated further.

One additional corridor exists primarily for propeller powered aircraft departing Runway 7. This departure turn would request aircraft to turn to a 120-degree heading upon reaching the end of the runway. This heading would allow departing aircraft to fly over an area of primarily industrial and commercial land uses along the I-10 corridor southeast of the airport.

Conclusion: Existing noise-compatible corridors southeast and southwest of the airport may be of some noise abatement value for implementing departure turn procedures. Therefore, consideration should be given to establishing the 240-degree departure turn procedure for Runway 25 and a 120-degree departure turn from Runway 7.

In addition, the continued use of the 4DME procedure should be evaluated for effectiveness in lieu of quieter aircraft that can climb faster and recent development efforts east of the airport. The effects of the use of these corridors and the associated 4DME procedure are analyzed in a later section.

Visual And Offset Instrument Approaches

Approaches involving turns relatively close to the airport can sometimes be defined over noise-compatible corridors. These can be defined as either VFR (visual flight rule) approaches or non-precision instrument approaches. A stabilized, straight-in final approach of at least one mile should be provided. If large aircraft are involved, a longer straight-in final approach of two to three miles is needed. In order to be effective for noise abatement, an offset or "side-step" approach must be used by

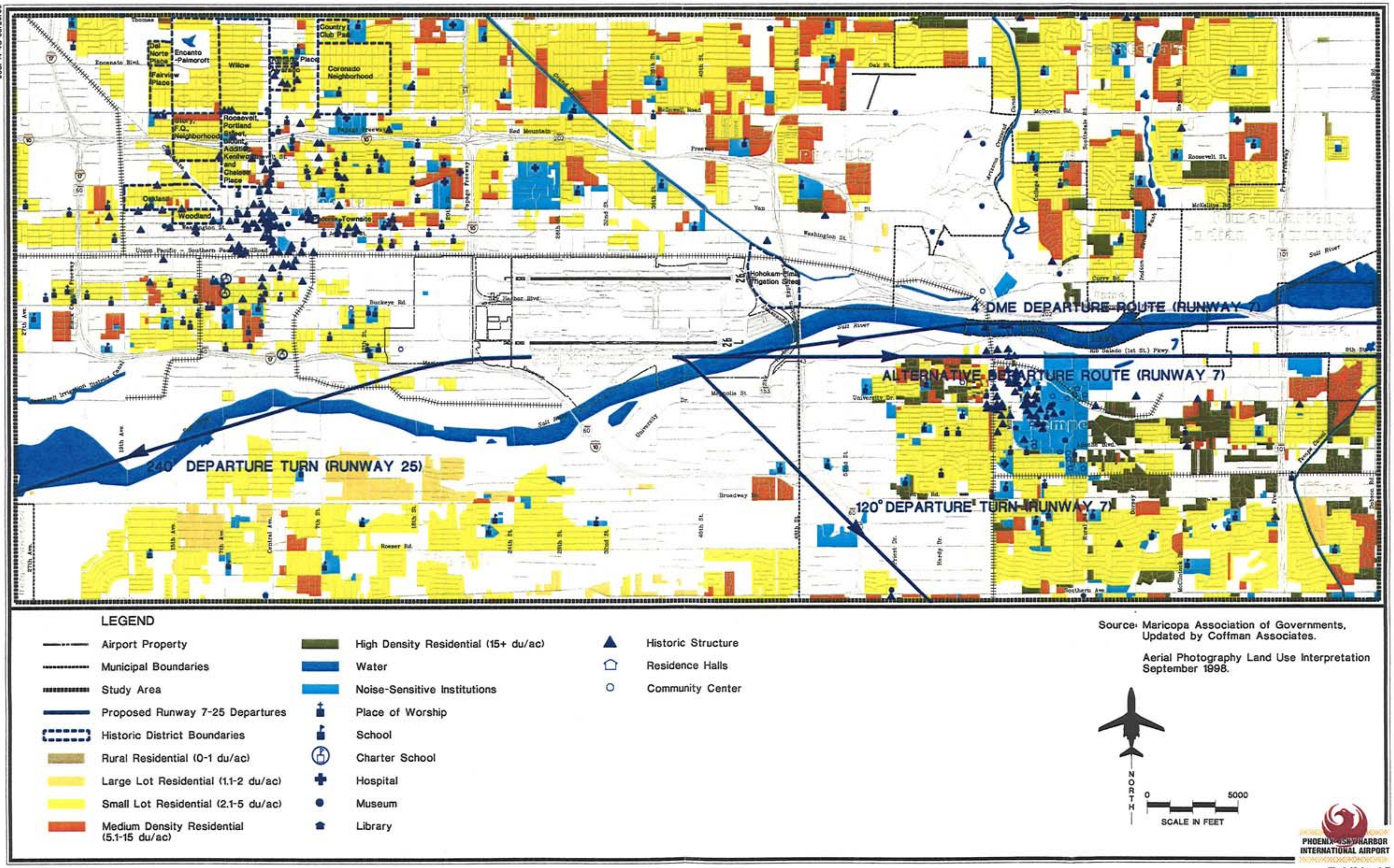


Exhibit 4C
PHOENIX SKY HARBOR INTERNATIONAL AIRPORT
DEPARTURE ROUTE ALTERNATIVES

the loudest aircraft, primarily air carrier and business jets, using the airport.

At Sky Harbor, approaches to most runways have relatively sustainable compatible corridors available for visual or instrument approaches. These corridors follow the current or planned precision and non-precision instrument approaches.

An approach of particular concern is the straight-in approach to Runway 25 (Currently under construction). The primary dilemma with this approach is an area of noise-sensitive development, including the Arizona State University (ASU) campus, slightly south of the final approach course. In 1994, an Inter Governmental Agreement (IGA) between the Cities of Phoenix and Tempe was established, intending to ensure the implementation of specific noise abatement measures. One procedure identified in this IGA was a "side-step" approach for aircraft approaching from the east to Runway 25. Aircraft approaching for landing on Runway 25 could be assigned to fly the ILS or other non-precision approach to Runway 26L and "side-step" (approximately 800 feet) to a visual final approach to Runway 25 upon reaching a point approximately three miles east of the runway end (approximately located over Sun Devil Stadium and Mill Avenue). The final decision to execute a "side-step" approach would be at the pilot's discretion. (During times of instrument meteorological conditions (IMC), aircraft would be required to use the straight-in ILS approach to Runway 25). Both the side-step and straight in approach to Runway 25 are depicted on **Exhibit 4D**. The noise abatement benefits versus a straight-in approach and the ideal location for the commencement of this "side-step" approach procedure deserves further consider-ation.

In the future, the use of Differential Global Positioning System (DPGS), Area Navigation (RNAV), and Flight Management System (FMS) technology may be used to define precision instrument approaches (and departures). It is anticipated that offset or curved precision approaches will then be possible. However, the FAA has not yet established criteria for "precision" flight operations using this technology.

Conclusion: Current precision and non-precision approaches to specific runways are adequately aligned with noise compatible corridors. An instrument approach to Runway 26L followed by a "side-step" final approach versus a straight-in final approach to Runway 25 deserves further evaluation.

AIRPORT FACILITIES

In some cases, airport facilities can be developed to reduce airport noise in noise-sensitive areas. For example, runways can be built or lengthened to shift aircraft noise to compatible areas. Runway thresholds can be displaced or relocated to shift noise, and barriers can be built to shield noise-sensitive areas from aircraft noise on the ground at the airport.

Runway Extensions And New Runways

New runways aligned with compatible land development, or runway extensions shifting aircraft operations further away from residential areas are a proven means of noise abatement. New runways are most effective where there are large compatible areas near an airport, and existing runways are aligned with residential areas.

At Sky Harbor, current and planned runways are aligned with compatible development to the greatest extent possible. In fact, the new Runway 7-25 should allow arriving and departing aircraft west of the airport to operate along the Salt River and I-17 corridor, south of current noise-sensitive development.

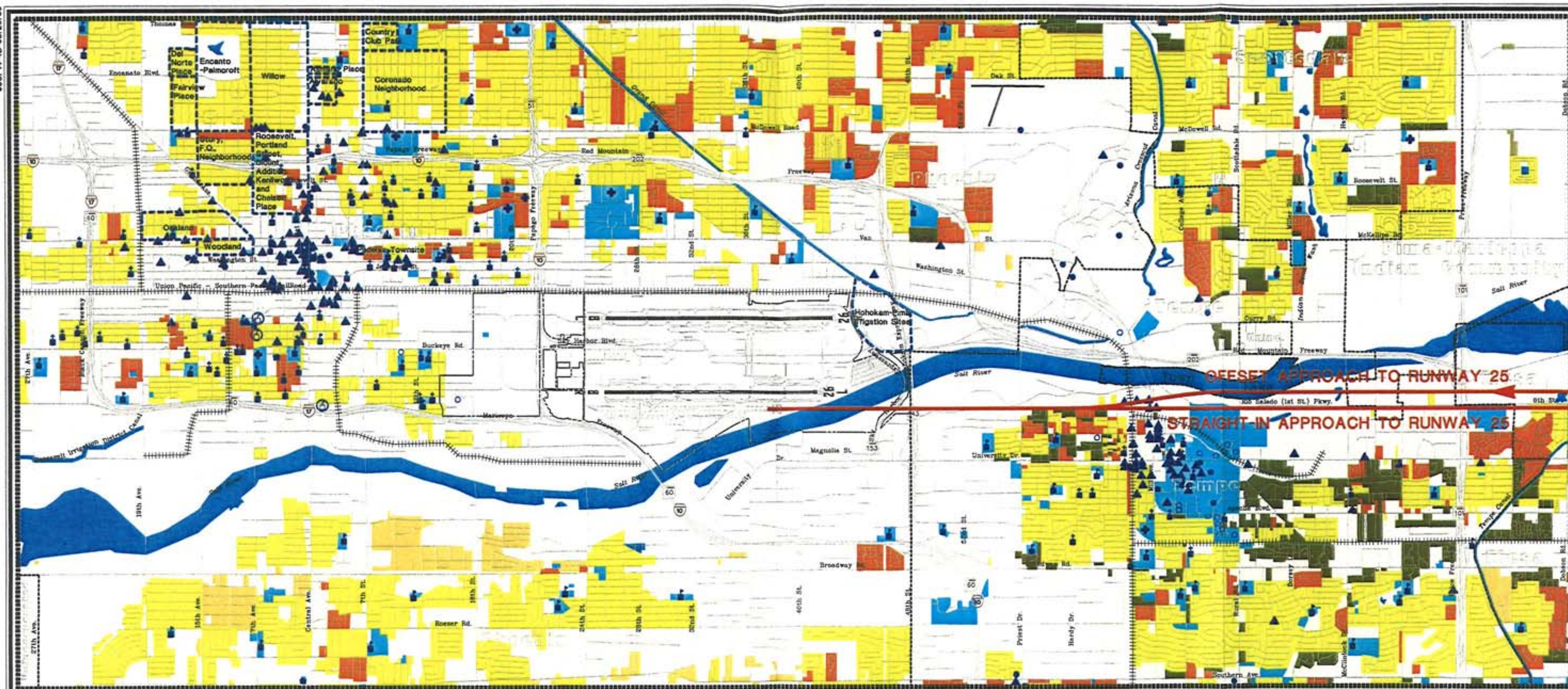
According to the "draft" *Phoenix Sky Harbor International Airport Master Plan*, a fourth runway has been proposed. This 9,500 foot runway, if constructed, would be located 816 feet north and parallel to Runway 8L-26R. The purpose of this runway would be "to permit Sky Harbor to continue its current role and function as the principal air carrier airport in Arizona". The addition of this runway may prove beneficial for noise abatement for two reasons. First, an additional runway may help disperse aircraft noise impacts by relieving some aircraft overflights resulting from using the current runway configuration. Second, the location of the proposed fourth runway is ideally aligned with a rail corridor extending to the west from the airport. This would allow aircraft arriving or departing this runway from/to the west to avoid overflights of noise-sensitive areas. Should the addition of this fourth runway become plausible, additional study into it's noise abatement implications should be analyzed.

Runway extensions are usually beneficial where there is substantial residential development very close to one end of a runway and not the other. This is not the case at Sky Harbor given that the closest noise-sensitive development is located greater than one mile from any runway end. It should be noted that an extension of Runway 8L-26R 900 feet to the west is currently under design, however, this is being undertaken for safety factors and will not significantly affect noise impacts.

Conclusion: Given that the current and planned runways possess the best noise abatement alignment possible, no alignment changes are warranted. In addition, runway extensions would do little if anything to significantly reduce aircraft noise in the vicinity of Sky Harbor Airport. These options therefore, do not merit further consideration. The current draft Phoenix Sky Harbor International Airport Master studies a fourth runway option. In the event that a fourth runway is implemented, additional analysis should be conducted to evaluate any potential noise effects and benefits.

Displaced And Relocated Thresholds

A displaced threshold involves the shifting of the touchdown zone for landings further down the runway. A relocated threshold involves shifting both the touchdown point and the takeoff initiation point. (In other words, the original runway end is completely relocated.) These techniques can promote noise abatement by



LEGEND

- Airport Property
- Municipal Boundaries
- Study Area
- Proposed Runway 25 Arrival Tracks
- Historic District Boundaries
- Rural Residential (0-1 du/ac)
- Large Lot Residential (1.1-2 du/ac)
- Small Lot Residential (2.1-5 du/ac)
- Medium Density Residential (5.1-15 du/ac)
- High Density Residential (15+ du/ac)
- Water
- Noise-Sensitive Institutions
- Place of Worship
- School
- Charter School
- Hospital
- Museum
- Library
- Historic Structure
- Residence Halls
- Community Center

Source: Maricopa Association of Governments, Updated by Coffman Associates.

Aerial Photography Land Use Interpretation September 1998.

NORTH

0 5000
SCALE IN FEET

PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Exhibit 4D
PHOENIX SKY HARBOR INTERNATIONAL AIRPORT
ARRIVAL ROUTE ALTERNATIVES

98SP14-4D-03/20/00

effectively increasing the altitude of aircraft at any given point beneath the approach. The amount of noise reduction depends on the increased altitude which, in turn, depends on the length of the displacement. Another potential noise abatement benefit of runway displacement may be the increased distance between the aircraft and noise-sensitive uses adjacent to the runway from the point at which reverse thrust is applied after touchdown.

The determination of the amount of threshold displacement must consider the runway length required for landing in addition to the amount of noise reduction provided by the displacement. A considerable displacement is needed to produce a significant reduction in noise. (For example, if a runway threshold is displaced 1,000 feet, the altitude of an aircraft along the approach path would increase by only 50 feet).

Unlike threshold displacement, threshold relocation increases noise off the runway end opposite the relocation because of the shift in the point of the takeoff. Aircraft would be at lower altitudes at any given downrange location after takeoff than they would be without the relocation. In conjunction with the aforementioned extension to Runway 8L-26R, this runway will also have the eastern threshold relocated 410 feet west. Again, this is due to safety factors and the effects of these changes are reflected in the 2004 and 2020 noise contours/impacts.

Conclusion: Threshold displacement and relocation generally offer only small noise reduction benefits. They are most helpful to residential areas located very near the end of the runway under the approach, a condition not present at Sky Harbor. Any reductions in arrival noise caused by threshold relocations would be offset by increases in departure noise off the opposite runway end. Threshold displacements would provide little if any benefit at Sky Harbor. These techniques do not merit further consideration.

Acoustical Barriers

Acoustical barriers such as noise walls or berms are intended to shield areas from the noise of aircraft powering up for takeoff and rolling down the runway. It is also possible to use the orientation of buildings on the airport to provide a noise barrier to protect nearby residential areas from noise. Noise walls act best over relatively short distances, and their benefits are greatly affected by surface topography and wind conditions. The effectiveness of a barrier is directly related to the distance of the noise source from the receiver and the distance of each from the barrier itself, as well as the angle between the ends of the berm and the receiver.

While noise walls and berms can attenuate noise, they sometimes are criticized by airport neighbors because they obstruct views. Another common complaint is that airport noise can become more alarming, particularly noise from unusual events, because people are unable to see the cause of the noise.

At Sky Harbor International Airport, noise walls or berms would be ineffective for the attenuation of aircraft noise. Given the distance and location of residential and most noise-sensitive development around the airport, there are no suitable areas for the effective placement of such barriers.

Conclusion: Since noise barriers such as noise walls or berms do not offer noise reduction benefits to airborne aircraft or noise-sensitive development not located adjacent to the airport, these devices would be of little benefit at Sky Harbor and will not receive further consideration.

Run-up Enclosures

An engine run-up enclosure is a special kind of noise barrier which can be appropriate at airports with aircraft engine maintenance operations. Engine run-ups are a necessary part of aircraft service and maintenance. They are necessary to diagnose problems and test the effectiveness of maintenance work. Run-up enclosures are designed so that aircraft can taxi or be towed into them. The structures are designed to absorb and deflect the noise from the run-up, thus reducing noise levels off the airport.

Run-up noise can be especially disturbing because it is so unpredictable. While the noise from takeoffs and landings is relatively brief and has a particular pattern to which a person can adjust, the noise from a run-up is completely unpredictable. The duration of the run-up can vary from 30 seconds to several minutes, and the listener has no way of knowing how long any given run-up will be. If the run-up is at or near full power, the noise level can be extremely high.

Some of the operators on the airport have established large aircraft maintenance facilities, including America West Airlines, AM & S, and Southwest Airlines. All three perform maintenance run-ups on large turbojet aircraft. It is appropriate to consider construction of a run-up enclosure to attenuate the noise from maintenance activities at Sky Harbor.

Conclusion: With large aircraft maintenance facilities at the airport, a run-up enclosure deserves consideration.

AIRCRAFT OPERATIONAL PROCEDURES

Aircraft operating procedures which may reduce noise impacts include:

- Reduced thrust takeoffs.
- Thrust cutbacks after takeoff.
- Maximum climb departures.
- Minimum approach altitudes.
- Use of minimum flaps during approaches.
- Steeper approach angles.
- Limitations on the use of reverse thrust during landings.

Reduced Thrust Takeoffs

A reduced thrust takeoff for jet aircraft involves takeoff with less than full thrust. A reduced power setting is used throughout both takeoff roll and climb.

Use of the procedure depends on aircraft weight, weather and wind conditions, pavement conditions, and runway length. Since these conditions vary considerably, it is not possible to mandate safely the use of reduced thrust departures.

In practice, most airline and business jet operators use reduced thrust departures to conserve fuel, reduce engine wear, and abate noise. Additional efforts to encourage the use of deeper reduced thrust takeoffs would reduce safety margins and are unlikely to yield noise abatement benefits.

Conclusion: Because of the safety implications of these procedures, they are best left to the discretion of pilots and aircraft operators.

Thrust Cutbacks For Jets

Standardized thrust cutback departure procedures have been established by each airline because of system wide operating needs and to promote noise abatement. While the procedures of each carrier differ somewhat, they all involve thrust reduction soon after takeoff and initial acceleration. This reduction normally occurs between 1,000 and 3,000 feet above the ground. The amount of thrust reduction depends on aircraft weight, temperature, and flap setting. A significant, but safe, reduction in thrust often can reduce noise within the 65 and 70 DNL noise contours but also can increase noise downrange from the airport.

For many years, the FAA has had an advisory circular describing recommended noise abatement departure procedures for large jets. In 1993, the FAA revised these guidelines and published them in Advisory Circular 91-53A. It provides for two standard thrust cutback procedures. One focuses on noise abatement near the airport (the close-in procedure) while the other abates noise further away from the airport (the distant procedure). The intent of the circular is to provide guidelines for aircraft operators to establish safe and effective procedures that can be used at all airports across the country. **Exhibit 4E** shows the version of the AC 91-53A procedure flown by Southwest Airlines. This is the "distant procedure" and is their standard departure. It is regularly used at Sky Harbor. The procedures flown by the other airlines are similar to that depicted in **Exhibit 4E.**

As a service to the general aviation industry, the National Business Aircraft Association (NBAA) prepared noise abatement takeoff and arrival procedures for business jets. This program has virtually become an industry standard for operators of business jet aircraft since that time. The departure procedures are of two types: the standard procedure and the close-in procedure. They are illustrated in **Exhibit 4F**.

The NBAA standard departure procedure calls for a thrust cutback at 1,000 feet above ground level (AGL) and a 1,000 feet per minute climb to 3,000 feet altitude during acceleration and flap retraction. The close-in procedure is similar except that it specifies a thrust cutback at 500 feet AGL. While both procedures are effective in reducing noise, the locations of the reduction vary with each. The standard procedure results in higher altitudes and lower noise levels over down-range locations, while the close-in procedure results in lower noise near the airport. Many aircraft manufactures have developed their own thrust cutback procedures. Neither NBAA procedure is intended to supplant a procedure recommended by the manufacturer and published in the aircraft operating manual.

While some airports have defined special thrust cutback departure procedures, this is frowned upon by the industry. The air carriers fear the consequences of a proliferation of airport-specific procedures. As the number of procedures increased, it would become more and more difficult for pilots to become proficient at all of them and still maintain comfortable safety margins. It would be like asking motorists to comply with a different set of braking and acceleration procedures at every intersection in the city. In any case, safety requires that the use of thrust cutbacks in any given situation must be left to the discretion of the pilot based on weather and the operational characteristics of the aircraft.

Conclusion: Standard thrust cutback departure procedures are already used by virtually all air carriers and many business jet operators. The Airport should continue to encourage the use of these procedures since they can produce important noise reductions. Efforts to mandate the use of these procedures, however, are not advised. As a critical flight operation, the use of thrust cutbacks in any given situation should be left to the discretion of the pilot to avoid eroding safety margins.

Maximum Climb Departures

Maximum climb departures can help reduce noise exposure over populated areas some distance from an airport. The procedure requires the use of maximum thrust with no cutback on departure. Consequently, the potential noise reductions in the outlying areas are at the expense of significant noise increases closer to the airport.

Previously at Sky Harbor, altitude conflicts with the location of the Biltmore Transition had required departing aircraft to cross the PXR VORTAC at or below 300 feet MSL. The relocation of the Biltmore Transition has since lifted this altitude restriction and aircraft routinely climb unrestricted to 7,000 feet MSL. **Exhibit 4G** depicts Stage-3 aircraft departure profiles for aircraft departing to the east for different periods during the study. As seen on **Exhibit 4G**, aircraft departing to the east do not stop their climb-out and level off at any point along their departure.

During their initial climb, turbojet aircraft departing Sky Harbor often use noise departure techniques involving methods to gain altitude quickly. Since January 1, 2000, all air-carrier aircraft using the airport must comply with stage-3 standards. The new aircraft technology utilized by Stage-3 aircraft allows these aircraft to climb faster, quieter, and more efficiently. **Exhibit 4G** also depicts a comparison of "Stage-

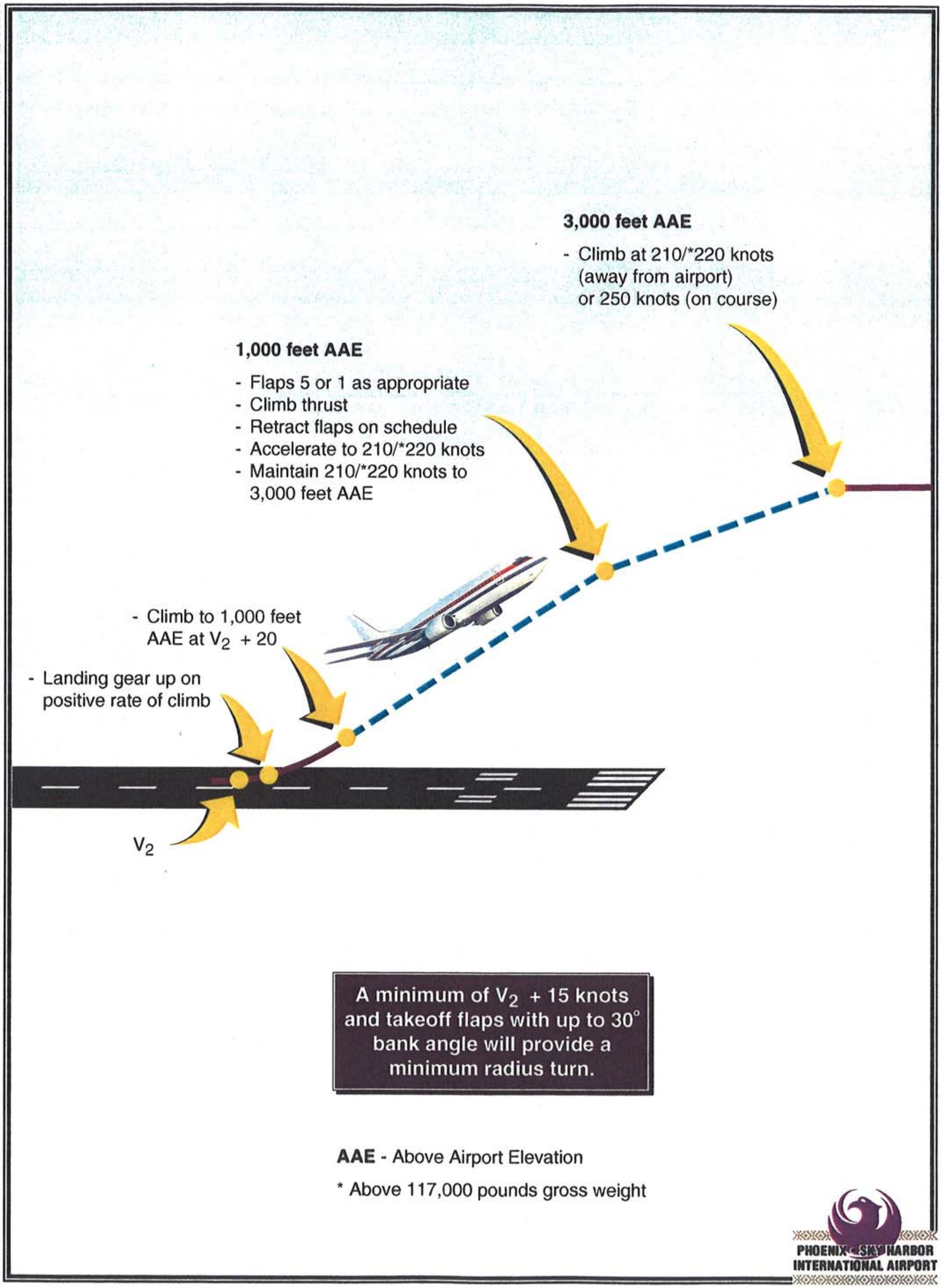
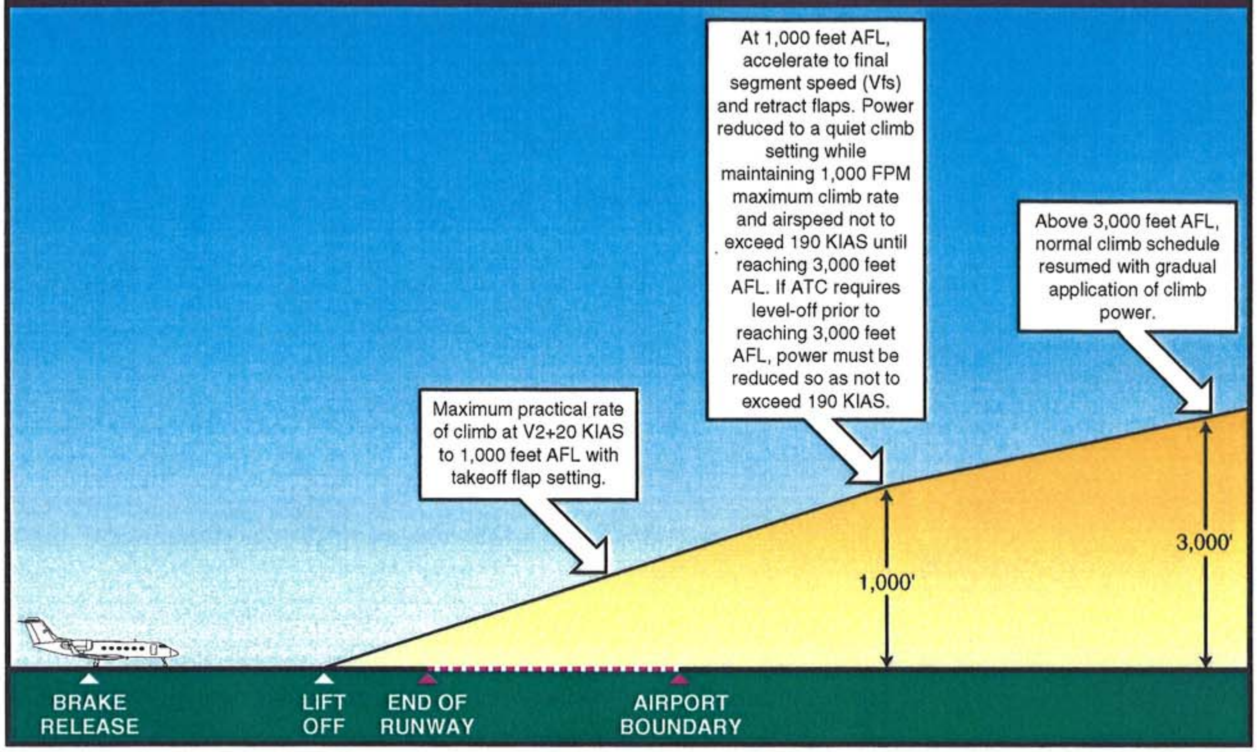


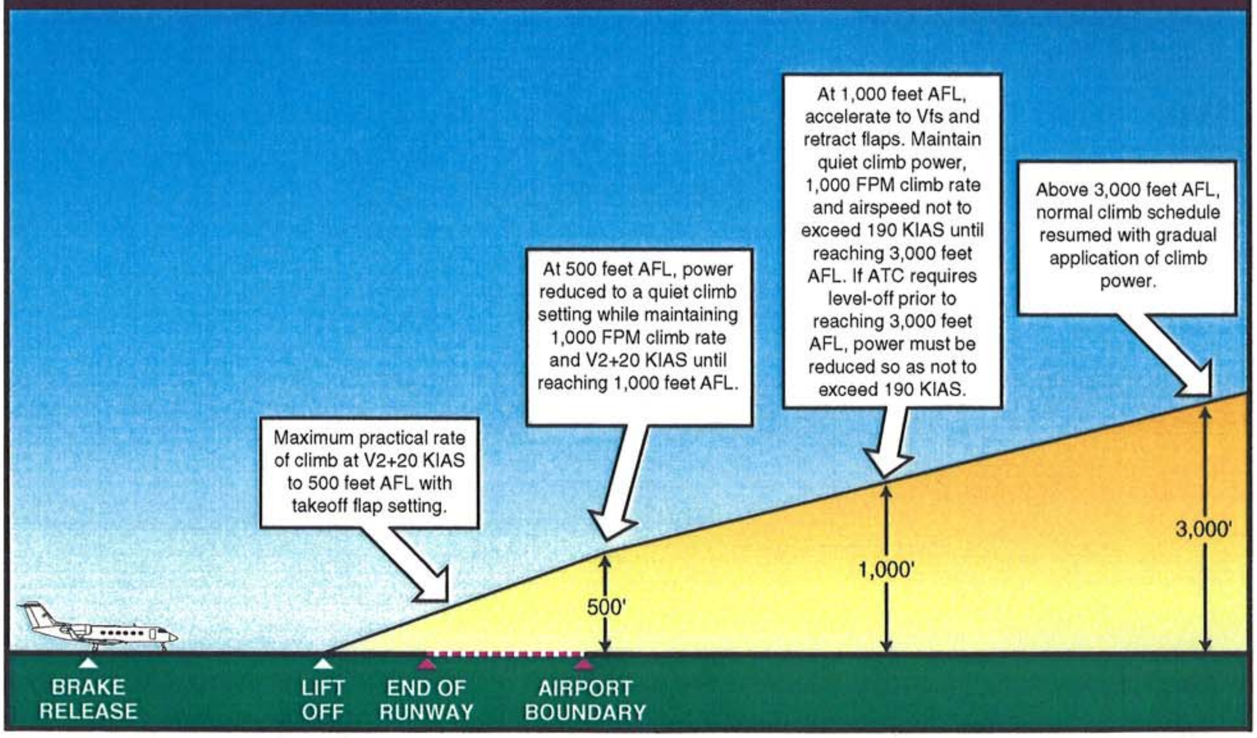
Exhibit 4E
TYPICAL AIRLINE DISTANT NOISE ABATEMENT DEPARTURE PROCEDURE

98DSP14-4F-3/2/00

STANDARD PROCEDURE



CLOSE-IN PROCEDURE



KEY

AFL - Above field elevation
ATC - Air traffic control
FPM - Feet per minute
KIAS - Knots, indicated airspeed

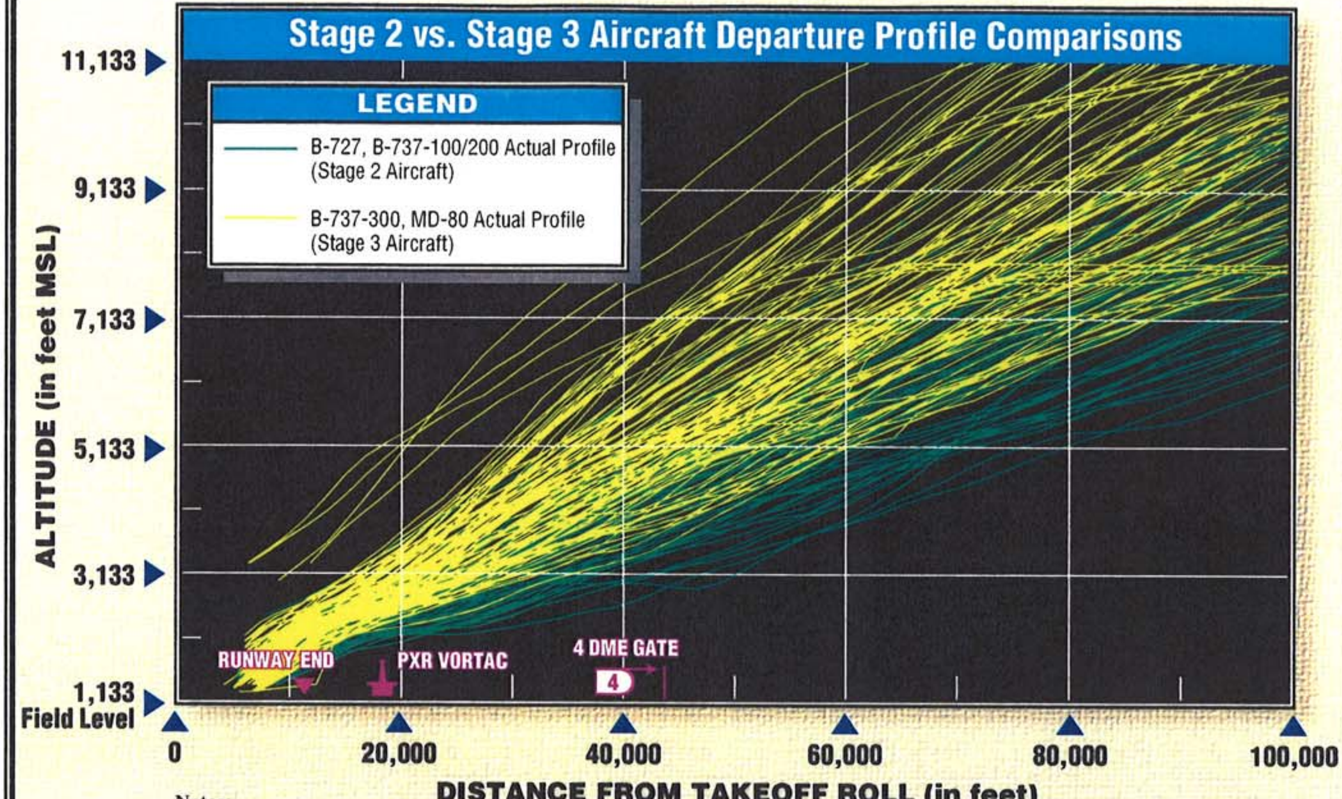
Note: It is recognized that aircraft performance will differ with aircraft type and takeoff conditions; therefore, the business aircraft operator must have the latitude to determine whether takeoff thrust should be reduced prior to, during, or after flap retraction.

Source: National Business Aircraft Association (NBAA), "NBAA Noise Abatement Program," January 1, 1993.

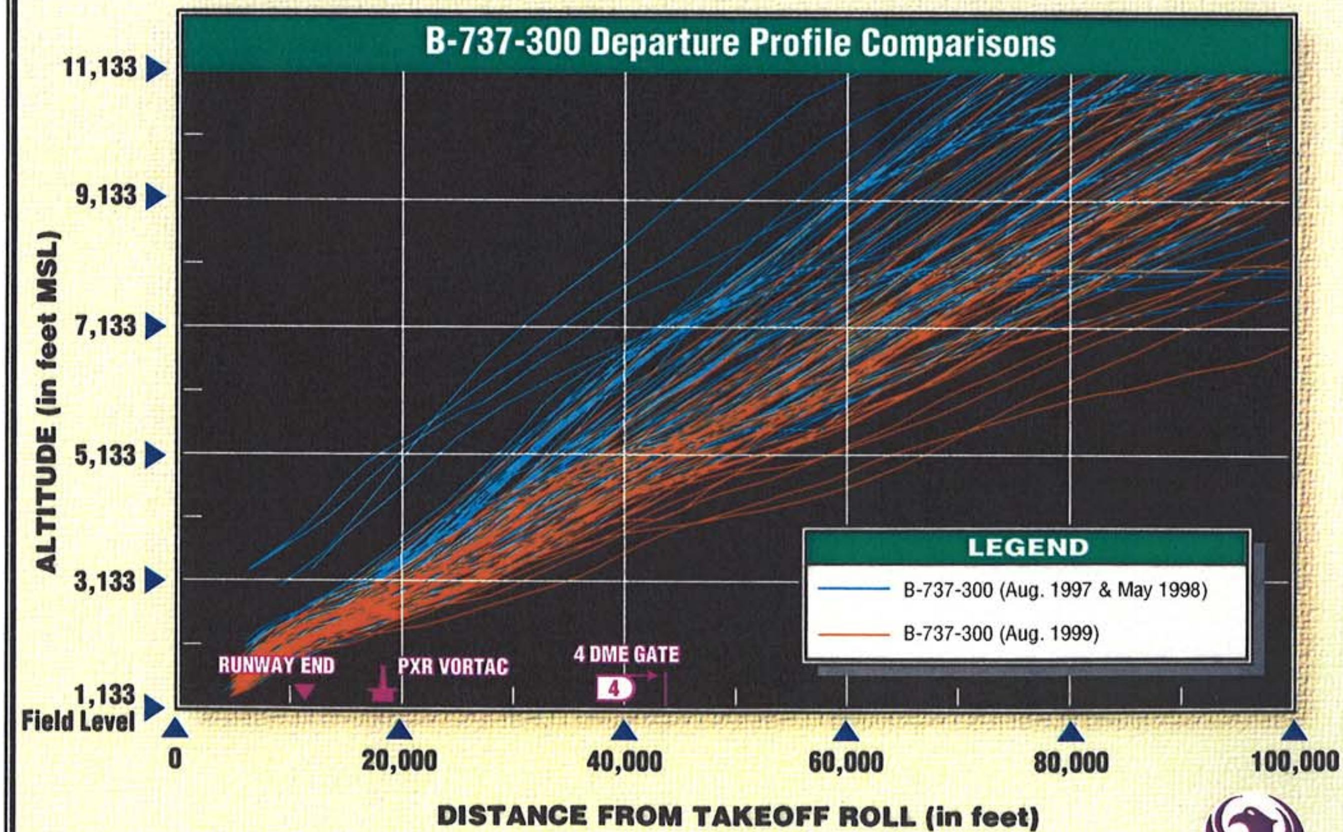
PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Exhibit 4F
NBAA NOISE ABATEMENT DEPARTURE PROCEDURES

98SP14-4G-3/9/00



Notes:
Observations from August 1997 and May 1998



PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Exhibit 4G
DEPARTURE PROFILE COMPARISONS

2 versus Stage-3 departure profiles". This exhibit shows that Stage-3 aircraft (yellow) consistently climb more quickly than the older Stage-2 aircraft (green). The use of stage-3 (non-hushkitted) aircraft at Sky Harbor should allow aircraft to gain altitude at a faster rate.

An additional requirement involving the use of maximum climb procedures would significantly increase fuel usage and engine wear, decrease safety margins, and create undue passenger discomfort in comparison with current noise abatement procedures. In addition, The noise benefit gained by the additional altitude would be offset by the additional thrust needed to maintain the higher rate of climb.

Conclusion: The removal of altitude restrictions at Sky Harbor has not, in effect, caused departing aircraft to gain altitude more quickly. This altitude gain has, however, been enhanced by the use of newer aircraft able to climb more effectively. Currently all commercial turbojet aircraft operating at Sky Harbor utilize some type of noise abatement departure procedure. Instituting maximum climb procedures would significantly increase fuel usage and engine wear, decrease safety margins, and create undue passenger discomfort. In addition, the noise benefit gained by the additional altitude would be offset by the additional thrust needed to maintain the higher rate of climb. Therefore, the use of maximum climb procedures for noise abatement will not be addressed further.

Minimum Approach Altitudes

These procedures entail an air traffic control (ATC) requirement that all positively controlled aircraft approaches be conducted at a specified minimum altitude until the aircraft must begin its descent to land. This would affect only aircraft quite some distance from the airport and well outside the noise contours. Since aircraft on approach are using little power, they tend to be relatively quiet. Accordingly, increases in approach altitudes result in only very small reductions in single event noise.

In the Phoenix area, altitudes of aircraft on approach are established to allow the safe mixing of large numbers of aircraft operating under both visual flight rules (VFR) and instrument flight rules (IFR) and heading for many different airports. Adjustments in altitudes of aircraft operating into one airport could well have an impact on the rest of the system. This could potentially create airspace and air traffic complications for other airports in the area.

Conclusion: Raising approach altitudes into Sky Harbor would produce only very small noise reductions well outside the 65 DNL noise contour and would be potentially complicated because of the dense air traffic in the area and the potential for aircraft interaction. This procedure does not merit further consideration.

Noise Abatement Approach Procedures

Approach procedures to reduce noise impacts were attempted in the early days of noise abatement, but are no longer favorably received. The procedures include the minimal use of flaps in order to reduce power settings and airframe noise, the use of increased approach angles, and two-stage descent profiles. All of these techniques raise safety concerns because they are nonstandard and require an aircraft to be operated outside of its optimal safe operating configuration. Increased approach slope angles require aircraft to be landed at more than optimal approach speed. The higher sink rates and faster speeds reduce pilot reaction time and erode safety margins. They also increase stopping distances on the runway and are especially inadvisable on relatively short runways. Some of these procedures actually have been found to increase noise because of power applications needed to arrest high sink rates.

Conclusion: Because these procedures erode safety margins and are of little practical noise abatement benefit, they do not deserve further consideration at Sky Harbor.

Reverse Thrust Restrictions

Thrust reversal is routinely used to slow jet aircraft immediately after touchdown. This is an important safety procedure which has the added benefit of reducing brake wear. Limits on the use of thrust reversal can reduce noise impacts off the sides of the runways, although they would not significantly reduce the size of the noise contours. Enforced restrictions on the use of reverse thrust, however, are not considered fully safe.

Given the location of noise-sensitive uses in the Phoenix Sky Harbor International Airport vicinity, a restriction on thrust reversal would not produce significant benefits. Reverse thrust restrictions tend to erode landing safety margins, increase runway occupancy time, and increase brake wear on aircraft.

Conclusion: Mandated limitations on the use of reverse thrust are inadvisable at Phoenix Sky Harbor Airport because of the reduced safety margins and the likelihood for only small benefits. As an operational flight procedure with a direct effect on safety, decisions about whether to use reverse thrust should be left to the discretion of pilots.

AIRPORT REGULATIONS

F.A.R. Part 150 requires that, in developing Noise Compatibility Programs, airports study the possible implementation of airport use restrictions to abate aircraft noise. See F.A.R. Part 150, B150.7(b)(5). The courts have recognized the right of airport proprietors to reduce their liability for aircraft noise by imposing restrictions which are reasonable and do not violate contractual agreements with the FAA conditioning the receipt of federal aid. (These are known as "grant assurances.") In addition, constitutional prohibitions on unjust discrimination and the imposition of undue burdens on interstate commerce must be respected. The restrictions must also be crafted to avoid infringing on regulatory areas preempted by the Federal government. Finally, the regulations must be evaluated under the requirements of F.A.R. Part 161.

Airport noise and access restrictions may be proposed by an airport operator in its F.A.R. Part 150 Noise Compatibility Program. The FAA has made it clear that the approval of a restriction in an F.A.R. Part 150 document would depend on the noise abatement benefit of the restriction at noise levels of 65 DNL or higher. Even if the FAA should accept a noise restriction as part of an F.A.R. Part 150 Noise Compatibility Program, the requirements of Part 161 still would need to be met before the measure could be implemented.

F.A.R. Part 161

In the Airport Noise and Capacity Act of 1990, Congress not only established a national phase-out policy for Stage 2 aircraft above 75,000 pounds, but it also established analytical and procedural requirements for airports desiring to establish noise or access restrictions on Stage 2 or Stage 3 aircraft. Regulations implementing these requirements are published in F.A.R. Part 161.

F.A.R. Part 161 requires the following actions to establish a local restriction on Stage 2 aircraft:

- An analysis of the costs and benefits of the proposed restriction and alternative measures.

- Publication of a notice of the proposed restriction in the Federal Register and an opportunity for comment on the analysis.

While implementation of a Stage 2 aircraft operating restriction does not require FAA approval, the FAA does determine whether adequate analysis has been done and all notification procedures have been followed.

For restrictions on Stage 3 aircraft, Part 161 requires a much more rigorous analysis as well as final FAA approval of the restriction. Before approving a local Stage 3 noise or access restriction, the FAA must make the following findings:

- The restriction is reasonable, non-arbitrary, and non-discriminatory.

- The restriction does not create an undue burden on interstate or foreign commerce.

- The restriction maintains safe and efficient use of navigable airspace.

- The restriction does not conflict with any existing federal statute or regulation.

- The applicant has provided adequate opportunity for public comment on the proposed restriction.

- The restriction does not create an undue burden on the national aviation system.

Based on FAA's interpretations of Part 161, the regulations do not apply to restrictions proposed only for aircraft under 12,500 pounds. Because these light aircraft, which include small, single engine aircraft, are not classified under Part 36 as Stage 2 or 3, the FAA has concluded that the 1990 Airport Noise and Capacity Act was not intended to apply to them. (See Airport Noise Report, Vol. 6, No. 18, September 26, 1994, p. 142.)

Very few Part 161 studies have been undertaken since the enactment of ANCA. **Table 4C** summarizes the studies that have been done to date.

TABLE 4C
Summary of F.A.R. Part 161 Studies

Airport	Year		Cost	Proposal, Status
	Started	Ended		
Aspen-Pitkin County Airport, Aspen, Colorado	N.A.	N.A.	N.A.	The study has not yet been submitted to FAA.
Kahului Airport, Kahului, Maui, Hawaii	1991	1994	$50,000 (est.)	Proposed nighttime prohibition of Stage 2 aircraft pursuant to court stipulation. Cost-benefit and statewide impact analysis found to be deficient by FAA. Airport never submitted a complete Part 161 Study. Suspended consideration of restriction.
Minneapolis-St. Paul International Airport, Minneapolis, Minnesota	1992	1992	N.A.	Proposed nighttime prohibition of Stage 2 aircraft. Cost-benefit analysis was deficient. Never submitted complete Part 161 study. Suspended consideration of restriction and entered into negotiations with carriers for voluntary cooperation.
Pease International Tradeport, Portsmouth, New Hampshire	1995	N.A.	N.A.	Have not yet submitted Part 161 study for FAA review.
San Francisco International Airport, San Francisco, California	1998	1999 (est.)	$200,000	Proposing extension of nighttime curfew on Stage 2 aircraft over 75,000 pounds. Started study in May 1998. Submitted to FAA in early 1999 and subsequently withdrawn.
San Jose International Airport, San Jose, California	1994	1997	Phase 1 - $400,000 Phase 2 - $5 to $10 million (est.)	Study undertaken as part of a legal settlement agreement. Studied a Stage 2 restriction. Suspended study after Phase 1 report showed costs to airlines at San Jose greater than benefits in San Jose. Never undertook Phase 2, system wide analysis. Never submitted study for FAA review.

N.A. - Not available.

Sources: Telephone interviews with Federal Aviation Administration officials and staffs of various airports.

Regulatory Options

Regulatory options discussed in this section include the following:

- Nighttime curfews and operating restrictions.
- Landing fees based on noise or time of arrival.
- Airport capacity limitations based on relative noisiness.
- Noise budgets.
- Restrictions based on aircraft noise levels.
- Restrictions on touch-and-goes or multiple approaches.
- Restrictions on engine maintenance run-ups.

Nighttime Curfews And Operating Restrictions

Curfews and operating restrictions can often be an effective methods for reducing aircraft noise exposure around an airport. Since noise is commonly assumed to be most annoying in the late evening and early morning hours, curfews are usually aimed at restricting nighttime operations. However, curfews have economic impacts on airport users, on those providing airport-related services, and on the community as a whole. Other communities also may be impacted through curtailment of service.

There are essentially three types of curfews or nighttime operating restrictions: (1) closure of the airport to all arrivals and departures (a full curfew); (2) closure to departures only; and (3) closure to arrivals and departures by aircraft exceeding specified noise levels.

The time during which nighttime restrictions could be applied varies. The DNL metric applies a 10 decibel penalty to noise occurring between 10:00 p.m. and 7:00 a.m. That period could be defined as a curfew period. A shorter period, corresponding to the very late night hours, say midnight to 6:00 a.m., also could be specified.

Full Curfews: While full curfews can totally resolve concerns about nighttime aircraft noise, they can be indiscriminately harsh. Not only would the loudest operations be prohibited, but quiet operations by light aircraft also would be banned by a total curfew. Total curfews also deprive the community of the services of some potentially important nighttime airport users. Of course, full curfews would restrict access to the airport by Stage 3 aircraft. Thus, a full Part 161 analysis and FAA approval would be required prior to implementation.

Important economic reasons drive nighttime airport activity. Early morning departures are often attractive for business travelers who wish to reach their destinations with a large part of the workday ahead of them. Not only is this a personal convenience, but it can result in a significant savings in the cost of travel by reducing the need for overnight stays. Accordingly, early morning departures are often very popular, and the airlines have attempted to meet this demand. Similarly, late night arrivals are important in allowing travelers to return home without incurring the costs of another night away. Air carriers also need to position their aircraft so they are ready for the next days schedule. This tends to mandate nighttime arrivals. Since Sky Harbor is the only commercial service airport serving the Phoenix area, economic impacts caused by restrictions at the airport could affect the entire region.

Different, but equally compelling, reasons encourage cargo carriers and courier companies to operate in the evening and at night. Cargo is collected during the business day. It is shipped to a hub facility in the evening or at night where it is sorted and, in the case of package express service, delivered to its destination the next business day. Bulk cargo companies work essentially the same way, although, where speed is not of paramount importance, the collection and delivery functions may involve more use of surface transportation. Modern air cargo service cannot operate without nighttime access to airports.

Prohibition of Nighttime Departures: The prohibition of nighttime departures would allow aircraft to return home but would prohibit departures, which are generally louder than arrivals. Although somewhat less restrictive, this would have similar impacts at Sky Harbor as a total curfew. It would interfere with air carriers in their attempts to schedule early morning departures for the business travel market. In addition, such a curfew would greatly affect air cargo carriers including UPS, Fed Ex, and the U.S. Postal Service.

As with a total curfew, a nighttime prohibition on departures would restrict access to the airport by Stage 3 aircraft. This would require a full Part 161 analysis and FAA approval of the restriction before it could be implemented.

Nighttime Restrictions Based on Aircraft Noise Levels: Nighttime operating restrictions can be designed to apply only to those aircraft which exceed specified noise levels. If it is to be effective in reducing the size of the DNL noise contours, the restricted noise level would have to be set to restrict the loudest, most commonly used aircraft at the airport. At Phoenix Sky Harbor International Airport, representative aircraft that could be involved would be the B-727 hushkit, B-737 hushkit, and the MD80. Because these aircraft all meet Stage 3 noise levels, F.A.R. Part 161 would require a detailed analysis and approval by the FAA. In setting the restricted noise level, care would need to be taken that the restriction did not fall too heavily upon one carrier. Otherwise, charges of unjust discrimination could be levied.

Conclusion: Curfews and nighttime operating restrictions can be an effective way to reduce the size of DNL noise contours around an airport. Because of the extra 10-decibel weight assigned to nighttime noise, removing a single nighttime operation is equivalent to eliminating 10 daytime operations. The effect on the noise contours can be significant.

A particularly troubling aspect of curfews and nighttime operating restrictions is their potential adverse effects on local air service and the region's economy. This is especially compelling since Sky Harbor is the only commercial service airport operating in the Phoenix area. Additionally, implementation of nighttime restrictions can be costly, problematic, and require the completion and subsequent FAA approval of a Part 161 Study.

Noise-Based Landing Fees

Commercial airports typically levy landing fees on aircraft to raise revenue for airport operations and maintenance. Fees are typically based on aircraft gross weight. Landing fees also can be based on aircraft noise levels and the time of day of landings. Thus, arrivals at night by loud aircraft would be charged the highest fees, while arrivals during the day by quiet aircraft would be charged the smallest.

If noise-based landing fees are set high enough, they might encourage airlines to bring quieter aircraft into the airport. Noise-based landing fees set high enough to affect air carrier behavior would almost certainly be subject to legal challenge. The system could be vulnerable to attack as an undue burden on interstate commerce. The fee structure could also possibly be attacked as discriminatory if its effect was to single out one, or a few, carriers for especially strict treatment. In practice, however, landing fees are such a small part of the total operating costs of an airline that increases in fees or noise-based surcharges may become merely an irritant to the carrier.

Before the adoption of the Aviation Noise and Capacity Act (ANCA) of 1990, noise-based landing fees were often considered a way to encourage air carriers to convert to Stage 3 aircraft. Under ANCA, full conversion of aircraft over 75,000 pounds to Stage 3 standards was mandated by the year 2000, so the traditional objective of noise-based landing fees is no longer relevant. Of course, different kinds of Stage 3 aircraft produce different levels of noise. B-727s and DC-9s equipped with Stage 3 hush kits, for example, are louder than B-737-300s and A-320s. In theory, a system of noise-based landing fees could be used to attempt to encourage carriers to convert to the quietest Stage 3 aircraft. It is questionable how effective this could be in practice. An air carrier's fleet composition is dictated by many variables, including aircraft purchase, financing, and leasing costs; operating and maintenance costs; air and maintenance crew training requirements; manufacturer support; and marketing strategy. Whether one airport can exert enough leverage through noise-based landing fees to influence aircraft acquisition and route assignment decisions is questionable.

If landing fees cannot be set high enough to have a demonstrable effect on airline behavior, noise-based fee surcharges can still be a reasonable way to raise money for financing noise abatement activities. This does not appear to be necessary at Sky Harbor, however, since adequate sources of funding such as Passenger Facility Charges (PFC's) are available.

Landing fees are typically set by the terms of an airline's lease with the airport. Thus, fees could only be adjusted at the time leases came up for renewal, even if the Airport did establish a noise-based landing fee.

Noise-based landing fees are considered airport noise restrictions under F.A.R. Part 161. A Part 161 analysis would be required before such a fee system could be implemented. Any fee structure that would place a noise surcharge on Stage 3 aircraft would require FAA approval prior to implementation.

Conclusion: A noise-based landing fee system intended to provide strong incentives for carriers to convert their fleets to quieter aircraft is not practical and is vulnerable to legal challenges. A noise-based landing fee surcharge intended to raise revenue for noise mitigation activities is not considered necessary. The airport has other potential sources of revenue such as PFC's which can be used to provide funding for noise mitigation projects. Noise based landing fees will not receive additional consideration.

Capacity Limitations

Capacity limits have been used by some severely impacted airports to control cumulative noise exposure. This kind of restriction would impose a cap on the number of scheduled operations. This is only an imprecise way to control aircraft noise. For one thing, unscheduled operations would not be subject to the limit. In addition, the limit on scheduled operations actually provides no incentive for conversion to quieter aircraft. Rather, if passenger demand is increasing, it would encourage airlines to convert to larger aircraft, which often (but not always) tend to be noisier than smaller aircraft in the same Part 36 stage classification.

The implementation of capacity limitations would entail the allocation of operating slots among air carriers, an ongoing process which would likely require additional airport staff to deal solely with airline negotiations for operating positions. The system would have to provide some allowance for entry by new carriers to avoid being found to be an illegal restraint of trade.

A cap on operations would not necessarily provide significant noise benefits. The forecast noise contours presented in Chapter Three provide an example. A comparison of the noise contours for forecast 2004 conditions and 2015 conditions (Table 2G on page 2-16 of the Noise Exposure Maps document) shows only a small increase in the size of the 65 DNL noise contour from 2004 to 2015 but, a slight decrease in the 70 and 75 DNL contours. During that period, however, the number of annual aircraft operations is projected to increase from 667,965 to 773,000 (Table 2B on page 2-5 of the Noise Exposure Maps document).

Conclusion: Airport capacity limitations intended to control noise are too imprecise to guarantee effectiveness and are unlikely to achieve significant noise reductions. They can also limit air service to the community, interfering with the needs of the local economy. They can be difficult and expensive to administer. Since they inevitably would restrict access to the airport by Stage 3 aircraft, capacity limitations would be subject to Part 161 analysis and approval by the FAA. Airport capacity restrictions therefore, do not merit additional analysis.

Noise Budgets

In the late 1980s, noise budgets gained attention as a potential noise abatement tool. After the enactment of the Aviation Noise and Capacity Act (ANCA) of 1990, mandating the retirement of Stage 2 aircraft over 75,000 pounds, interest in noise budgets waned. Noise budgets are designed to limit airport noise and allocate noise among airport users. The intent is to encourage aircraft operators to convert to quieter aircraft or to shift operations to less noise-sensitive hours. Before ANCA, the intent was to encourage conversion to Stage 3 aircraft and to discourage the use of Stage 2 aircraft.

While noise budgets can be designed in many different ways, six basic steps are involved. First, the airport must set a target level of cumulative noise exposure, usually expressed in DNL, which it intends to achieve by a certain date. Second, it must determine how to express that overall noise level in a way that would permit allocation among airport users. Third, it must design the allocation system. Fourth is the design of a monitoring system to ensure that airport users are complying with the allocations. Fifth is the establishment of sanctions for carriers that fail to operate within their allocations. Sixth, the system should be fine-tuned based on actual experience. The only simple step in this process is the first, setting a goal. From that point, it becomes increasingly complex.

Different approaches can be used to define noise in a way which permits allocation. It is possible to use the DNL metric, or a variant, for this purpose. This has some advantages in that the FAA's Integrated Noise Model can be easily used to derive DNL levels attributable to the average daily operations of the various airport operators. The INM database can be used to establish a basis for noise allocations based on aircraft type. An alternative is to use the EPNL (effective perceived noise level) metric. This is the metric used to certify aircraft noise levels for compliance with F.A.R. Part 36. Noise levels of various aircraft expressed in EPNL are published in FAA Advisory Circulars 36-1E and 36-2C. EPNL values for the aircraft used by each operator on an average day could be summed to define the total noise attributable to the operator.

The third step, the design of the allocation system, is the most difficult and the least subject to fair and objective definition. The allocations can be handled in different ways. They could be auctioned, but without careful controls this could cause serious problems. It could give the financially stronger carriers the opportunity to buy extra noise allocations for purposes of speculation or restraint of competition. Another way to allocate the noise would be through a lottery. A drawback with both of these methods is that they would not recognize past operating histories. It is also important that any allocation system include provisions for the entry of new carriers in order to have any chance of being legally permissible.

An allocation system based on the recent operating histories of each airline would probably be the fairest approach, but it would not be problem-free. To be as fair as theoretically possible, the allocation should be based on each carrier's contribution to existing noise levels at the airport and its past performance in helping to reduce that noise. If the allocation system is based only on current noise contribution, the carriers that have made significant investments in converting their fleets will be penalized in comparison with those which have not. The noisier airline, for example, could conceivably be given a competitive advantage because, if they were willing to convert to quieter aircraft, they would be able to increase their number of flights while still reducing their overall noise output. Carriers can also argue that their corporate aircraft operating procedures result in less noise than the operating procedures of their competitors and that this should be recognized in the noise allocation system.

After establishing the initial allocation system, it would be necessary to develop a schedule of declining noise allocations to each carrier in order to reach the overall noise reduction goals of the program. Each carrier would have the flexibility to develop scheduling at any time of the day with any aircraft type, so long as its allocation is not exceeded. The use of quieter aircraft or operations during less noise-sensitive hours would result in increased flights per allocation.

The fourth step involves monitoring compliance with the noise allocations. Any monitoring system will require extensive bookkeeping. The simplest method would involve the monitoring of aircraft schedules. Total noise contribution by carrier would be summed for the reporting period based on the activity during the reporting period. Noise levels for each flight would be based on the certificated noise level, or the INM data base noise level, for each aircraft. While this system would require large amounts of staff time to administer, it would be relatively simple to computerize and would have the advantage of enabling carriers to plan their activities with a clear understanding of the noise implications of their decisions.

A theoretically more precise method of compliance monitoring, but a more expensive and complex method, would be to monitor actual aircraft noise levels. The Airport's permanent noise monitoring and flight tracking systems could be used for this purpose. Actual noise from each aircraft operation would be recorded for each operator. The advantage of this approach is that it would be based on actual experience. A significant disadvantage, however, is that it could be quite difficult for carriers to make predictions about the noise impact of their scheduling decisions. Many variables influence the noise occurring from any particular aircraft operation, including the weather, pilot technique, and air traffic control instructions.

The fifth step is to establish a system of fines or other sanctions to levy against carriers which fail to operate within their assigned noise allocations. To be effective, the sanctions should be severe enough to provide a strong incentive to cooperate with the program.

In an era where all aircraft weighing more than 75,000 pounds are Stage 3, it is difficult to imagine how a noise budget could promote significant noise reduction without reducing air service in the community. While some Stage 3 aircraft are louder than others, some carriers operate with fleets almost completely composed of among the quietest Stage 3 aircraft. Depending on the noise allocation and the reduction target assigned to such a carrier, they might be able to meet the target only by eliminating flights.

Conclusion: Noise budgets are complex methods of promoting airport noise reduction. They are particularly vulnerable to attack on grounds of discrimination and interference with interstate commerce. Noise budgets are extremely difficult to design in a way that will be seen as fair by all airport users and are likely to be quite expensive to develop. Negotiations on noise budget design and noise allocations are likely to be long and contentious and would require the assistance of noise consultants and attorneys. The costs of administering the system also would be substantial. The bookkeeping requirements are complex and additional administrative staff would definitely be required.

At Sky Harbor, a noise budget does not appear to be a practical option. The process would be long, expensive, and contentious. Its potential for delivering real and substantial improvements in the local airport noise environment is questionable and will not be discussed further.

Restrictions Based On Aircraft Noise Levels

Outright restrictions on the use of aircraft exceeding certain noise levels can reduce cumulative noise exposure at an airport. Aircraft producing noise above certain thresholds, as defined in F.A.R. Part 36, could be prohibited from operating at the airport at all or certain times of the day. A variation is to impose a non-addition rule, prohibiting the addition of new flights by aircraft exceeding the threshold level at all or certain times of the day. These restrictions would be subject to the special analysis procedures of F.A.R. Part 161. Any restrictions affecting Stage 3 aircraft would have to receive FAA approval.

Noise limits based on F.A.R. Part 36 certification levels have the virtue of being fixed national standards which are understood by all in the industry. They are average values, however, and do not consider variations in noise levels based on different methods of operating the aircraft. As an alternative, restrictions could be based on measured noise levels at the airport. This has the advantage of focusing on noise produced in a given situation and, in theory, gives aircraft operators increased flexibility to comply with the restrictions by designing special approach and departure procedures to minimize noise. It has the disadvantage of requiring extra administrative effort to design testing procedures, monitor tests, interpret monitoring data, and design the restrictions.

Whether threshold noise levels are based on F.A.R. Part 36 or measured results, care must be taken to ensure that the restriction does not fall with undue harshness on any one carrier. The feasibility of complying with the restriction given existing technologies and equipment also must be considered. If these things are ignored, the restriction could reduce the amount of air service in the community. It also would make the restriction subject to legal challenge and rejection by FAA as unjust discrimination and potentially burdensome to interstate commerce.

Since January 1, 2000, Sky Harbor has an air carrier fleet that is 100 percent Stage 3 compliant. Stage 2 business jets under 75,000 pounds are not subject to the Stage 2 phase-out law. This includes nearly all typical business jets. Restrictions of these aircraft would require an analysis based on F.A.R. Part 161.

Conclusion: Restrictions based on noise levels could be viewed as discriminatory and therefore be subject to litigation and rejection by the FAA. In addition, the requirements of a costly F.A.R. Part 161 Study would have to be met before any restriction on Stage 2 business jets under 75,000 pounds and Stage 3 air carrier aircraft could be implemented.

Touch-and-Go Restrictions

Restrictions on touch-and-go or multiple approach operations can be effective in reducing noise when those operations are extremely noisy, unusually frequent, or occur at very noise-sensitive times of the day. At many airports, touch-and-goes are associated with primary pilot training, although this type of operation is also done by licensed pilots practicing approaches.

Touch-and-go operations are already restricted at Sky Harbor due to high traffic volumes and congested airspace. In the event that civilian aircraft wish to perform these operations, they are required to receive prior permission from air traffic control. Pilots with aircraft based at Sky Harbor, including military, wishing to practice approach and departure maneuvers will often utilize another of the region's airports. In fact, all traffic operating at Sky Harbor is considered to be itinerant.

Conclusion: Training operations, including practice instrument approaches and touch-and-go operations are rarely if ever performed at Sky Harbor due to current operational and capacity restrictions. Additional restrictions on touch-and-go operations for noise abatement purpose would yield little benefit and do not merit further discussion.

Engine Run-up Restrictions

Engine run-ups are a necessary and critical part of aircraft operation and maintenance. Run-ups are required for various aircraft maintenance operations. Aircraft maintenance is often done at night when aircraft are not typically needed for service and when run-up noise can be especially disturbing. Of course, nighttime operators, such as air cargo companies and freight forwarders, must typically schedule maintenance during the day. Engine run-ups are often more annoying than aircraft overflight noise because they are more unpredictable, have a more sudden onset rate, and usually last longer. In addition, because run-ups occur on the ground, they tend to be more sensitive than overflights to atmospheric effects. Temperature inversions, for example, can cause noise on the ground to travel further. For all these reasons, run-up noise can be more annoying than a cursory analysis of A-weighted noise levels might indicate.

Engine maintenance run-ups may be restricted by airport operators. These restrictions, when they apply to run-ups as a separate function from the takeoff and landing of the aircraft, do not appear to need special FAA review or approval under F.A.R. Part 161. (See Airport Noise Report, Vol.6, No. 18, September 26, 1994, p. 142.) They are, nevertheless, subject to other legal and constitutional limitations on unjust discrimination, undue interference with interstate commerce, or conflict with FAA grant assurances. As previously discussed, noise due to aircraft maintenance run-up operations could be mitigated through the installation of a run-up enclosure such as a hush-house. If constructed, it will be essential to establish policies for the use of that facility.

Conclusion: Aircraft operational and maintenance run-ups are an integral part of operations at Sky Harbor Airport. Restrictions on these procedures would greatly hinder airport operators, safety, and would likely facilitate litigation. The mitigation of run-up noise would best be addressed through the utilization of a run-up enclosure such as a "hush-house" and the establishment of policies governing run-up procedures.

SELECTION OF MEASURES FOR DETAILED EVALUATION

Preliminary screening of the complete list of noise abatement techniques indicated that some measures may be potentially effective in the Sky Harbor area. These are evaluated in detail in this section.

EVALUATION CRITERIA

Four operational alternatives have been selected for detailed analysis in addition to the possible effects of a run-up enclosure. The noise analysis for each alternative was based on the 2004 baseline analysis presented in Chapter Three, "Aviation Noise Impacts." The 2004 baseline was chosen to offer a common base of comparison for all alternatives. This time frame allows time for FAA review and approval of the final Noise Compatibility Program and any environmental assessments which may be required prior to implementation of the procedures. The alternatives are evaluated using the following criteria:

Noise Reduction Effects. The purpose of this evaluation is to reduce aircraft noise on people. A reduction in noise impacts, if any, over noise-sensitive areas are assessed.

Operational Issues. The effects of the alternative on the operation of aircraft, the airport, and local airspace are considered. Potential airspace conflicts and air traffic control (ATC) constraints are discussed, and the means by which they could be resolved are evaluated.

Potential impacts on operating safety are also addressed. FAA regulations and procedures will not permit aircraft operation and pilot workload to be handled other than in a safe manner, but within this limitation, differences in safety margins occur. A significant reduction in safety margins will render an abatement procedure unacceptable.

Air Service Factors. These factors relate to a decline in the quality of air transportation service which would be expected from adoption of an abatement measure. Declines could possibly result from lowered capacity or rescheduling requirements.

Costs. Both the cost of operating aircraft to comply with the noise abatement measure and the cost of construction or operation of noise abatement facilities are considered. Estimated capital costs of implementing the noise abatement alternative, where relevant, are also presented.

Environmental Issues. Environmental factors related to noise are of primary concern in an F.A.R. Part 150 Update analysis. Procedures that involve a change in air traffic control procedures or increase noise over residential areas may require a separate environmental assessment.

Implementation Factors. The agency responsible for implementing the noise abatement procedure is identified. Any difficulties in implementing the procedure are discussed. This is based on the extent to which it departs from accepted standard operating procedures; the need for changes in FAA procedures, regulations, or criteria; the need for changes in airport administrative procedures; and the likelihood of community acceptance.

Upon completion of a review of each measure based on the above criteria, an assessment of the feasibility of each measure and the strategies required for its implementation are presented. At the end of the section a summary comparison of the noise impacts of each alternative is presented. Recommendations as to alternatives which deserve additional consideration are presented.

ALTERNATIVE 1 - EVALUATE RUNWAY USE FOR NOISE ABATEMENT

Goals

This alternative seeks to reduce aircraft overflights of noise-sensitive areas east and west of the airport. By utilizing runways aligned with noise compatible corridors, reductions in noise impacts created by aircraft arrivals and departures could be achieved.

Procedure

When Sky Harbor Airport is operating in an eastern flow (landing aircraft from the west and departing to the east) arriving aircraft would use Runways 8L and 7. Departing aircraft would use Runways 8L/R. During times of west flow operations the reciprocal of east flow operations would be implemented. Arriving aircraft would use Runways 26L/R while departing aircraft would use Runways 26R and 25.

For noise modeling purposes, the 2004 baseline input was modified to reflect the runway use percentages listed in **Table 4D**.

TABLE 4D
Average Annual Runway Use By Aircraft Class
Alternative Runway Use Program

Runway	% Daytime			% Nighttime		
	Commercial	Commuter	Gen. Av.	Commercial	Commuter	Gen. Av.
Departure Runway Use (West Flow)						
8R	0%	0%	0%	0%	0%	0%
8L	0%	0%	0%	0%	0%	0%
26R	50%	45%	35%	50%	45%	35%
26L	40%	35%	20%	30%	25%	20%
07	0%	0%	0%	0%	0%	0%
25	10%	20%	45%	20%	30%	45%
Total	100%	100%	100%	100%	100%	100%
Arrival Runway Use (West Flow)						
8R	0%	0%	0%	0%	0%	0%
8L	0%	0%	0%	0%	0%	0%
26R	45%	50%	40%	45%	45%	45%
26L	45%	25%	40%	45%	45%	45%
07	0%	0%	0%	0%	0%	0%
25	10%	25%	20%	10%	10%	10%
Total	100%	100%	100%	100%	100%	100%
Departure Runway Use (East Flow)						
8R	45%	40%	30%	45%	40%	30%
8L	45%	40%	20%	45%	40%	20%
26R	0%	0%	0%	0%	0%	0%
26L	0%	0%	0%	0%	0%	0%
07	10%	20%	50%	10%	20%	50%
25	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%
Arrival Runway Use (East Flow)						
8R	25%	25%	15%	15%	15%	15%
8L	45%	45%	40%	45%	45%	40%
26R	0%	0%	0%	0%	0%	0%
26L	0%	0%	0%	0%	0%	0%
07	30%	30%	45%	40%	40%	45%
25	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%

Noise Effects

The noise contours presented in **Exhibit 4H** illustrate the effects of this procedure. The shape of the alternative noise contours is similar to the 2004 baseline contours except for increased size of the contours along Interstate 17 west of the airport and long the Salt River east of the airport. Small decreases in the contours occur to the west of the airport off Runway 8L-26R and southeast over Tempe.

Table 4E presents the population impacts for this alternative. This alternative impacts 690 fewer people than the baseline condition. Only a few homes on the north side are brought into the 65 DNL contour while many on the south side are removed from the 65 DNL. The level-weighted population (LWP), an estimate of the number of people actually annoyed by noise, decreases from 8,377 to 8,098 with the procedure.

TABLE 4E
Population Impacted By Noise
Alternative 1 - Runway Use For Noise Abatement

DNL Range	2004 Baseline	Alternative 1	Net Change
Existing Population[1]			
Phoenix			
65-70	4,455	4,520	+ 65
70-75	0	3	+ 3
75+	0	0	0
Tempe			
65-70	3,329	2,654	- 675
70-75	0	0	0
75+	0	0	0
Subtotal	7,784	7,177	- 607
Potential Population[2]			
Phoenix			
65-70	1,188	1,303	+ 115
70-75	0	0	0
75+	0	0	0
Tempe			
65-70	13,106	12,981	- 125
70-75	117	44	- 73
75+	0	0	0
Subtotal	14,411	14,328	- 83
Total	22,195	21,505	- 690
LWP	8,377	8,098	- 279

Notes: 1. Existing population based on 1999 housing counts.
2. Based on additional potential new dwelling units in 2004 reflecting current land use plans and zoning.

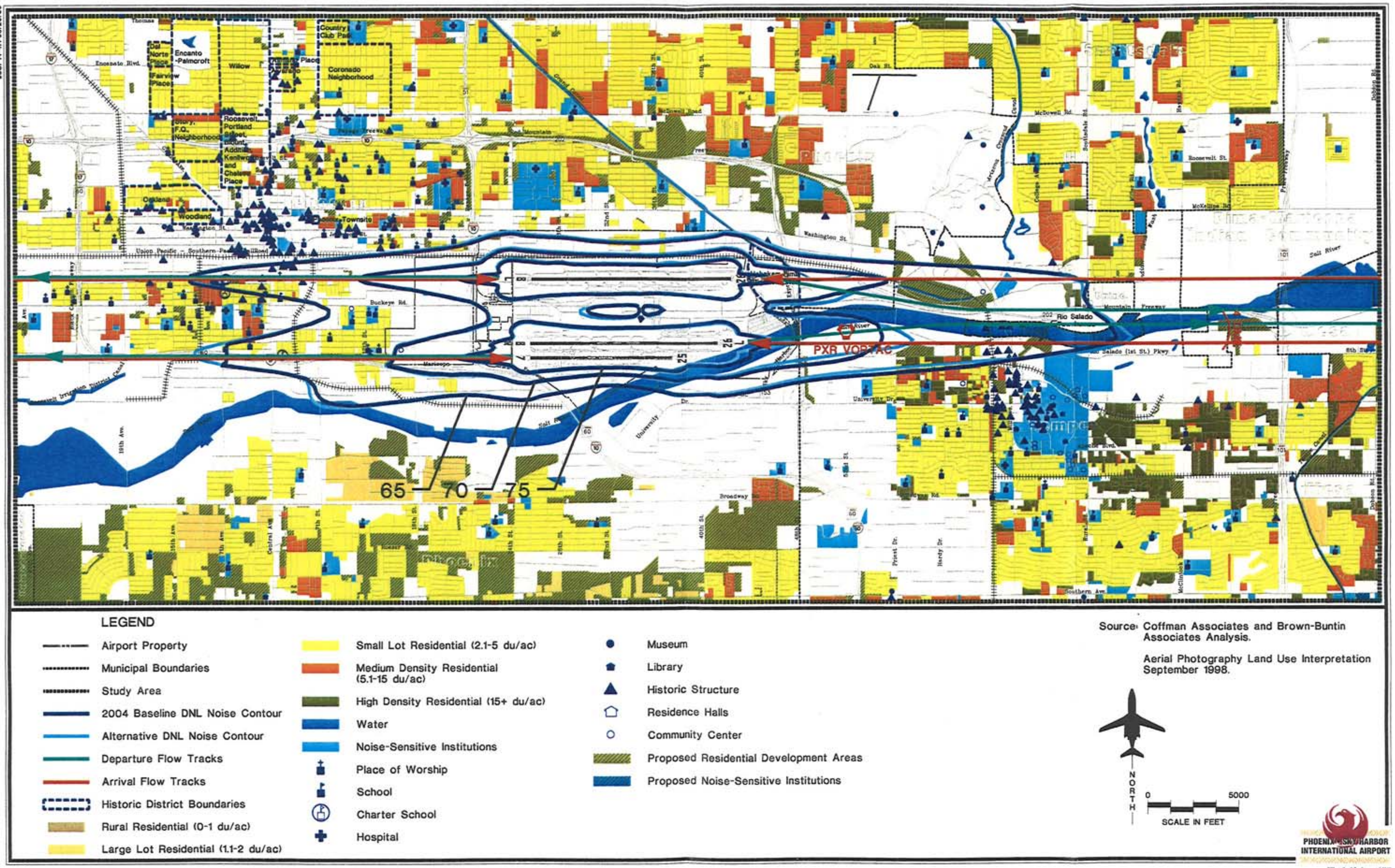


Exhibit 4H
ALTERNATIVE 1 - EVALUATION OF RUNWAY USE FOR NOISE ABATEMENT

A breakdown of the increase or decrease in population from the 2004 baseline and Alternative 1 noise contours is presented in **Table 4F**. This reveals that 607 people have less noise during the existing land use conditions with the use of this alternative. Given the potential for future development, both the 2004 baseline and Alternative 1 noise contours would impact additional individuals (see **Table 4E**). The implementation of Alternative 1 would, however, impact 83 fewer individuals than the 2004 baseline operations. Individuals were removed from the 65-70 DNL contour in both the existing (610) and ultimate (10) land use conditions. Three individuals were added to the 70-75 DNL contours during existing land use conditions, 73 were removed from the ultimate land use scenario. Neither the existing or ultimate land use conditions contain individuals within the 75 DNL contour. A total of 690 individuals would receive reduced noise impacts with the implementation of this alternative versus 2004 baseline operations.

TABLE 4F
Population Increase or Decrease with Alternative 1

2004 vs. Alt. 1	65-70	70-75	75+	Net Impact
Existing Land Use	-610	3	0	-607
Ultimate Land Use	-10	-73	0	-83
Totals	-620	-70	0	-690

Operational Issues

Runways 8L-26R and 8R-26L are the primary departure runways because of their longer length 11,000 and 10,300 feet respectively (Runway 7-25 will only be 7,800 feet long). In a west flow, increased use of the shorter Runway 25 for departures may be potentially unsafe for large commercial aircraft due to reduced climb performance during warm/hot weather conditions. The *Sky Harbor International Airport 1993 Environmental Impact Statement (EIS)* declares that no jet aircraft will be allowed to use Runway 7 for departures until a "one DME departure" procedure is operational. In an east flow, arrivals are moved to Runways 8L and 7 and away from Runway 8R which currently has the only Instrument Landing System (ILS) in this direction. However, Runway 7 is planned to have an ILS system.

Air Service Factors

No negative effect is anticipated.

Costs

A slight increase in taxi and flight times may occur as aircraft would occasionally be directed to the southern most runway. There would be no other costs to the airport, FAA, or other airport users.

Environmental Issues

The current policy of the FAA is to require an environmental assessment (EA) on most noise abatement procedures, particularly those that expose residential areas to new or increased aircraft noise. Consequently, an EA probably would be required to change runway use policies.

Implementation

This procedure would primarily be implemented by ATC. A Tower Order would describe the preferential use program and the runway assignments to be issued by controllers. Information regarding the procedure also could be published in a Notice to Airmen (NOTAM). In addition, the allowance of a significant number of any jet aircraft departing Runway 7 could require an amendment to the Airport's 1993 EIS.

Conclusion

This procedure is moderately effective in reducing the population exposed to noise. Residential areas, however, that are not currently within the 65 DNL contours west of the airport along the Interstate 17 would be brought within the 65 DNL contour if this nighttime preferential runway use program were used. These impacts would have to mitigated in order to implement this alternative. This could also aggravate noise complaints in these areas.

ALTERNATIVE 2 - TEST EFFECTIVENESS OF 4DME PROCEDURE FOR NOISE ABATEMENT

Goals

The 4 DME procedure is designed to concentrate aircraft departure activity over the Salt River east of the airport. However with the completion of the Rio Salado Town Lake on the Salt River, residential development pressure as well as increased recreational activity has increased in this area. In addition, the Federally mandated use of quieter Stage 3 aircraft that have better climb performance make it necessary to verify the continued noise abatement benefits of the 4 DME procedure.

Procedure

Jet aircraft departing Runways 8L, 8R, and 7 would depart using a 15-degree splay to the east. Aircraft departing on Runway 8L would turn 7.5-degrees north of the extended runway centerline and aircraft departing Runways 8R and 7 would turn 7.5 degrees south of their respective extended runway centerlines. The aircraft would continue to climb on this heading until being released to course headings. The procedure would attempt to disperse aircraft operations to the east. It is suggested that this procedure apply only to jets so that they can be separated from the slower aircraft, thus avoiding potential delays.

For noise modeling purposes, the 2004 baseline input was modified to reflect the new turns for jet traffic departing from each runway. All traffic assignments and runway use percentages remained unchanged.

Noise Effects

The noise contours presented in **Exhibit 4J** illustrate the effects of this procedure. The shape of the alternative noise contours is very different to the 2004 baseline contours east of the airport reflecting the traffic turning to the northeast and southeast. The 65 DNL noise contour to the east forms two distinct lobes instead of one. The 70 DNL noise contours to the east are narrower and bent slightly to the northeast off Runway 8L-26R and southeast off of Runways 8R-26L and 7-25. Increased noise and overflights would be experienced by Tempe to the southeast and northeast of the airport.

Table 4G presents the population impacts for this alternative. This alternative impacts 2,939 additional people than the baseline condition. Only a few homes on the north side are brought into the 65 and 70 DNL contours along the railroad corridor. The population impacted by noise between 70-75 DNL increases slightly from 117 up to 225. The 75+ and 65-70 contours show a net increase in population impacts. The level-weighted population (LWP), an estimate of the number of people actually annoyed by noise, increases to 9,511 from 8,377 with the procedure.

A breakdown of the increase or decrease in population from the 2004 baseline and Alternative 2 noise contours is presented in **Table 4H**. This reveals that 4,763 people have more noise during the existing land use conditions with the use of this alternative. Given the potential for future development, both the 2004 baseline and Alternative 2 noise contours would impact additional individuals (see **Table 4G**). The implementation of Alternative 2 would, however, impact 1,824 fewer individuals than the 2004 baseline operations. Individuals were added to the 65-70 DNL contour in the existing (4,763) and reduced during ultimate (1,932) land use conditions. While no individuals were added or removed from the 70-75 DNL contours during existing land use conditions, 108 were added to the ultimate land use scenario. Neither the existing or ultimate land use conditions contain individuals within the 75 DNL contour. A total of 2939 individuals would receive additional noise impacts with the implementation of this alternative versus 2004 baseline operations.

Operational Issues

This procedure would increase ATC flexibility and airport capacity by allowing the fanning of the departures to the east. Successive departures would not be following the same track, reducing takeoff sequencing to maintain adequate separation.

Air Service Factors

No negative effect is anticipated.

Costs

The primary cost impact of this procedure would be a reduction in operational expenditures due to decreased departure delays currently associated with the 4 DME procedure. These would likely be sizeable given the large number of departures to the east.

This procedure would bring noise sensitive land uses into the 65 DNL noise contours that were not previously exposure to aircraft noise above 65 DNL. Therefore an EA would have to be prepared and impacts would have to be mitigated. This would also be sizeable given the number of homes added to the noise contours.

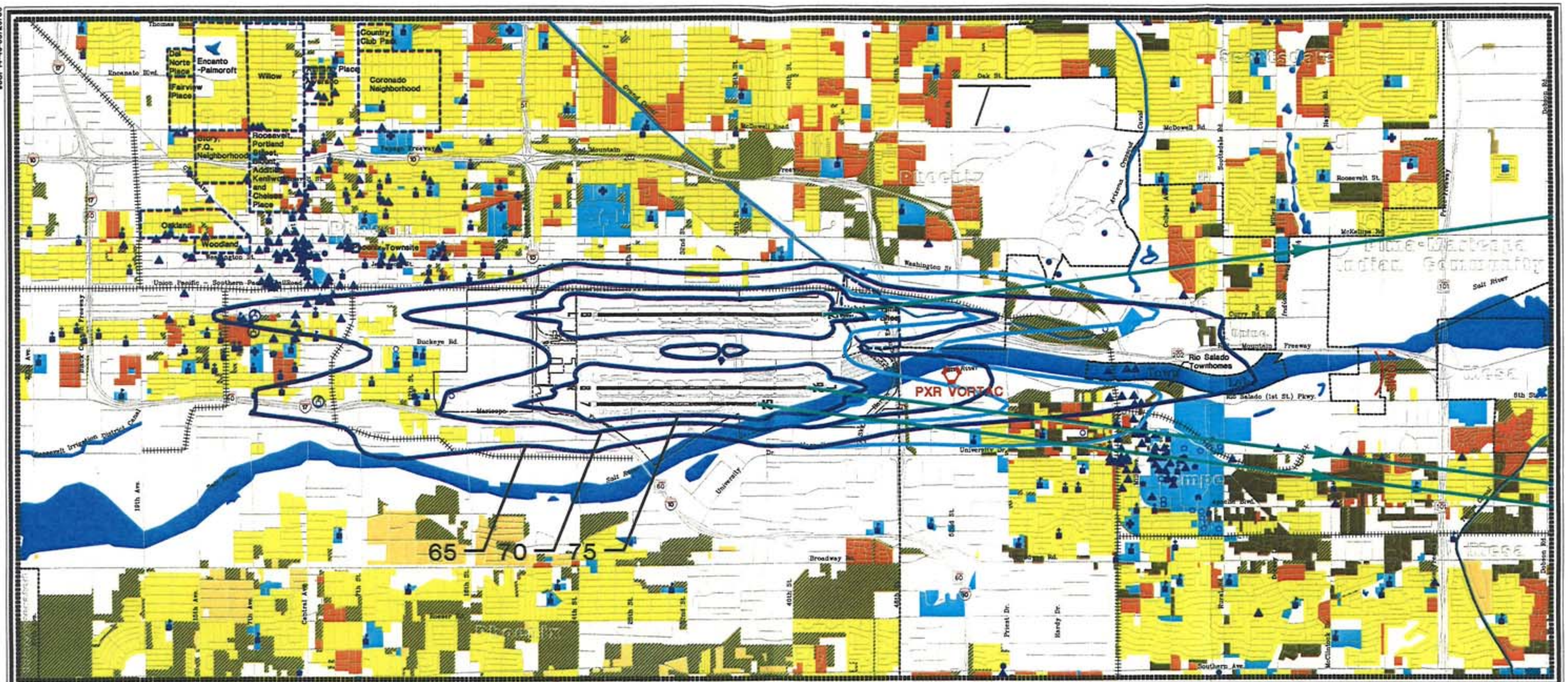
Environmental Issues

As previously mentioned, the current policy of the FAA is to require an EA on most noise abatement procedures, particularly those that expose residential areas to new or increased aircraft noise. Consequently, an EA probably would be required in this case.

TABLE 4G
Population Impacted By Noise
Alternative 2 - Runway Use For Noise Abatement

DNL Range	2004 Baseline	Alternative 2	Net Change
Existing Population[1]			
Phoenix			
65-70	4,455	4,458	+ 3
70-75	0	0	0
75+	0	0	0
Tempe			
65-70	3,329	8,089	+ 4,760
70-75	0	0	0
75+	0	0	0
Subtotal	7,784	12,547	+ 4,763
Potential Population[2]			
Phoenix			
65-70	1,188	1,708	+ 520
70-75	0	0	0
75+	0	0	0
Tempe			
65-70	13,106	10,654	- 2,452
70-75	117	225	+ 108
75+	0	0	0
Subtotal	14,411	12,587	- 1,824
Total	22,195	25,134	+ 2,939
LWP	8,377	9,511	+ 1,134

Notes: 1. Existing population based on 1999 housing counts.
2. Based on additional potential new dwelling units in 2004 reflecting current land use plans and zoning.



LEGEND

- Airport Property
- Municipal Boundaries
- Study Area
- 2004 Baseline DNL Noise Contour
- Alternative DNL Noise Contour
- Consolidated Future Departure Tracks
- Historic District Boundaries
- Rural Residential (0-1 du/ac)
- Large Lot Residential (1.1-2 du/ac)
- Small Lot Residential (2.1-5 du/ac)
- Medium Density Residential (5.1-15 du/ac)
- High Density Residential (15+ du/ac)
- Water
- Noise-Sensitive Institutions
- Place of Worship
- School
- Charter School
- Hospital
- Museum
- Library
- Historic Structure
- Residence Halls
- Community Center
- Proposed Residential Development Areas
- Proposed Noise-Sensitive Institutions

Source: Coffman Associates and Brown-Buntin Associates Analysis.

Aerial Photography Land Use Interpretation September 1998.

NORTH

0 5000 SCALE IN FEET

PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Exhibit 4J
ALTERNATIVE 2 - EFFECTIVENESS OF 4DME PROCEDURE FOR NOISE ABATEMENT

TABLE 4H
Population Increase or Decrease with Alternative 2

2004 vs. Alt. 2	65-70	70-75	75+	Net Impact
Existing Land Use	+4,763	0	0	+4,763
Ultimate Land Use	-1,932	+108	0	-1,824
Totals	+2,831	+108	0	+2,939

Implementation

As with Alternative 1, this procedure would primarily be implemented by ATC. A Tower Order would define instructions to be issued by controllers. In addition, the inter-governmental agreement between Phoenix and Tempe would have to be amended.

Conclusion

The use of the 4 DME procedure significantly reduces the airport's operational efficiencies and capacity. However, this procedure continues to be an effective noise abatement procedure and should be continued.

ALTERNATIVE 3 - ANALYZE A DEPARTURE TURN FOR PROPELLER-POWERED AIRCRAFT DEPARTING RUNWAY 7 TO TURN TO A 120-DEGREE HEADING UPON REACHING THE RUNWAY END

Goals

This alternative seeks to reduce the number of aircraft overflights east of the airport by redirecting departing propeller powered aircraft from Runway 7 over a noise compatible corridor southeast of the airport. This may also increase operational efficiency.

Procedure

Propeller aircraft departing Phoenix Sky Harbor International Airport on Runway 7 would turn right at the runway end to approximately a 120-degree heading. The aircraft would continue to climb on this heading until being released to course headings. The procedure would concentrate traffic over a commercial/industrial corridor and Interstate 10 southeast of the airport. It is suggested that this procedure apply only to propeller-powered aircraft because of the early turn that is required for this procedure.

For noise modeling purposes the 2004 baseline input was modified to reflect the 120 degree turn for all propeller aircraft departing Runway 7.

Noise Effects

The noise contours presented in **Exhibit 4K** illustrate the effects of this procedure. The shape of the alternative noise contours is very similar to the 2004 baseline contours except for increased size of the contours to southeast of the airport. A very small decrease in the contours occurs to the east of the airport off of Runway 8R-26L.

Table 4J presents the population impacts for this alternative. This alternative impacts 54 fewer people than the baseline condition. The 65-70 DNL and 70-75 DNL contours both show a net decrease in population impacts. No persons are impacted by aircraft noise above 75 DNL in either the baseline or ultimate contours. The level-weighted population (LWP), an estimate of the number of people actually annoyed by noise, decreases slightly from 8,377 to 8,371 with the procedure.

TABLE 4J
Population Impacted By Noise
Alternative 3 - Runway Use For Noise Abatement

DNL Range	2004 Baseline	Alternative 3	Net Change
Existing Population[1]			
Phoenix			
65-70	4,455	4,458	+ 3
70-75	0	0	0
75+	0	0	0
Tempe			
65-70	3,329	3,319	- 10
70-75	0	0	0
75+	0	0	0
Subtotal	7,784	7,777	- 7
Potential Population[2]			
Phoenix			
65-70	1,188	1,186	- 2
70-75	0	0	0
75+	0	0	0
Tempe			
65-70	13,106	13,104	- 2
70-75	117	74	- 43
75+	0	0	0
Subtotal	14,411	14,364	- 47
Total	22,195	22,141	- 54
LWP	8,377	8,371	- 6

Notes: 1. Existing population based on 1999 housing counts.
2. Based on additional potential new dwelling units in 2004 reflecting current land use plans and zoning.

A breakdown of the increase or decrease in population from the 2004 baseline and Alternative 3 noise contours is presented in **Table 4K**. This reveals that 7 people have less noise during the existing land use conditions with the use of this alternative. Given the potential for future development, both

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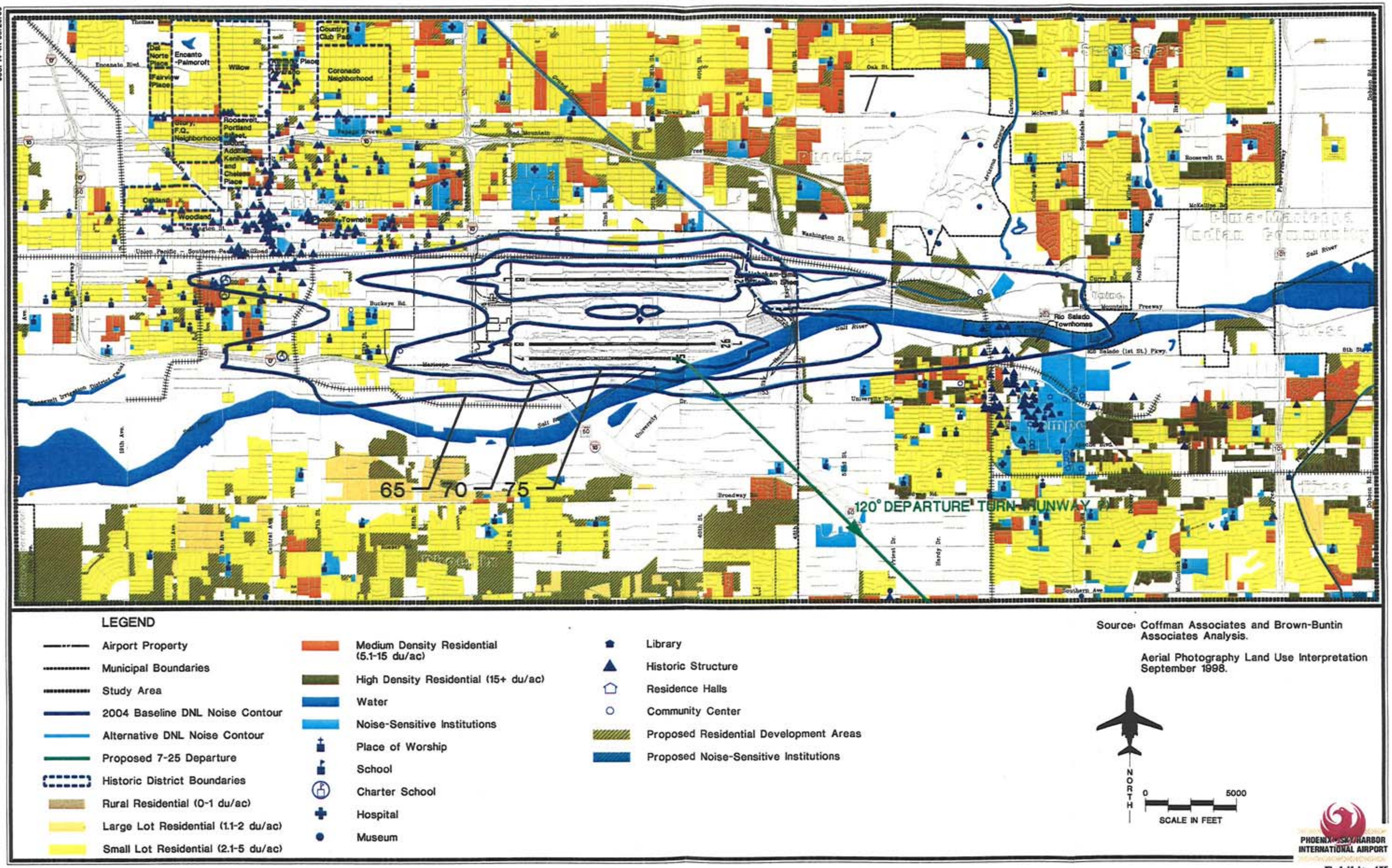

Source: Coffman Associates and Brown-Buntin Associates Analysis.

Aerial Photography Land Use Interpretation September 1998.

PHOENIX SKY HARBOR INTERNATIONAL AIRPORT

Exhibit 4K

ALTERNATIVE 3 - DEPARTURE TURN FOR PROPELLER POWERED AIRCRAFT DEPARTING RUNWAY 7 TO A 120-DEGREE HEADING the 2004 baseline and Alternative 3 noise contours would impact additional individuals (see **Table 4J**). The implementation of Alternative 3 would, however, impact 47 fewer individuals than the 2004 baseline operations. Individuals were removed from the 65-70 DNL contour in both the existing (7) and ultimate (4) land use conditions. While no individuals were added or removed from the 70-75 DNL contours during existing land use conditions, 43 were removed from the ultimate land use scenario. Neither the existing or ultimate land use conditions contain individuals within the 75 DNL contour. A total of 54 individuals would receive reduced noise impacts with the implementation of this alternative versus 2004 baseline operations.

TABLE 4K
Population Increase or Decrease with Alternative 3

2004 vs. Alt. 3	65-70	70-75	75+	Net Impact
Existing Land Use	-7	0	0	-7
Ultimate Land Use	-4	-43	0	-47
Totals	-11	-43	0	-54

Operational Issues

This procedure would increase ATC flexibility and airport capacity by turning the slower propeller aircraft early, thus reducing the amount of time turbojet aircraft have wait before departing after propeller aircraft.

Air Service Factors

No negative effect is anticipated.

Costs

The only operational costs of this procedure might be slightly decreased departure delays due to departure separation requirements. These likely would not be sizeable since some propeller aircraft are currently being turned to the southeast.

Environmental Issues

No negative environmental impacts are anticipated.

Implementation

This procedure would primarily be implemented by ATC. A Tower Order would define instructions to be issued by controllers. Information regarding the procedure also could be published in a Notice to Airmen (NOTAM).

Conclusion

This procedure is moderately effective in reducing both the existing population exposed to noise. The concern with this procedure is the exposure of new residential areas to noise above 65 DNL.

ALTERNATIVE 4 - TEST EFFECTIVENESS OF A STRAIGHT-IN APPROACH VERSUS A "SIDE-STEP" TO RUNWAY 25

Goals

This alternative seeks to evaluate the noise impacts of a straight-in approach to Runway 25 compared to a "side-step" approach. The origin of the "side-step" approach was to keep aircraft on final approach for landing on Runway 25 north of the Arizona State University (ASU) campus. A straight-in approach would decrease aircraft overflights of the Rio Salado Town Lake development area and increase airport operating efficiency.

Procedure

Aircraft noise was modeled using a straight-in approach to Runway 25 versus a currently planned "side-step" approach. An item in a 1994 Inter Governmental Agreement (IGA) between the City of Phoenix and the City of Tempe established a "side-step" approach procedure for aircraft on final approach to Runway 25. This agreement consists of a requirement that aircraft on approach to Runway 25 would maintain an alignment with Runway 26L until reaching a point approximately three miles east of the runway (Sun Devil Stadium and Mill Avenue) followed by a turn to align with Runway 25 (approximately 800 feet south of the Runway 26L final approach course). The use of this "side-step" approach to Runway 25 is also supported in the Airport's 1993 EIS. Upon approach, the decision to execute a "side-step" approach versus a straight-in approach would ultimately be at the pilot's discretion.

The 2004 baseline noise contours were created utilizing the "side-step" approach to Runway 25. For noise modeling purposes reflecting this alternative, the 2004 baseline noise contours were modified to reflect a straight-in approach to Runway 25. The straight-in Runway 25 use percentages remain the same as in the 2004 baseline condition.

Noise Effects

The noise contours presented in **Exhibit 4L** illustrate the effects of a straight-in approach compared with the "side-step" approach procedure. Since this alternative focuses on the alteration of an approach procedure from the east, the alternative noise contours west of the airport are identical to the baseline contours. East of the airport, only the 65 DNL contour was affected by the proposed alternative straight-in approach. The shape of the alternative 65 DNL noise contour is approximately 1,500 feet shorter than the 2004 65 DNL baseline contour. The alternative contour does bow out slightly south of the baseline contour along the north edge of the ASU campus while the baseline contour concentrates aircraft noise along the Salt River corridor.

Table 4L presents the population impacts for this alternative. This alternative impacts 133 additional people than the baseline condition. A majority of these people are added to the 65-70 DNL contour South of the Salt River within the City of Tempe. The level-weighted population (LWP), an estimate of the number of people actually annoyed by noise, increases from 8,377 to 8,426 with the procedure.

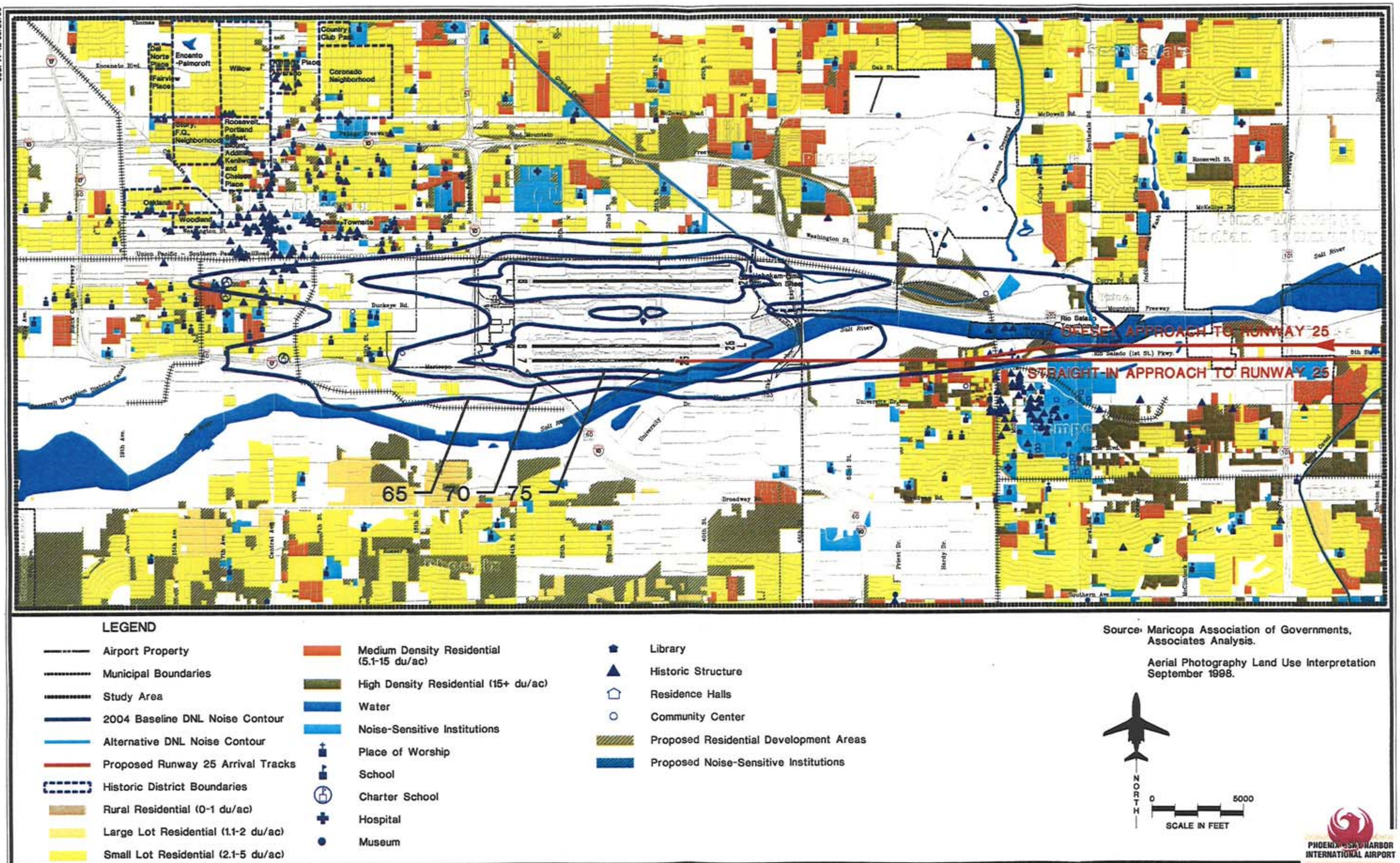

Exhibit 4L
ALTERNATIVE 4 - EVALUATION OF A "STRAIGHT-IN" APPROACH VERSUS A "SIDE-STEP" APPROACH TO RUNWAY 25

TABLE 4L
Population Impacted By Noise
Alternative 4 - Runway Use For Noise Abatement

DNL Range	2004 Baseline	Alternative 4	Net Change
Existing Population[1]			
Phoenix			
65-70	4,455	4,458	+ 3
70-75	0	0	0
75+	0	0	0
Tempe			
65-70	3,329	3,450	+ 121
70-75	0	0	0
75+	0	0	0
Subtotal	7,784	7,908	+124
Potential Population[2]			
Phoenix			
65-70	1,188	1,187	- 1
70-75	0	0	0
75+	0	0	0
Tempe			
65-70	13,106	13,116	+ 10
70-75	117	117	0
75+	0	0	0
Subtotal	14,411	14,420	+9
Total	22,195	22,328	+133
LWP	8,377	8,426	+49

Notes: 1. Existing population based on 1999 housing counts.
2. Based on additional potential new dwelling units in 2004 reflecting current land use plans and zoning.

A breakdown of the increase or decrease in population from the 2004 baseline and Alternative 4 noise contours is presented in **Table 4M**. This reveals that 124 people have more noise during the existing land use conditions with the use of this alternative. Given the potential for future development, both the 2004 baseline and Alternative 4 noise contours would impact additional individuals (see **Table 4L**). The implementation of Alternative 4 would impact 9 additional individuals than the 2004 baseline operations. Individuals were added to the 65-70 DNL contour in both the existing (124) and ultimate (9) land use conditions. No individuals were added or removed above 70 DNL during either the existing or ultimate land use scenarios. A total of 133 individuals would receive additional noise impacts with the implementation of this alternative versus 2004 baseline operations.

TABLE 4M
Population Increase or Decrease with Alternative 4

2004 vs. Alt. 4	65-70	70-75	75+	Net Impact
Existing Land Use	+124	0	0	+124
Ultimate Land Use	+9	0	0	+9
Totals	+133	0	0	+133

Operational Issues

The use of a straight-in approach to Runway 25 would benefit airport capacity limitations by not restricting departures on Runway 26L until approaching aircraft have commenced a "side-step" from Runway 26L to Runway 25. During times of IMC, approaches to Runway 25 would follow a straight-in approach along that runway's ILS.

Air Service Factors

No negative effect is anticipated.

Costs

There are no operational cost associated with the straight-in procedure.

Environmental Issues

The current policy of the FAA is to require an environmental assessment (EA) on most noise abatement procedures, particularly those that expose residential areas to new or increase aircraft noise. Consequently, an EA would probably be required in this case. In addition, the use of a straight-in approach to Runway 25 would contradict recommendations made in the Airport's 1993 EIS.

Implementation

Prior to an adoption of a straight-in approach to Runway 25 as the standard approach to this runway, revisions of the 1994 IGA between the cities of Phoenix and Tempe, and the Airport's 1993 EIS, would be required. This approach procedure would primarily be implemented by ATC. A Tower Order would define instructions to be issued by controllers. Information regarding the procedure also could be published in a Notice to Airmen (NOTAM).

Conclusion

A straight-in approach to Runway 25 would create increased aircraft overflights and noise impacts for noise sensitive areas south of the Salt River, including the ASU campus, when compared to a "side-step" approach. The effects of the planned "side-step" approach appears to be an effective means for concentrating aircraft noise along the Salt River corridor.

ADDITIONAL NOISE ABATEMENT CONSIDERATIONS

ENGINE RUN-UP NOISE

America West and Southwest Airlines, both dominate air-carriers at Phoenix, operate large aircraft maintenance facilities at Sky Harbor International Airport. Following maintenance, engine run-ups are done as a safety precaution to test the aircraft. Both operators perform maintenance run-ups on large turbojet aircraft.

The Integrated Noise Model (INM) version 5.2a was used for this analysis of engine maintenance run-up noise. Single event noise patterns (SEL noise contours) were prepared for the loudest and most common aircraft used by these operators - the hush-kitted B737 (INM designation N177). The noise contours were modeled with this aircraft using a one minute warm-up at 50-percent power followed by a 30 second full power run-up concluded by another one minute 50-percent power engine cool-down. The INM does not account for noise attenuation provided by structures when calculating noise exposure. Therefore the noise exposure contours represent a worse case picture of the run-up noise.

Run-up noise is different from overflight noise in some important respects. Because the noise occurs on the ground, the effects of attenuation, reflection, and diffraction as the noise travels across the ground can vary greatly from place to place. In addition, atmospheric effects can cause significant variation in sound levels. Temperature inversions, for example, can cause noise on the ground to travel great distances.

From the perspective of an airport area resident, run-up noise can be especially disturbing. It differs significantly from aircraft overflight noise. While overflight noise has a particular and predictable pattern and duration, run-up noise does not. The duration of run-ups can vary greatly, depending on the specific reason for the run-up and the difficulty in diagnosing a problem or completing required tests. This lack of a predictable pattern is perhaps the most important thing contributing to reports of annoyance about maintenance run-ups. Another problem that can occur with run-ups by propeller aircraft is the propagation of a penetrating tone, almost a pure tone, over long distances. Finally, the low frequency component of run-up noise can also travel great distances, create structural vibrations, and is not well attenuated by obstacles.

An analysis was conducted for three locations on the airfield, the first at the eastern terminus of taxiway C outside of the America West Airlines maintenance facility on the northeastern part of the airport. The second run-up location was on the tarmac outside the Southwest Airlines maintenance facility east of Taxiway R. The third run-up location was on the planned cargo apron at the southernmost part of the airport south of Taxiway G.

Exhibit 4M shows the noise exposure patterns associated with aircraft at each run-up area. The contour in *green* represents the B737 aircraft at the America West Airlines location, the contour in *magenta* represents the B737 aircraft at the Southwest Airlines location, and the contour in *blue* represents the B737 aircraft at the planned cargo apron. The contours represent L_{max} decibel levels 65 dBA. (L_{max} represents the peak noise level of the event -- the noise level that would actually be heard by the human ear). Given exterior to interior sound attenuation of 20 to 25 dBA, typical homes with the windows closed, 65 dBA translates into an interior noise level of about 40 to 45 dBA. These levels generally represent the lower end of the sleep disturbance spectrum.

Table 4N presents the population impacted by the 65 dBA L_{max} contours at these sites during the baseline and ultimate land use development periods. At the America West Airlines maintenance facility, B737 run-up operations impact 70 people within the 65 dBA L_{max} contour during the baseline land use conditions. Given the potential for future development, a total of 1,904 people could be affected within the 65 dBA L_{max} contour. Run-up noise impacts at the Southwest Airlines facility impacts fewer individuals in both the baseline and ultimate conditions than the America West site. During the baseline conditions no persons are impacted within the 65 dBA L_{max} contour. This increases to 743 individuals during the ultimate conditions. Run-up operations performed at the planned cargo apron located in the southern portion of the airport impacts the fewest people of the three potential run-up locations. During the baseline land use conditions, no individuals are affected by run-up noise within the 65 dBA L_{max} contour. During the ultimate land use conditions, 568 individuals could potentially be affected by run-up noise within the 65 dBA L_{max} contour.

TABLE 4N
Population Exposed to Run-up Noise (B737-Hush Kit Aircraft)
L_{max} of 65+ dBA

	Dwelling Units			Population		
Land Use Scenario	**America West A.L. Facility**	**Southwest A.L. Facility**	**Cargo**	**America West A.L. Facility**	**Southwest A.L. Facility**	**Cargo**
Baseline	28	0	0	70	0	0
Ultimate	761	295	227	1,904	743	568

POTENTIAL ABATEMENT OF RUN-UP NOISE

Run-up Location

Currently, large aircraft maintenance run-ups occur along a existing blast fence at the America West Airlines maintenance facility and the tarmac in front of the Southwest Airlines maintenance facility. As presented, both of these locations do/could impact residents in the airport vicinity. Therefore, an evaluation of additional alternate run-up locations may have merit.

Run-up Restrictions

The airport has prohibited maintenance run-ups from 11:00 p.m. to 5:00 a.m. since 1984. This restriction completely prevents nighttime maintenance run-ups, when they are potentially the most disturbing. This restriction was

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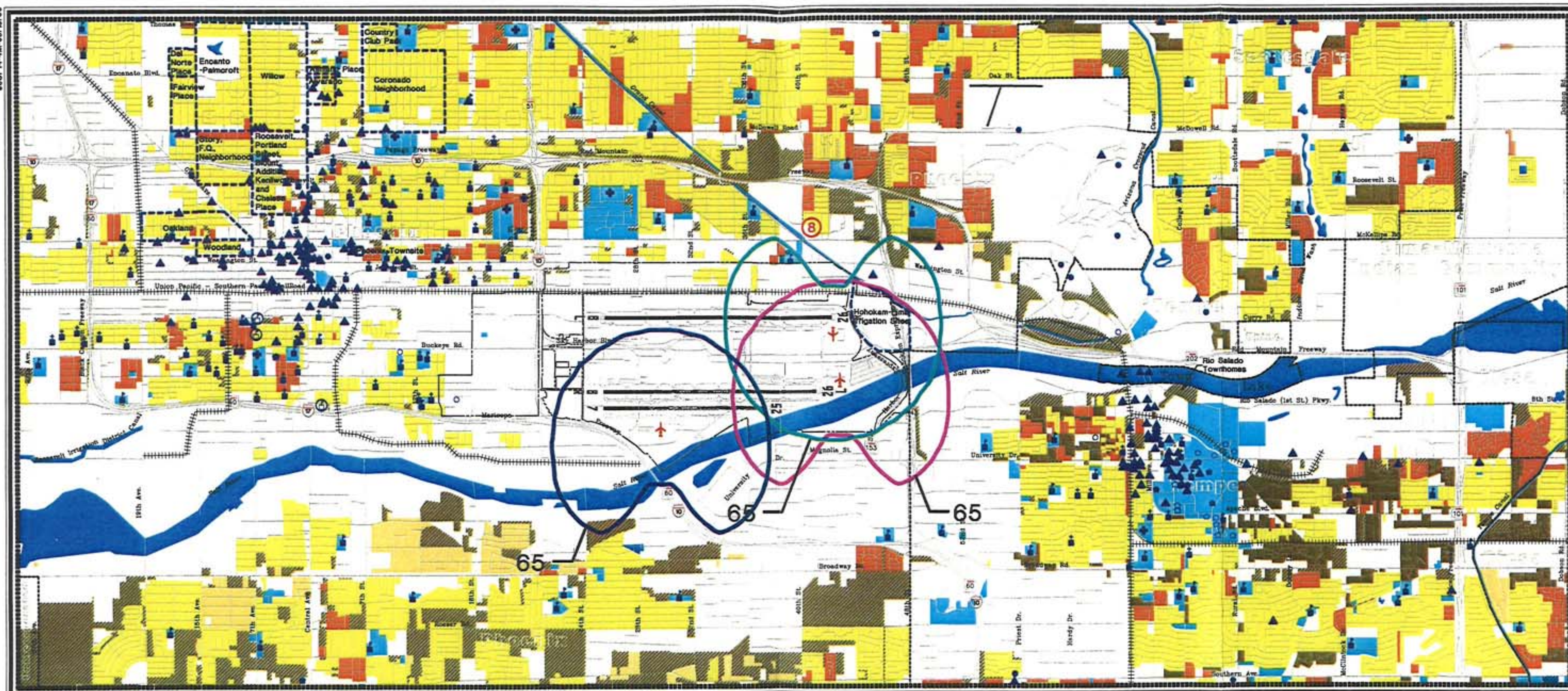

LEGEND

- Airport Property
- Municipal Boundaries
- Study Area
- Run-up dBa-Lmax Noise Contours
- Historic District Boundaries
- Noise Monitor Terminal
- Rural Residential (0-1 du/ac)
- Large Lot Residential (1.1-2 du/ac)
- Small Lot Residential (2.1-5 du/ac)
- Medium Density Residential (5.1-15 du/ac)
- High Density Residential (15+ du/ac)
- Water
- Noise-Sensitive Institutions
- Place of Worship
- School
- Charter School
- Hospital
- Museum
- Library
- Historic Structure
- Residence Halls
- Community Center
- Proposed Residential Development Areas
- Proposed Noise-Sensitive Institutions

Source: Coffman Associates and Brown-Buntin Associates Analysis.

Aerial Photography Land Use Interpretation September 1998.

NORTH

0 — 5000
SCALE IN FEET

Exhibit 4M
PHOENIX SKY HARBOR INTERNATIONAL AIRPORT
AIRCRAFT RUN-UP NOISE ENCLOSURE

instituted as a result of numerous run-up noise related complaints received near the location of noise monitor eight, north of the airport. (See Exhibit 4M for the location of monitor eight). Run-up related noise complaints subsided significantly following the prohibition of late night run-up operations.

Run-Up Enclosures

There are various designs for run-up enclosures. Fully enclosed buildings are known as hush houses. They are most commonly found on air bases and are typically designed for use by fighter aircraft. Run-up enclosures without roofs are often referred to as run-up pens.

Exhibit 4N shows an example of a typical run-up pen. This consists of a three-sided enclosure which can reduce noise by 15 decibels. Noise would not be attenuated out the open end of the enclosure. The estimated cost of this structure is $2.5 million. This includes construction of a additional ramp space needed for the structure.

Cost-Effectiveness Of A Run-up Enclosure

The run-up enclosure discussed above would reduce noise by approximately 15 decibels at a cost of approximately $2.5 million. One way to determine the cost-effectiveness of a run-up enclosure is to estimate the cost of alternative methods of noise attenuation. There are at least three conceivable alternatives:

1. Complete prohibition of maintenance run-ups;
2. Removal of the homes that are subject to run-up noise;
3. Sound insulation of the homes to provide an equal amount of sound attenuation as a run-up enclosure.

Total prohibition of maintenance run-ups is not considered acceptable because of the needs of based operators at the airport. It is not the desire of the Airport to cause the closure of these operators or to take other actions which would interfere with safe use of the airport.

Acquisition and removal of the homes subject to run-up noise is a drastic solution with very high costs and potentially severe impacts on several neighborhoods. If Federal funds are used to acquire property, the airport must comply with the Federal Uniform Relocation Assistance and Real Property Acquisition Act. This mandates that in addition to the purchase of the property at the "fair market" value, displaced homeowners are also entitled to relocation costs, closing costs, and a potential interest rate adjustment. (Refer to Chapter Five, Land Use Alternatives, page 5-24, for a detailed explanation of property acquisition).

Sound insulation of the homes impacted by noise is a conceivable alternative to a run-up enclosure. Acoustical treatment measures typically involve the installation of acoustical windows, insulation, and forced heating and air conditioning systems. Average costs are estimated at $30,000 per home based on the Airport's experience with the current acoustical treatment program. The costs to sound insulate dwellings affected by current run-up noise associated with the America West Airlines facility location would be approximately $840,000. This would increase significantly to $22,830,000 when accounting for a maximum ultimate development scenario in the airport vicinity. There are currently no dwellings impacted by the L_{max} 65 dBA contour resulting from run-up operations at the Southwest Airlines facility location. Given the likelihood of potential ultimate residential development, the costs associated with acoustical treatment could reach $8,850,000. There are no current dwellings impacted by run-up noise at the planned cargo apron location. Again, given the prospect for a maximum ultimate development scenario, acoustical treatment costs would be approximately $17,040,000. While 80 percent of this cost is eligible for Federal funding, the remaining 20 percent, plus a possible $5,000 code deficiency allowanced, per dwelling would be paid by the City of Phoenix or Passenger Facility Charges (PFC). (A detailed discussion of acoustical treatment options is presented in Chapter Five, Land Use Alternatives, page 5-28).

Based on this discussion, construction of a run-up enclosure may be a more cost-effective and a less invasive method to reduce the impact of run-up noise than the other available alternatives.

Conclusion

With maintenance operations at the airport, construction of a run-up pen by the Airport deserves consideration. A three-sided design capable of reducing noise by 15 decibels should be considered.

It would also be helpful if the maintenance operators would keep detailed logs recording important facts about their run-up procedures. This would enable DNL noise contour analyses to be done in the future. It would also help in investigating complaints about engine maintenance run-ups. The following data should be recorded: type of aircraft, time of run-up, duration of run-up, location, aircraft orientation, number of engines used, and percentage of power used. The City of Phoenix could develop a form which it could supply to the maintenance operators.

SUMMARY

This chapter has analyzed the range of potential noise abatement techniques at Phoenix Sky Harbor International Airport. A summary of the noise abatement alternatives are listed in **Table 4P**.

Two of the four alternatives presented reduce the number of people impacted by aircraft noise above 65 DNL. The use of specific runways for departures and/or approaches as presented in Alternative One would reduce the net (2004) population by 690. Alternative Three would reduce the net (2004) population by 54 while increasing airport efficiency by allowing for simultaneous departure operations to the east.

The two remaining alternatives create a net effect of increasing the number of individuals exposed to aircraft noise above 65 DNL. The largest increase in population impacts due to aircraft noise would be the result of the removal of

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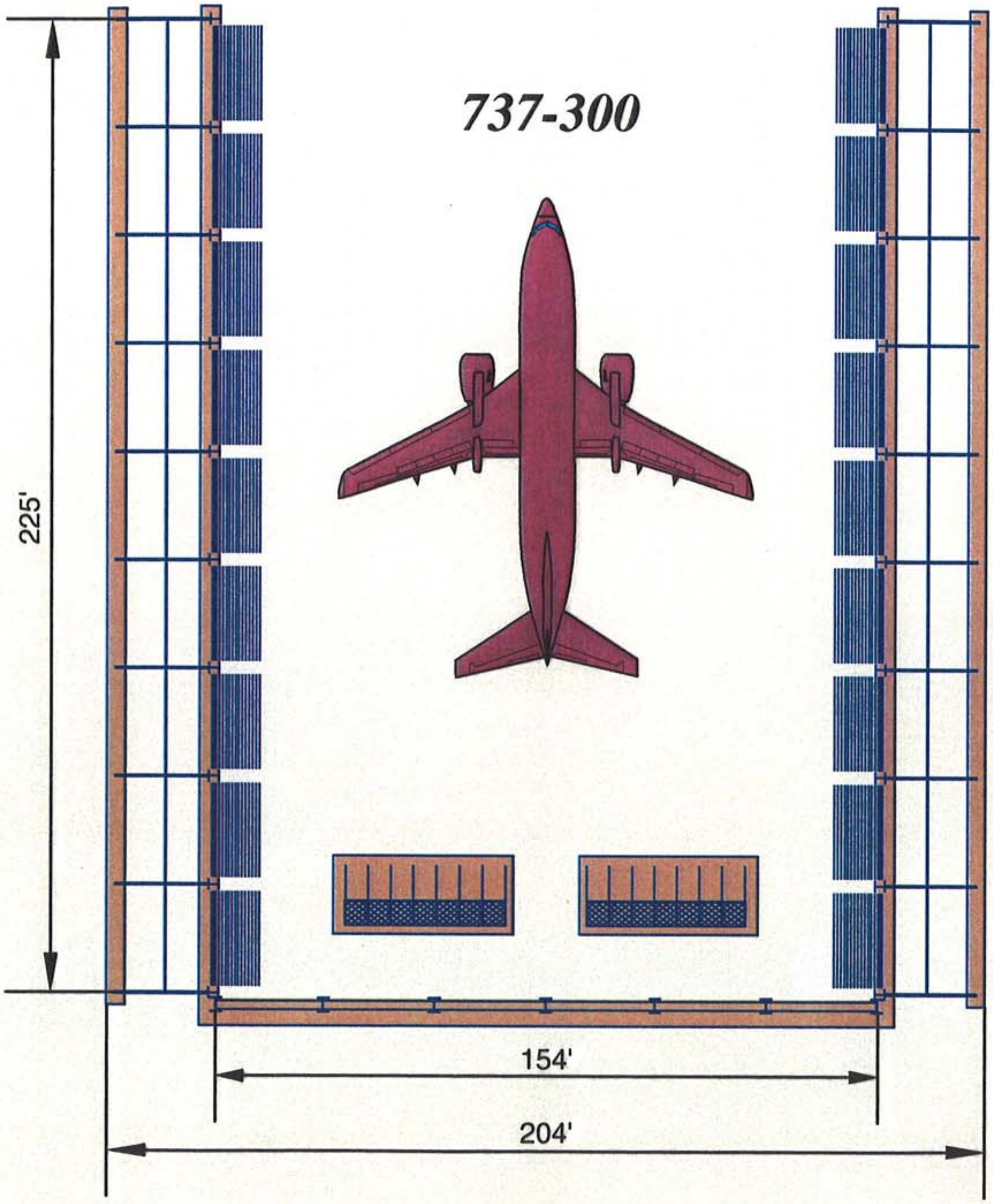

Height: 32' TO 43'

Source: Rheinhold & Mahla AG
Puchheim, Germany

0 40
SCALE IN FEET

PHOENIX SKY HARBOR
INTERNATIONAL AIRPORT

Exhibit 4N
POTENTIAL RUN-UP
ENCLOSURE DESIGN

the 4DME procedure (Alternative Two). The effect of this alternative is to increase the number of people within the 65 DNL contour by 2,939. Although not as significant, the use of a straight-in approach to Runway 25 (Alternative Four) increase the number of people exposed to aircraft noise above 65 DNL by 133 when compared to a planned "side-step" approach procedure.

In addition to these formal alternatives, the airport may wish to pursue the implementation of a three-sided run-up pen. Such a structure could effectively reduce run-up noise exposure by 15 dBA. The cost comparison in this chapter demonstrated that the installation of a run-up pen would be far more cost effective than other methods of attenuating run-up noise.

The results of this analysis must be reviewed by the Study Advisory Committee, City of Phoenix, and the general public before final recommendations can be made. Final recommendations will be presented in Chapter Seven, the Noise Compatibility Plan.

TABLE 4P
Summary Of Noise Abatement Alternatives

Alternative	Advantages	Disadvantages
1. Evaluate Runway Use for Noise Abatement.	• Reduces net population above 65 DNL (2004) by 690.	• Larger aircraft couldn't use Runway 7 for departures due to shorter length & EIS. • Environmental Assessment needed. • Currently no Instrument Landing System on Runways 8L and 7.
2. Test Effectiveness of 4DME Procedure for Noise Abatement. (*Evaluate removal of 4 DME procedure)*	• Increases airport operational efficiency by allowing simultaneous departures to the east.	• Increases net population above 65 DNL (2004) by 2,939. • Environmental Assessment needed.
3. Analyze a Departure Turn for Propeller Powered Aircraft Departing Runway 7 to Turn to a 120-Degree Heading Upon Reaching the End of the Runway.	• Reduces net population above 65 DNL (2004) by 54. • Increases airport operational efficiency by turning slower aircraft out of departure path.	• New residents exposed to noise impacts.
4. Test Effectiveness of a Straight-In Approach Versus a "Side-step" Approach to Runway 25. (*Evaluate straight-in approach*)	• Increases airport efficiency by not restricting departing traffic on Runway 8L until arriving traffic commences "side-step" approach.	• Increases net population above 65 DNL (2004) by 133. • Environmental Assessment needed. • Alternative is contrary to IGA & EIS.
Additional Considerations		
5. Direct aircraft departing Runway 25 to turn to a 240-degree heading upon reaching the end of the runway.	• Meets separational requirements for simultaneous operations with Runway 26L/R. • Reduce overflights of noise-sensitive areas north of I-17.	• Planned development southwest of the airport may receive significant overflight impacts.
6. DGPS, RNAV, FMS equipment and procedures for enhanced noise abatement navigation	• Increased ability to follow noise-compatible corridors. • Reduced aircraft overflights of noise-sensitive areas.	• Cost. • Some equipment not yet approved for "precision" navigation.

TABLE 4P (Continued)
Summary Of Noise Abatement Alternatives

Alternative	Advantages	Disadvantages
7. Abatement of run-up noise through curfew, location, and installation of a run-up enclosure.	• Cost effective versus acoustical treatment options. • Planned cargo apron site would impact fewer individuals than current run-up locations.	• Initial cost. • Siting limitations. • Increased taxi/tow distance. • Safety (crossing active runways to access facilities).