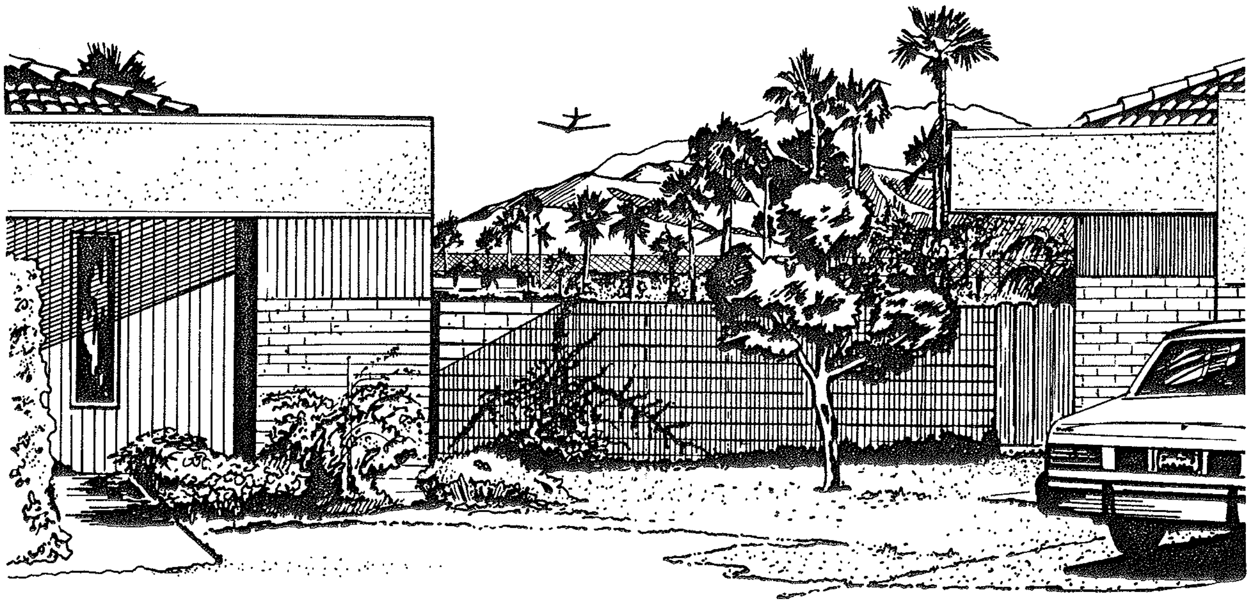
Chapter Four
NOISE IMPACTS



Chapter Four
NOISE IMPACTS

The land use and noise information presented in Chapters One and Two provides the basis for determining noise impacts within the Detailed Study Area. Noise exposure patterns are assessed relative to both population and land use in order to determine the impact that aircraft noise has on the study area. This establishes a benchmark which will be used in later chapters to evaluate the effectiveness of aviation and land use management measures intended to reduce noise impacts. Analysis of impacts in this chapter is limited to the Detailed Study Area, as the Ldn contours in all years for the unabated operating conditions are contained within the boundaries of the Detailed Study Area.

The major sections in this chapter include:

- Current Population Impacts
- Impacts on Nonresidential Uses
- Potential Growth Risk
- Potential Future Population Impacts

EFFECTS OF NOISE EXPOSURE

Before describing the impacts of aircraft noise in the Sky Harbor Detailed Study Area, this section presents general background information on noise and human response to it.

PHYSICAL AND PSYCHOLOGICAL EFFECTS

Noise of all types influences human behavior and activities in many different ways. In particular, aircraft noise may affect people both physically and psychologically. Detailed quantification of these impacts is extremely difficult due to different individual reactions to noise. The U.S. Environmental Protection Agency (EPA) has sponsored and conducted a number of studies with the goal of determining the impact of aircraft noise on the human environment.

The most immediate and verifiable health danger presented by noise is loss of hearing. The EPA document, **Information on Levels of Environmental Noise Requisite to Protect Health and Welfare with an Adequate Margin of Safety**, has indicated that exposure to noise of 70 Leq (approximately Ldn 75) or higher on a continuous basis, over a very long period, at the human ear's most damage-sensitive frequency may result in a very small but permanent loss of hearing. (In order to relate hearing loss to noise exposure, the basic consideration is the actual energy entering the ear. Leq is a measure of this actual energy, whereas Ldn is a measure which includes a weighing penalty for nighttime noise).

In **Aviation Noise Effects**, published in 1985 by the FAA, three studies are cited which examined the question of hearing loss among people in an airport's environs. The results indicated that, under normal circumstances, people in the community near an airport are in no danger of suffering hearing damage from aircraft noise.

It is sometimes claimed that aviation noise can harm the general physical and mental health of airport neighbors. (See **Aviation Noise Effects**, Steven Newman and Kristy R. Beattie, FAA Report No. FAA-EE-85-2, March 1985.) Effects on the cardiovascular system, mortality rates, birth defects, achievement scores, and psychiatric admissions have been suggested and examined in research studies. Unfortunately, the quality of the studies has been very uneven, so these questions remain unsettled. While research is continuing; there is currently little valid scientific evidence to support these concerns.

While this is possible for noise to cause structural damage to buildings, it is quite uncommon. Sound rarely carries sufficient energy to damage safely-constructed structures. The major exceptions to this are sonic booms produced by supersonic aircraft, low frequency sound produced by rocket engines and some construction equipment, and high-impulse noises such as blasting.

Structural vibration from low frequency aircraft noise is sometimes a concern of airport neighbors. The risk of structural damage from low frequency aircraft noise was studied as part of the environmental assessment of the Concorde supersonic jet transport. The studies indicated that the probability of damage from Concorde overflights was extremely slight. Since the Concorde causes significantly more vibration than conventional commercial jet aircraft, the danger of structural damage caused by aircraft noise near airports is considered to be negligible (See **Aviation Noise Effects**, cited above.)

The psychological impact of aircraft noise is a more serious concern than direct physical impact. Studies conducted during the late 1960's and early 1970's (**Noise Burden Factor -- A New Way of Rating Noise**, E. J. Richards and J. B. Ollerhead, Sound and Vibration, V.7, no. 12, December 1973; **Impact of Noise on People**, Federal Aviation Administration, May 1977; and others) have shown that in communities impacted by aircraft noise, the interruption of communication, rest, relaxation, and sleep are among the most important causes for registering complaints. In addition, the sound of approaching aircraft may elicit fear in some people about the possibility of a crash. This fear appears to be a factor motivating complaints of annoyance in neighborhoods near airports. The EPA has also found that continuous exposure to high noise levels can affect work performance, especially in high-stress occupations.

Finally, it is important to recognize that individual human response to noise is highly variable. A wide range of factors can influence an individual's reaction to noise including emotional variables, feelings about the necessity or preventability of the noise, judgments about the value of the activity creating the noise, an individual's activity at the time the noise is heard, general sensitivity to noise, beliefs about the impact of noise on health, and feelings of fear associated with the noise. Physical factors can also influence an individual's reaction to noise including the type of neighborhood in which the individual resides (residents of urban neighborhoods are often more tolerant of noise than rural residents), the time of day at which the noise occurs, the season of the year, the predictability or regularity of the noise, and the individual's control over the noise source. Fortunately, although individual responses to noise can vary greatly, average communitywide responses tend to be much less variable. This enables us to make reasonable statistical evaluations of the average impacts of aircraft noise on a community despite the wide variations in individual response.

LAND USE COMPATIBILITY

The degree of annoyance which people suffer from aircraft noise varies greatly depending on the activities in which they are engaged. People rarely are as disturbed by aircraft noise when they are shopping, working, or driving as when they are at home. Transient hotel and motel residents seldom express as much concern with aircraft noise as do permanent residents of the area.

The concept of "land use compatibility" has arisen from this systematic variability in human tolerance to aircraft noise. Various studies by governmental agencies and private researchers, in particular those by HUD and FAA, have defined the general compatibility of different land uses with varying noise levels. Table 4A lists land use compatibility guidelines from F.A.R. Part 150. These are shown graphically in Exhibit 4A, Land Use Compatibility Matrix.

The guidelines show that mobile home parks and outdoor music shells and amphitheaters are incompatible in areas subject to noise above 65 Ldn. Nautre exhibits and zoos are considered incompatible at levels exceeding 70 Ldn. Several other uses including residential,schools, hospitals, nursing homes, churches, auditoriums, concert halls, livestock breeding, amusement parks, resorts, and camps are considered incompatible at levels above 75 Ldn.

Many uses are considered compatible in areas subject to noise between 65 Ldn and 75 Ldn, provided that prescribed levels of sound attenuation can be achieved through soundproofing. These include residential, sc hools, hospitals, nursing homes, churches, auditoriums, and concert halls.

Experience has shown that new residential development should be prohibited in undeveloped areas subject to noise levels of Ldn 65 or higher, unless there are local factors which suggest that soundproofed residences would not be adversely impacted by such noise levels. The most obvious factor would be the presence of high background noise levels such as are found in high-density urban environments.

Where existing residential uses already exist, further expansion should be discouraged, or measures to mitigate noise impacts should be taken, especially if further residential development cannot be prevented.

Obviously, these are generalized guidelines since, for all land uses, some people and even entire communities may be more or less sensitive to given noise levels than others. In addition, noise sensitivity within an individual land use class may vary. For example, occupants of an older, poorly insulated home may be more sensitive to noise than those of a new, well-insulated, energy-efficient home. It is important to remember that Part 150 specifically points out that determinations of noise compatibility, and regulation of land uses, is a local prerogative and responsibility.

Human response to noise is highly variable, and the effect of noise on human activity is complex and difficult to measure with precision. The following sections quantify noise impacts on the population of the study area with the acknowledgement that variations in response may be present.

TABLE 4A
Land Use Compatibility Guidelines
From F.A.R. Part 150

	Yearly Day-Night Average Sound Level(Ldn) in Decibels					
LAND USE	Below 65	65-70	70-75	75-80	80-85	Over 85
RESIDENTIAL						
Residential, other than mobile homes and transient lodgings	Y	N[1]	N1	N	N	N
Mobile home parks	Y	N	N	N	N	N
Transient lodgings	Y	N[1]	N[1]	N[1]	N	N
PUBLIC USE						
Schools	Y	N[1]	N[1]	N	N	N
Hospitals and nursing homes	Y	25	30	N	N	N
Churches, auditoriums, and concert halls	Y	25	30	N	N	N
Governmental services	Y	Y	25	30	N	N
Transportation	Y	Y	Y[2]	Y[3]	Y[4]	Y[4]
Parking	Y	Y	Y[2]	Y[3]	Y[4]	N
COMMERCIAL USE						
Offices, business and professional	Y	Y	25	30	N	N
Wholesale and retail--building materials, hardware, and farm equipment	Y	Y	Y[2]	Y[3]	Y[4]	N
Retail trade--general	Y	Y	25	30	N	N
Utilities	Y	Y	Y[2]	Y[3]	Y[4]	N
Communication	Y	Y	25	30	N	N
MANUFACTURING AND PRODUCTION						
Manufacturing, genral	Y	Y	Y[2]	Y[3]	Y[4]	N
Photographic and optical	Y	Y	25	30	N	N
Agriculture (except livestock) and forestry	Y	Y[6]	Y[7]	Y[8]	Y[8]	Y[8]

TABLE 4A (Continued)
Land Use Compatibility Guidelines
From F.A.R. Part 150

LAND USE	Yearly Day-Night Average Sound Level(Ldn) in Decibels					
	Below 65	65-70	70-75	75-80	80-85	Over 85
Livestock, farming and breeding	Y	Y[6]	Y[7]	N	N	N
Mining and fishing, resource production and extraction	Y	Y	Y	Y	Y	Y
RECREATIONAL						
Outdoor sports arenas and spectator sports	Y	Y[5]	Y[5]	N	N	N
Outdoor music shells, amphitheaters	Y	N	N	N	N	N
Nature exhibits and zoos	Y	Y	N	N	N	N
Amusement parks, resorts, and camps	Y	Y	Y	N	N	N
Golf courses, riding stables, and water recreation	Y	Y	25	30	N	N

* The designations contained in this table do not constitute a Federal determination that any use of land covered by the program is acceptable under Federal, State or local law. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities. FAA determinations under Part 150 are not intended to substitute federally determined land uses for those determined to be appropriate by local authorities in response to locally determined needs and values in achieving noise compatible land uses.

KEY TO TABLE 4A

Y (Yes)	Land use and related structures compatible without restrictions.
N (No)	Land use and related structures are not compatible and should be prohibited.
NLR	Noise Level Reduction (NLR), (outdoor to indoor), to be achieved through incorporation of noise attenuation into the design and construction of the structure.
25,30, or 35	Land Use and related structures generally compatible; measures to achieve NLR or 25, 30, or 35 dB must be in corporated into design and construction of structure.

NOTES FOR TABLE 4A

1. Where the community determines that residential uses must be allowed, measures to achieve outdoor to indoor Noise Level Reduction (NLR) of at least 25 dB and 30 dB should be incorporated into building codes and be considered in individual approvals. Normal construction can be expected to provide a NLR or 20 dB, thus, the reduction requirements are often stated as 5, 10, or 15 dB over standard construction and normally assume mechanical ventilation and closed windows year round. However, the use of NLR criteria will not eliminate outdoor noise problems.

2. Measures to achieve NLR of 25 dB must be incorporated into the design and construction of portions of these buildings where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

3. Measures to achieve NLR of 30 dB must be incorporated into the design and construction of portions of these buildings where the public is receiv ed, office areas, nhoise sensitive areas, or where the normal noise level is low.

4. Measures to achieve NLR of 35 dB must be incorporated into the design and construction of portions of these buildngs where the public is received, office areas, noise sensitive areas, or where the normal noise level is low.

5. Land use compatible provided special sound reinforcement systems are installed.

6. Residential buildings require a NLR of 25.

7. Residential buildings require a NLR of 30.

8. Residential buildings not permitted.

Source: F.A.R. Part 150, Appendix A, Table 1.

IMPACTS ON CURRENT POPULATION

Exhibit 4B shows noise contours for current unabated conditions superimposed on a map of residential land use patterns. These land uses are divided into three groups: single-family residential, multiple-family residential, and mobile homes. The noise contours shown are the Ldn 65, 70 and 75 contours, all above the federally-defined significant level of impact on residential population. Residential land use patterns were derived from aerial photography taken in June of 1986.

Exhibit 4B shows noise levels and residential land uses to the west of the airport, entirely in the City of Phoenix. The Ldn 75 contour extends westward along the centerlines of the two parallel runways into areas off airport property. The north finger of the contour extends one mile west to 16th Street and lies entirely within land now controlled by the Sky Harbor Center. This land no longer is occupied by residences and is being redeveloped for commercial and industrial uses which will be compatible with aircraft noise and overflight activity.

☐ COMPATIBLE (C)	☐ COMPATIBLE WITH RESTRICTIONS (CR)	■ NOT COMPATIBLE (NC)

	LAND USE	60–65	65–70	70–75	75–80	80–85	85+
		DAY-NIGHT AVERAGE SOUND LEVEL (LDN) IN DECIBELS					
RESIDENTIAL	Residential Other Than Mobile Homes And Transient	C	CR	CR	NC	NC	NC
RESIDENTIAL	Mobile Home Parks	C	NC	NC	NC	NC	NC
RESIDENTIAL	Transient Lodgings	C	CR	CR	CR	NC	NC
PUBLIC USE	Schools	C	CR	CR	NC	NC	NC
PUBLIC USE	Hospitals And Nursing Homes	C	CR	CR	NC	NC	NC
PUBLIC USE	Churches, Auditoriums And Concert Halls	C	CR	CR	NC	NC	NC
PUBLIC USE	Governmental Services	C	C	CR	CR	NC	NC
PUBLIC USE	Transportation	C	C	CR	CR	CR	CR
PUBLIC USE	Parking	C	C	CR	CR	CR	NC
COMMERCIAL	Offices, Business And Professional	C	C	CR	CR	NC	NC
COMMERCIAL	Wholesale And Retail	C	C	CR	CR	CR	NC
COMMERCIAL	Retail—General	C	C	CR	CR	NC	NC
COMMERCIAL	Utilities	C	C	CR	CR	CR	NC
COMMERCIAL	Communication	C	C	CR	CR	NC	NC

Exhibit 4A
LAND USE COMPATIBILITY MATRIX

☐ COMPATIBLE ☐ COMPATIBLE WITH RESTRICTIONS ■ NOT COMPATIBLE

	LAND USE	DAY-NIGHT AVERAGE SOUND LEVEL (LDN) IN DECIBELS					
		60	65	70	75	80	85
MANUFACTURING AND PRODUCTION	Manufacturing, General						■
	Photographic And Optical					■	■
	Agriculture (Except Livestock) And Forestry						
	Livestock Farming And Breeding				■	■	■
	Mining, Fishing And Resource Production						
RECREATIONAL	Outdoor Sports Arenas				■	■	■
	Outdoor Music Shells And Amphitheaters		■	■	■	■	■
	Nature Exhibits And Zoos			■	■	■	■
	Amusement Parks, Resorts And Camps				■	■	■
	Golf Courses, Riding Stables And Water Recreation					■	■

Exhibit 4A
LAND USE COMPATIBILITY MATRIX (Continued)

The southern finger of the Ldn 75 contour extends much farther to the west, nearly to 7th Avenue, a distance of three miles from the airport. The residential area most impacted by the Ldn 75 contour is the Nuestro Barrio neighborhood which lies between the Sky Harbor Center and 7th Street and is composed of small single-family homes. The westernmost tip of the Ldn 75 contour extends beyond Nuestro Barrio over more small single-family homes and touches a multiple-family residential area.

The Ldn 70 contour extends westward as a broad, single-pointed projection which reaches to 15th Avenue along the northern runway centerline (approximately three miles from the airport) and to 25th Avenue along the southern runway centerline (approximately five miles from the airport). The contour lies immediately south of the Southern Pacific tracks and north of the Salt River. Within the contour, most residential areas are single-family, except for four large housing projects which lie north and east of I-17, west of 7th Avenue and south of Grant Street. Much of this area is in the Buckeye Road Redevelopment Area.

The Ldn 65 contour is a two-mile wide projection which extends over six miles west of the airport beyond 35th Avenue. The 75-70 band of the contour overlays much commercial and railroad land south of Washington Street and affects a mixture of scattered single-family and multiple-family residential areas. The Ldn 65-70 band overlays dense single-family areas west of I-17, south of Buckeye Road. The southern portion of the Ldn 65-70 band overlays mostly industrial land and river bed south of the Maricopa Freeway and, consequently, affects only two small single-family areas.

East of Sky Harbor, on Exhibit 4B, the significant noise contours project through the Phoenix territory into the city of Tempe, but do not touch Scottsdale or Mesa. The Ldn 75 contour forms a single point, due to the traffic from both runways proceeding to the Rio Salado beacon. The contour extends out nearly three miles into the Papago Park between the extended alignments of Mill Avenue and Rural Road. There are no residential areas affected by the Ldn 75 contour east of Sky Harbor.

The Ldn 70 contour extends over four miles from the airport, over a mile wide, to McClintock Road, the edge of the Indian reservation. The Ldn 70-75 band does not affect any residential areas until reaching two single-family subdivisions located east and west of Rural Road and two new multiple-family areas west of Rural Road. The Ldn 65-70 contour band extends over five miles east, nearly a mile into the Indian reservation and over a small pocket of unincorporated Maricopa County south of the reservation. No large groups of housing are affected by the Ldn 65-70 band until east of 52nd Street to Mill Avenue in Tempe, along the south side, and east and west of Rural Road along the north side. No Indian reservation housing is touched by the Ldn 65 contour.

As indicated earlier in Chapter Two, and as shown below, the overall size of the noise contours is forecast to decrease over time. If existing land uses and population were distributed uniformly, and if the contours maintained their present shape, the land use and population impacts would decrease accordingly. However, the population and noise-sensitive land uses are most dense to the west of the airport and beneath the northerly of the two parallel runways. As the runway usage changes in the future, it is possible for impacts on existing land uses and population to actually increase while contour areas decrease. Table 4B indicates the total acreage within contour ranges for both existing and anticipated conditions.

TABLE 4B
Total Acres in Contour Range

Ldn Range	1987	1992	1997	2007
65-70	5,683	5,504	5,530	5,613
70-75	4,288	4,153	4,122	4,167
75+	3,968	3,245	3,110	2,470
65+	13,939	12,902	12,762	12,250

Table 4C shows the population impacted by 1987 unabated noise levels above Ldn 65. The population data was developed from reports for Traffic Analysis Zones produced for the Maricopa Association of Governments by Mountain West. The population data was then further refined by allocating population to blocks or block groups on the basis of the 1986 aerial photography and direct field observation. The resulting number is a general approximation of the mid-1986 population distribution throughout the Study Area. The population data is reported on Table 4C for Phoenix west of the airport, Phoenix east of the airport, Tempe, and totals.

TABLE 4C
Impacts of Current Noise on Current Population

Ldn	Phoenix	Phoenix-East	Phoenix West	Tempe	Total
65-70	8,781	215	8,566	6,335	15,116
70-75	9,415	0	9,415	2,230	11,645
75+	4,232	0	4,232	0	4,232
65+	22,248	215	22,213	8,565	30,993

From Table 4C it can be seen that nearly 31,000 people reside in the Sky Harbor International Airport Ldn 65 contour, 72 percent in Phoenix and 28 percent in Tempe. Nearly 74 percent of Tempe's impacts are in the Ldn 65-70 range, and the remaining 26 percent are in the Ldn 70-75 range. No Tempe population resides in the Ldn 75 contour.

The Phoenix population to the east of the airport in the impact area is relatively very small. Only 215 people reside in the Ldn 65-70 band and no population was found at higher levels.

The vast majority (70 percent) of persons impacted by Sky Harbor noise reside to the west of the airport, in

Exhibit 4B (WEST)
1987 NOISE LEVELS OVER
CURRENT RESIDENTIAL AREAS

Sky Harbor
INTERNATIONAL AIRPORT

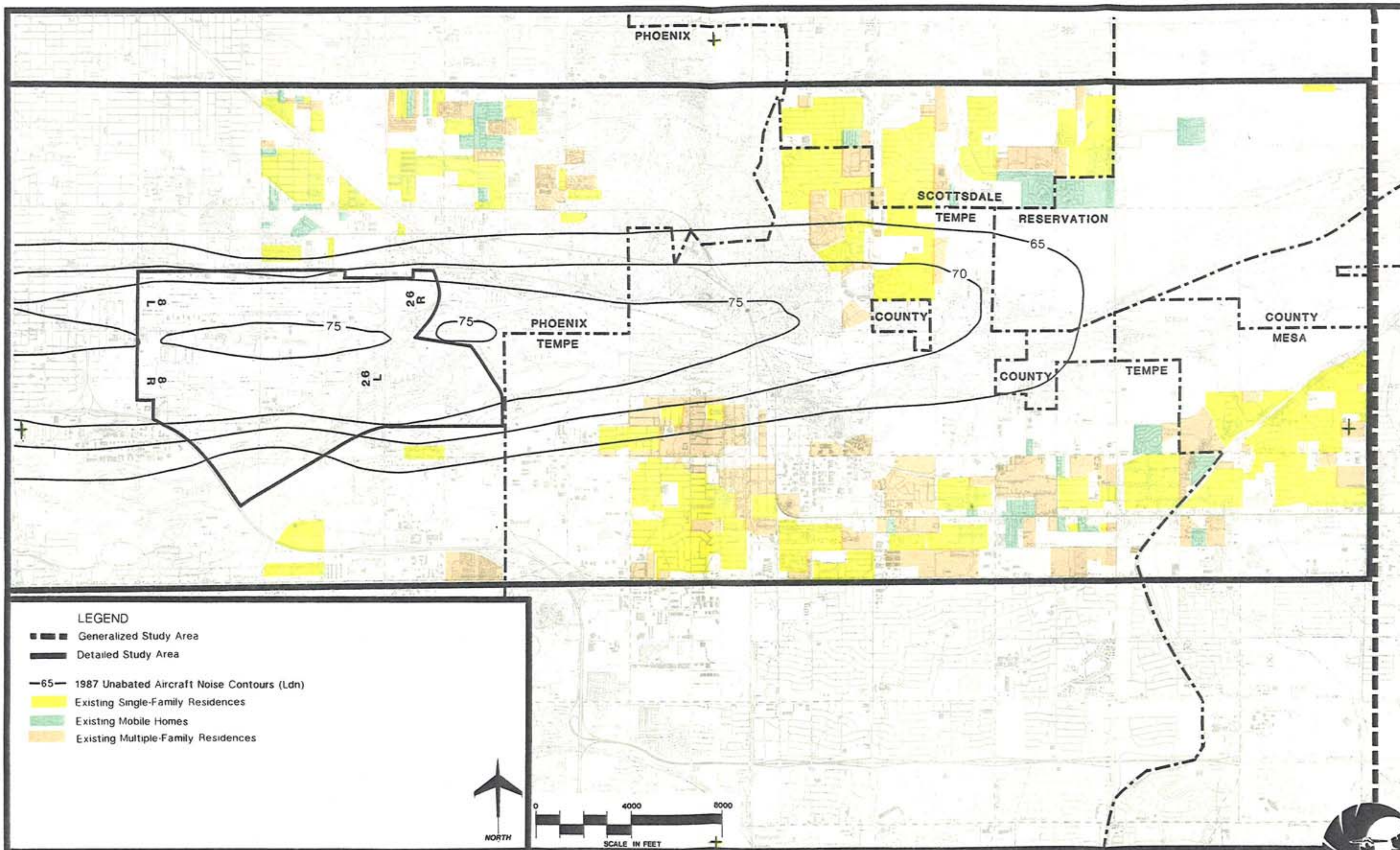


Exhibit 4B (EAST)
1987 NOISE LEVELS OVER
CURRENT RESIDENTIAL AREAS

Sky Harbor
INTERNATIONAL AIRPORT

Phoenix. This impact area contains over 22,000 people and the only population affected by Ldn 75+ levels (over 4,200 people). Another 9,400 people reside in the Ldn 70-75 contour range, 81 percent of the total found in that range. Finally, nearly 8,600 people reside in the Ldn 65-70 range, nearly 28 percent of the total population impacted.

As should be apparent from the preceding discussion, it is awkward to attempt to compare noise impacts on population between two or more sets of conditions because the impacts are defined in more than one level (i.e. 65-70, 70-75, 75+). The use of absolute numbers does not permit easy comparison between two sets of impacts such as City A vs. City B, 1987 vs. 1992, abated vs. unabated, etc. because the significance of the values varies by their noise levels.

The approach selected for comparatively assessing noise impacts is the Level-Weighted Population (LWP) methodology. This technique was developed in 1977 under the auspices of the National Research Council Committee on Hearing, Bioacoustics and Biomechanics (CHABA), **(Guidelines for Preparing Environmental Impact Statements on Noise, Report of Working Group 69 on Evaluation of Environmental Impact of Noise**, National Academy of Sciences). This methodology is based on a large number of studies of community response to noise. Those studies revealed that the percentage of a residential population that was highly annoyed by noise increased as the noise exposure level increased. For instance, within the Ldn 65-70 range, 62.5 percent of the population was, on average, found to be highly annoyed by noise, while within the Ldn 70-75 range, 87.5 percent were highly annoyed.

The first step in using the LWP process is to estimate the population residing within each 5 Ldn range (65-70 Ldn, 70-75 Ldn etc.). The population within each Ldn range is then multiplied by the corresponding LWP response factor. The figures for each Ldn range are added together to provide the total level-weighted population, an estimate of the total number of persons who are expected to be highly annoyed by noise at their residences.

The LWP procedure does not incorporate personal and political distinctions. Each individual and each geographical area is considered equally since research has indicated that there is no significant relationship between noise impact and social or economic factors, although some social or economic groups may be more vocal in their complaints than others because they are more accustomed to using the media, public participation processes, or the courts.

The LWP methodology is an excellent technique for considering the impact of noise on a population because it considers not only the total number of persons affected, but also the intensity of the impact. Since the percentage of the population which is highly annoyed by noise increases with increasing noise levels, the LWP value may be different between abatement scenarios, even though the total population within the noise impact boundary is equal.

An example below illustrates the LWP methodology. Scenarios A and B show the effects of two alternative noise abatement programs in a highly impacted area. While the total number of people subject to noise above 65 Ldn is the same for both scenarios, Scenario B has a significantly lower LWP and would be the preferred alternative. This is because fewer people are subjected to higher noise levels under this Scenario. Naturally, the goal of the alternatives analysis is to reduce both the total impacted population and the LWP to the lowest levels possible.

Ldn Range	LWP Factor	Scenario A Population		LWP Factor	Scenario B Population	
		Population	LWP		Population	LWP
65-70	.625 x	2,000 =	1,250	.625 x	3,000 =	1,875
70-75	.875 x	1,400 =	1,225	.875 x	700 =	613
75+	1.000 x	600 =	600	1.000 x	300 =	300
Total		4,000	3,075		4,000	2,788

The absolute and level-weighted current population impacts for Phoenix and Tempe are shown below in Table 4D, based on the methodology described above. Due to the peculiar set of local circumstances the LWP values do not result in substantially different indications of comparative impacts. The LWP value for Phoenix rises slightly to 75 percent of total LWP and Tempe's value drops slightly to 25 percent. The more important use for LWP will come later when it will be useful to compare the net effects of various noise abatement alternatives.

TABLE 4D
Current Level-Weighted Population Impacts

Ldn	Phoenix		Tempe		Total	
	Population	LWP	Population	LWP	Population	LWP
65-70	8,781	5,488	6,335	3,959	15,116	9,447
70-75	9,415	8,238	2,230	1,951	11,645	10,189
75+	4,232	4,232	0	0	4,232	4,232
65+	22,428	17,958	8,565	5,910	30,993	23,868

NONRESIDENTIAL IMPACTS

A brief look back at Table 4A, the Part 150 Land Use Compatibility Guidelines, will reveal that, other than residential uses, most land uses are relatively insensitive to off-airport aircraft noise levels. The notable exceptions to this are schools, medical institutions (where bed-patients are kept), churches, and performing arts (indoors and outdoors). No performing arts land uses were found in the Ldn 65 contour, but, as would be expected, the study area contains many schools, churches, and hospitals, many of them in the Ldn 65 contour.

Another exception is historic structures, which are required under Part 150 to be identified. The actual impact of noise on historic structures cannot be determined except on a detailed case-by-case analysis.

A tabular summary of noise-sensitive nonresidential land uses is shown, by sub-area, in Table 4E. The map in

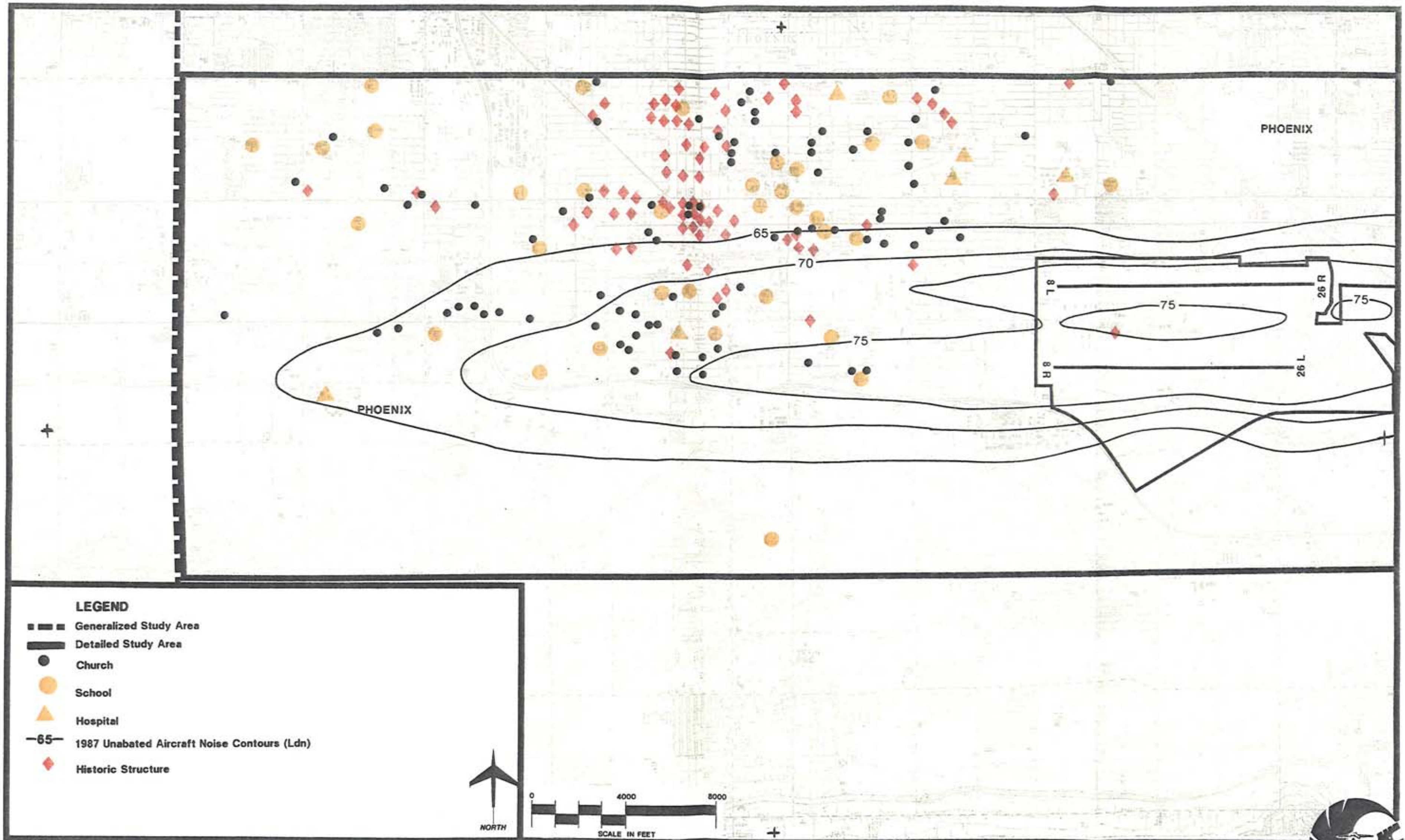


Exhibit 4C (WEST)
EXISTING NOISE-SENSITIVE
LAND USES

Sky Harbor International Airport

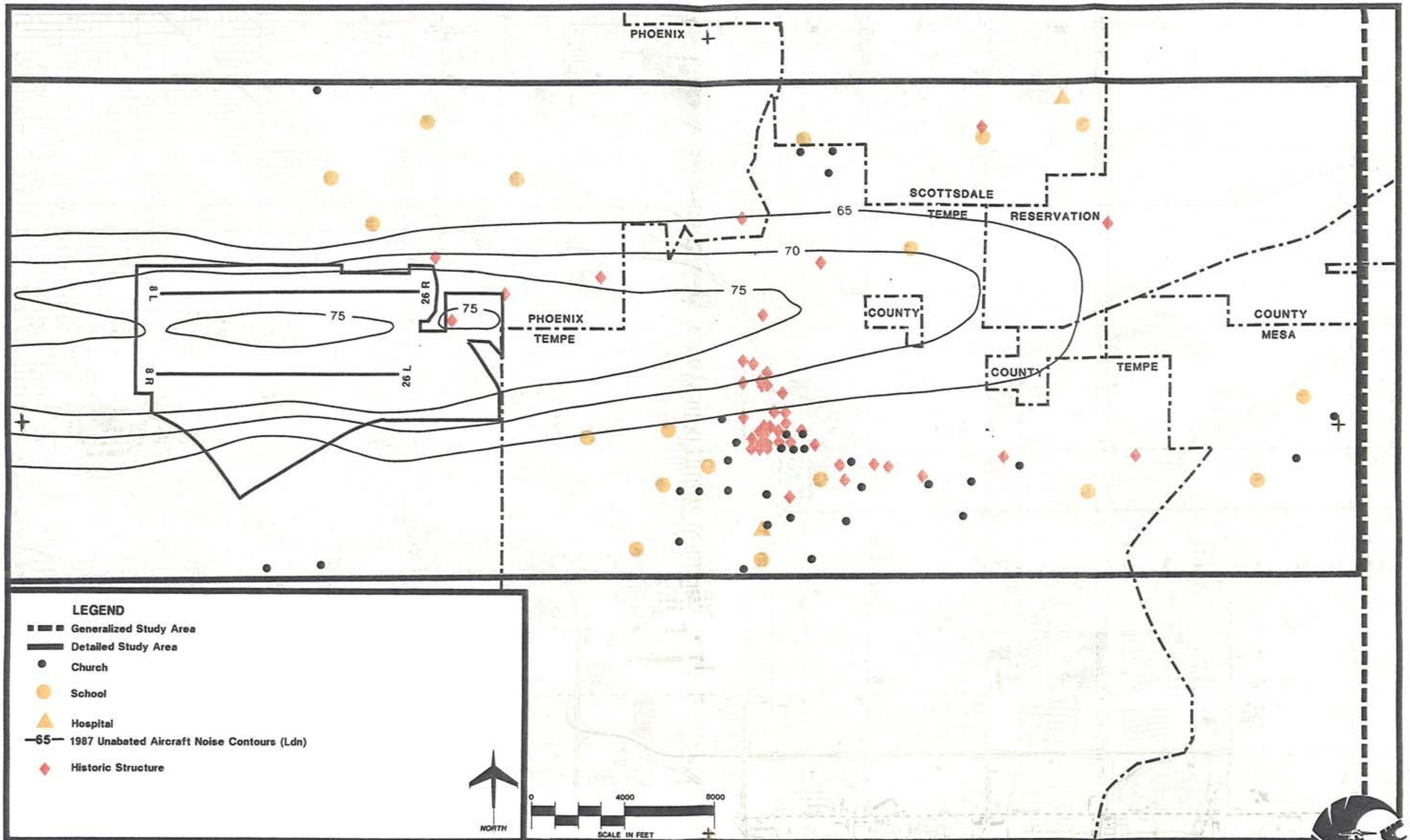


Exhibit 4C (EAST)
EXISTING NOISE-SENSITIVE
LAND USES

Sky Harbor International Airport

Exhibit 4C shows the location of these historic structures, churches, schools and hospitals found in the Detailed Study Area. Historic structures are the most numerous of these uses, with a total of 142 in the study area listed as being on or eligible for inclusion on the National Register of Historic Places. Churches are the second most numerous of these uses, followed closely by schools and by a small number of hospitals.

Over 60 percent of the historic structures are found in the western half of the study area, all in Phoenix. Another four percent are located in the eastern half also in Phoenix. Over 34 percent of the total structures are located in Tempe, mostly clustered in the old original part of the community in and around the present downtown area. Scottsdale and the Reservation also have one structure each.

Of the 104 churches found in the Detailed Study Area, most (69%) are located in Phoenix west of Sky Harbor, concentrated primarily north of the Maricopa Freeway, east of 31st Avenue, and west of 20th Street. Only three churches are found in Phoenix east of the airport and two are in Mesa. The remainder, 26 percent (27 churches), are found in Tempe, primarily in or on the edge of the business district.

A total of 62 schools were found in the Detailed Study Area. Of these, 71 percent are located in Phoenix west of Sky Harbor, most to the north of the Maricopa Freeway, east of 35th Avenue and west of 16th Street. The remaining 18 schools are scattered throughout Phoenix east of Sky Harbor, Tempe, Mesa and Scottsdale.

There are eight hospitals in the Detailed Study Area representing a diverse group of hospital types. Six hospitals are located throughout Phoenix west of Sky Harbor, one hospital is found in Scottsdale, and one is located in Tempe.

Table 4F shows the number of the above noise-sensitive nonresidential land uses which are impacted by aircraft noise levels of Ldn 65 or more. Noise contours from which these impacts are derived were shown earlier in this report in Exhibits 2J, 2K, 2L and 2M for the years 1987, 1992, 1997 and 2007, respectively.

TABLE 4E
Existing Noise Sensitive Land Uses In Detailed Study Area

	Historic Structures	Churches	Schools	Hospitals
Phoenix - West	86	72	44	6
Phoenix - East	5	5	4	0
Phoenix - Total	91	77	48	6
Mesa	0	2	2	0
Tempe	49	7	9	1
Scottsdale	1	0	3	1
Maricopa Co.	1	0	0	0
Total Area	142	104	62	8

Currently, there are 27 historic structures, 37 churches, 13 schools and 2 hospitals impacted by levels of Ldn 65 or more. Fifteen historic structures are in Phoenix, mostly to the west and 13 are in Tempe. All but one of these churches are located in Phoenix west of Sky Harbor, as are all but three of the schools and all of the hospitals. Of these, only three historic structures, four churches and one school are in the Ldn 75 contour and that school is a noise-compatible new earth-sheltered structure (located in Nuestro Barrio). The only impacted noise-sensitive uses are located in Phoenix east of Sky Harbor are two historic structures. One church and three schools in Tempe are exposed to noise levels between Ldn 65 and 70.

Based on the forecast noise levels for 1992, these impacts will increase in Phoenix and decline in Tempe. Impacted historic structures and churches will increase from 15 to 29 and 36 to 44, respectively, in Phoenix and impacted schools will increase from 10 to 17. In Tempe, the number of impacted schools will decrease from three to one. By 1997 the impacts on noise-sensitive nonresidential land uses should level off in all areas.

The long-term projections of aircraft operations, reflected in the 2007 noise contours, shows a marked decrease in noise levels. Correspondingly, the 2007 land use impacts should decline to slightly less than in 1987.

TABLE 4F
Impacted Noise-Sensitive Nonresidential Uses

	Unabated Ldn Level	Land Use	Phoenix	Phx-West	Phx-East	Tempe	Total
1987	65-70	Historic	8	8	0	6	14
		Church	20	20	0	1	21
		School	3	3	0	3	6
		Hosp.	1	1	0	0	1
	70-75	Historic	5	3	2	5	10
		Church	12	12	0	0	12
		School	6	6	0	0	6
		Hosp.	1	1	0	0	1
	75+	Historic	2	0	2	1	3
		Church	4	4	0	0	4
		School	1	1	0	0	1
		Hosp.	0	0	0	0	0
	65+	Historic	15	11	4	13	27
		Church	36	36	0	1	37
		School	10	10	0	3	13
		Hosp.	2	2	0	0	2
1992	65-70	Historic	18	18	0	8	26
		Church	18	18	0	0	18
		School	6	5	1	1	7
		Hosp.	0	0	0	0	0
	70-75	Historic	9	6	3	2	11
		Church	24	24	0	0	24
		School	10	10	0	0	10
		Hosp.	1	1	0	0	1

TABLE 4F (continued)
Impacted Noise-Sensitive Nonresidential Uses

	Unabated Ldn Level	Land Use	Phoenix	Phx-West	Phx-East	Tempe	Total
	75+	Historic	2	0	2	1	3
		Church	2	2	0	0	2
		School	1	1	0	0	1
		Hosp.	0	0	0	0	0
	65+	Historic	29	23	6	11	40
		Church	44	44	0	0	44
		School	17	16	1	1	18
		Hosp.	1	1	0	0	1
1997	65-70	Historic	6	3	3		
		Church	21	21	0	0	21
		School	7	6	1	1	8
		Hosp.	0	0	0	0	0
	70-75	Historic	9	6	3	3	12
		Church	21	21	0	0	21
		School	6	6	0	0	6
		Hosp.	1	1	0	0	1
	75+	Historic	2	0	2	0	2
		Church	2	2	0	0	2
		School	1	1	0	0	1
		Hosp.	0	0	0	0	0
	65+	Historic	26	21	5	10	36
		Church	44	44	0	0	44
		School	14	13	1	1	15
		Hosp.	1	1	0	0	1
2007	65-70	Historic	13	13	0	7	20
		Church	25	25	0	0	25
		School	6	5	1	2	8
		Hosp.	1	1	0	0	1
	70-75	Historic	6	4	2	2	8
		Church	11	11	0	0	11
		School	5	5	0	0	5
		Hosp.	0	0	0	0	0
	75+	Historic	2	0	2	0	2
		Church	0	0	0	0	0
		School	0	0	0	0	0
		Hosp.	0	0	0	0	0
	65+	Historic	21	17	4	9	30
		Church	36	36	0	0	36
		School	11	10	1	2	13
		Hosp.	1	1	0	0	1

POTENTIAL GROWTH RISK

Before evaluating the impact of future aircraft noise on the study area, it is important to understand the likelihood of future residential development in the area. Analyzing development trends in the airport vicinity is of critical importance in noise compatibility planning. Future residential growth can potentially further constrain the operation of the airport if it occurs beneath aircraft flight tracks and within areas subject to high noise levels.

METHODOLOGY

The growth risk analysis focuses primarily on undeveloped or nearly undeveloped land which is planned and zoned for residential use. It is recognized that additional development will also occur through in-filling or redevelopment of currently developed areas. In-filling and redevelopment are quite difficult to predict but the process is inevitable study area as developable land disappears and as market forces dictate that a more productive use be made of land occupied by smaller, obsolete and deteriorating residential structures.

The methodology for potential growth risk analysis is as follows:

- Identify all vacant unplatted tracts of land zoned and/or planned for future residential development.
- Calculate the area of these tracts, apply a factor accounting for development inefficiencies and the platting of streets, multiply by the dwelling unit densities specified in the zoning ordinance, multiply by a forecast occupancy rate, and multiply by forecast household size to obtain the population holding capacity of presently vacant, unplatted land.
- Identify platted, undeveloped and developing subdivisions, apply dwelling unit densities, occupancy rates, and household size factors to obtain population holding capacity.
- Identify areas likely to be converted from residential to nonresidential uses. Sources for such conclusions of land use trends are interviews with local municipal planners, general plan documents, analysis of aerial photography, and changes in population forecast for each Traffic Analysis Zone (TAZ) by Mountain West.
- Identify areas likely to be converted from low-density single-family residential to high-density multiple-family residential. These land use trends are determined in the same manner as those pointing to nonresidential conversion. However, it is generally more difficult to precisely identify the specific parcels which might be redeveloped residentially because there is usually a large potential area in which a relatively limited amount of redevelopment might occur.
- Identify areas most likely to be cleared for freeway construction. Such clearances could displace existing residences or prevent residential development of vacant, developable land. The future freeway alignments are firm, in some cases, such as the Papago and the Squaw Peak Freeways, the Sky Harbor Extension, and portions of the Price-Pima. Others, such as the East Papago, the Hohokam extension, S.R. 153, portions of the Price-Pima, and the Red Mountain are not yet precisely identified. In those cases, the favored alternative routings were assumed to be used.
- Identify the probable timing and extent of such land use development,

conversion, redevelopment, infilling, and clearance. The Mountain West TAZ population projections were used as the primary source of such decisions, along with interviews of local planners. This process is necessarily quite speculative and should be regarded only as a general indicator of the potential risk of increases in land use compatibility.

A key tool in each of the above steps was the officially adopted community general plans and special area plans such as the Tempe Rio Salado Plan, and the Sky Harbor Center Master Plan. All of these plans were incorporated directly into the growth risk estimation process. The Rio Salado Plan, which has not yet received voter approval, and which has not been developed beyond broad concepts, will be evaluated in detail in the Land Use Alternatives chapter to provide development guidelines for insuring compatibility between the project and Sky Harbor operations.

RESIDENTIAL DEVELOPMENT

The potential population growth for the Detailed Study Area is presented in Table 4G, by jurisdiction and by type of residence, for current baseline (1986) conditions, and forecast conditions (1992, 1997 and 2007).

Presently, the Detailed Study Area contains approximately 193,170 residents, 106,246 (55%) of whom are in Phoenix, 56,229 (29%) are in Tempe, and the remaining 29,795 (16%) are in Mesa, Scottsdale and unincorporated Maricopa County. By 2007, the total population is expected to grow to 228,773, an increase of 19 percent. Roughly one third of this increase is expected to occur in the next five years. The relative shares of the five jurisdictions, however, are expected to remain relatively static.

The distribution of population by type of structure in which they reside should change significantly. For instance, currently approximately 53 percent of the total population resides in single-family dwellings, 40 percent in multi-family units, and 7 percent in mobile homes. During the next 20 years, mobile home population should decline very slightly in absolute terms and from 7 to 6 percent relatively. Single-family residents should increase slightly in absolute terms, but decline markedly in relative terms (from 53% to 45%). The major gains will be in multi-family residents which will rise markedly in absolute terms (from 77,289 to 110,629) and in relative terms (from 40% to 49%). This trend is very much to the good because most of the population growth will be in the most noise-tolerant type of housing; population in the most noise-sensitive housing, mobile homes, will actually decline in absolute numbers.

TABLE 4G
Potential Population Growth In Detailed Study Area

	Phoenix	Tempe	Mesa	Scottsdale	County	Total
1986	106,746	56,229	13,163	15,335	1,297	193,170
Single Family	69,006	17,408	7,815	8,150	32	102,411
Multi-Family	29,708	36,662	5,212	5,707	0	77,289
Mobile Home	8,032	2,559	136	1,478	1,265	13,470

TABLE 4G (continued)
Potential Population Growth In Detailed Study Area

	Phoenix	Tempe	Mesa	Scottsdale	County	Total
1992	116,063	60,306	13,664	15,980	1,297	207,310
Single-Family	69,419	17,887	8,160	7,937	32	103,435
Multi-Family	38,649	39,860	5,368	6,565	0	90,442
Mobile Home	7,995	2,559	136	1,478	1,265	13,433
1997	122,283	62,743	14,147	16,256	1,297	216,726
Single-Family	69,404	18,224	8,495	8,074	32	104,229
Multi-Family	44,912	41,960	5,516	6,704	0	99,092
Mobile Home	7,967	2,559	136	1,478	1,265	13,405
2007	129,178	66,649	15,067	16,582	1,297	228,773
Single-Family	69,195	18,173	9,145	8,248	32	104,793
Multi-Family	52,070	45,917	5,786	6,856	0	110,629
Mobile Home	7,913	2,559	136	1,478	1,265	13,351

No jurisdiction is expected to experience an increase in population in mobile homes over the next 20 years. Phoenix, Tempe, Scottsdale and the County should retain their present numbers of population in single-family dwellings, with little or no increase. Only Mesa should have a significant increase in single-family homes, due primarily to a new development north of the Tempe Canal between Dobson and Alma School Roads.

FUTURE POPULATION IMPACTS

The evaluation of noise impacts on future resident population is approached in two distinct ways. In the first, the forecast Ldn noise contours for 1992, 1997 and 2007 are compared solely to the 1986 baseline population distribution in order to determine the probable conditions in store for those residents who now are in the study area. Secondly, the forecast Ldn noise contours are compared to the population distributions developed as part of the growth risk projections. This analysis provides an opportunity to gauge the levels of impacts that should be expected to occur if the airport and other aviation interests do nothing more to abate noise than what is assumed in the forecasts, and if the local municipalities continue their development policies more or less as they now are.

The population impacts which would result from the forecast noise levels over present inhabitants are shown in Table 4H. The respective noise contours are depicted over current (and forecast) land uses in Exhibit 4D, 4E and 4F. The noise contours are drawn from those in Exhibits 2K, 2L and 2M. The existing residential land use patterns were developed during the analysis of potential growth risk, described in the previous section.

TABLE 4H
Population Impacts In Ldn Contour Ranges
(Current Population)

1987 Unabated	Phoenix	Phx-West	Phx-East	Tempe	Total
65-70	8,781	8,566	215	6,335	15,116
70-75	9,415	9,415	0	2,230	11,645
75+	4,232	4,232	0	0	4,232
65+	22,428	22,213	215	8,565	30,993
1992 Unabated					
65-70	9,905	9,571	334	5,369	15,274
70-75	12,002	12,001	21	2,711	14,773
75+	1,557	1,557	0	0	1,557
65+	23,484	22,129	355	8,080	31,564
1997 Unabated					
65-70	10,792	10,448	344	5,919	16,211
70-75	11,978	11,978	0	2,380	14,358
75+	1,309	1,309	0	0	1,309
65+	24,079	23,735	344	8,299	32,378
2007 Unabated					
65-70	9,751	9,553	198	5,941	15,692
70-75	9,615	9,494	121	1,205	10,870
75+	20	20	0	0	20
65+	19,386	19,067	319	7,146	26,532

The total impacts on current resident population is shown in Table 4H to be expected to increase slowly at a relatively constant rate until beyond 1997. By that time the numbers should decline by 5,800 from more than 32,000 to approximately 26,500, a decrease of 18 percent. The greatest change at that time will occur within the Ldn 75+ range, where impacts should decline from nearly 3,200 to nearly none. Reductions of impacts after 1997 are also pronounced in the Ldn 70-75 range (down 24%), while the population in the Ldn 65-70 range should decrease slightly, and many of these impacts will occur on residents previously exposed to higher Ldn levels.

The largest reduction in impacts over the 20 years will be in Phoenix-west (4,668 people out of 5,846 total decrease). This disproportionately large effect has to do with the present location of population relative to the contours. To the east of Sky Harbor most population lies along the contour sidelines, while most impacted population to the west lies directly beneath the flight tracks. As contour sizes are reduced, however, the greatest shrinkage occurs down-range beneath the flight tracks, rather than perpendicularly along the side lines.

The population impacts which would result from the forecast noise levels over current (1986) and forecast (1992, 1997 and 2007) inhabitants are shown in Table 4I. The respective noise contours are depicted over forecast land uses in Exhibits 4D, 4E and 4F. The noise contours are those developed in Chapter Two and the forecast population distribution was developed as part of the preceding analysis of potential growth risk.

TABLE 4I
Population Impacts In Ldn Contour Ranges (Forecast Population)

Current Population vs. 1987 Unabated Noise	Phx.	Phx. West	Phx. East	Tempe	Total
65-70	8,781	8,566	215	6,335	15,116
70-75	9,415	9,415	0	2,230	11,645
75+	4,232	4,232	0	0	4,232
65+	22,428	22,213	215	8,565	30,993
Forecast Population vs. 1992 Unabated Noise					
65-70	11,101	10,819	282	5,801	16,902
70-75	13,367	13,367	0	3,150	16,517
75+	1,668	1,668	0	0	1,668
65+	25,136	24,854	282	8,951	34,087
Forecast Population vs. 1997 Unabated Noise					
65-70	10,611	10,346	265	7,070	17,681
70-75	14,106	14,106	0	2,724	16,830
75+	1,511	1,511	0	0	1,511
65+	25,228	25,963	265	9,794	36,022

Exhibit 4D (WEST)
1992 NOISE LEVELS OVER
1992 RESIDENCES

Sky Harbor INTERNATIONAL AIRPORT

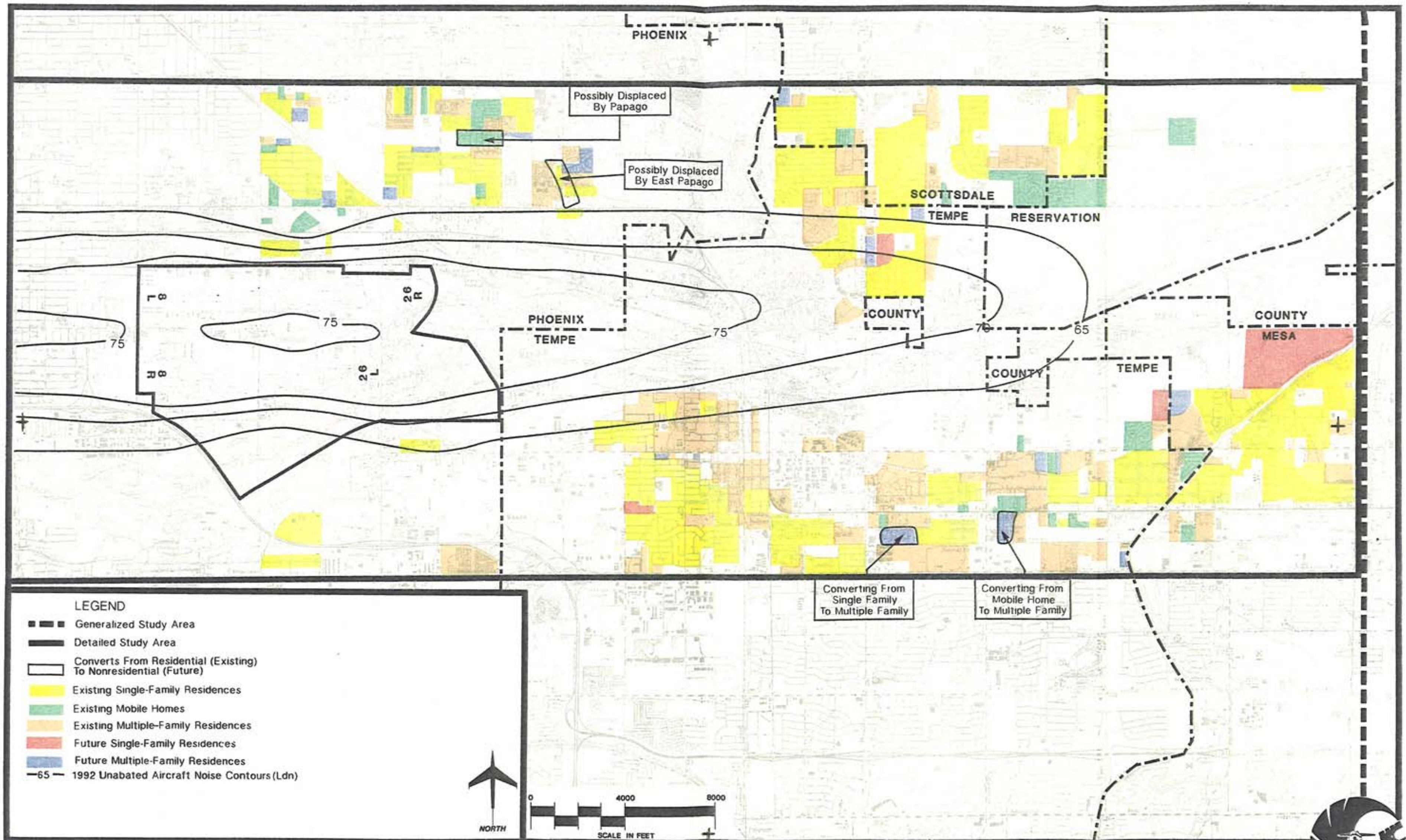


Exhibit 4D (EAST)
1992 NOISE LEVELS OVER
1992 RESIDENCES

Sky Harbor
INTERNATIONAL AIRPORT

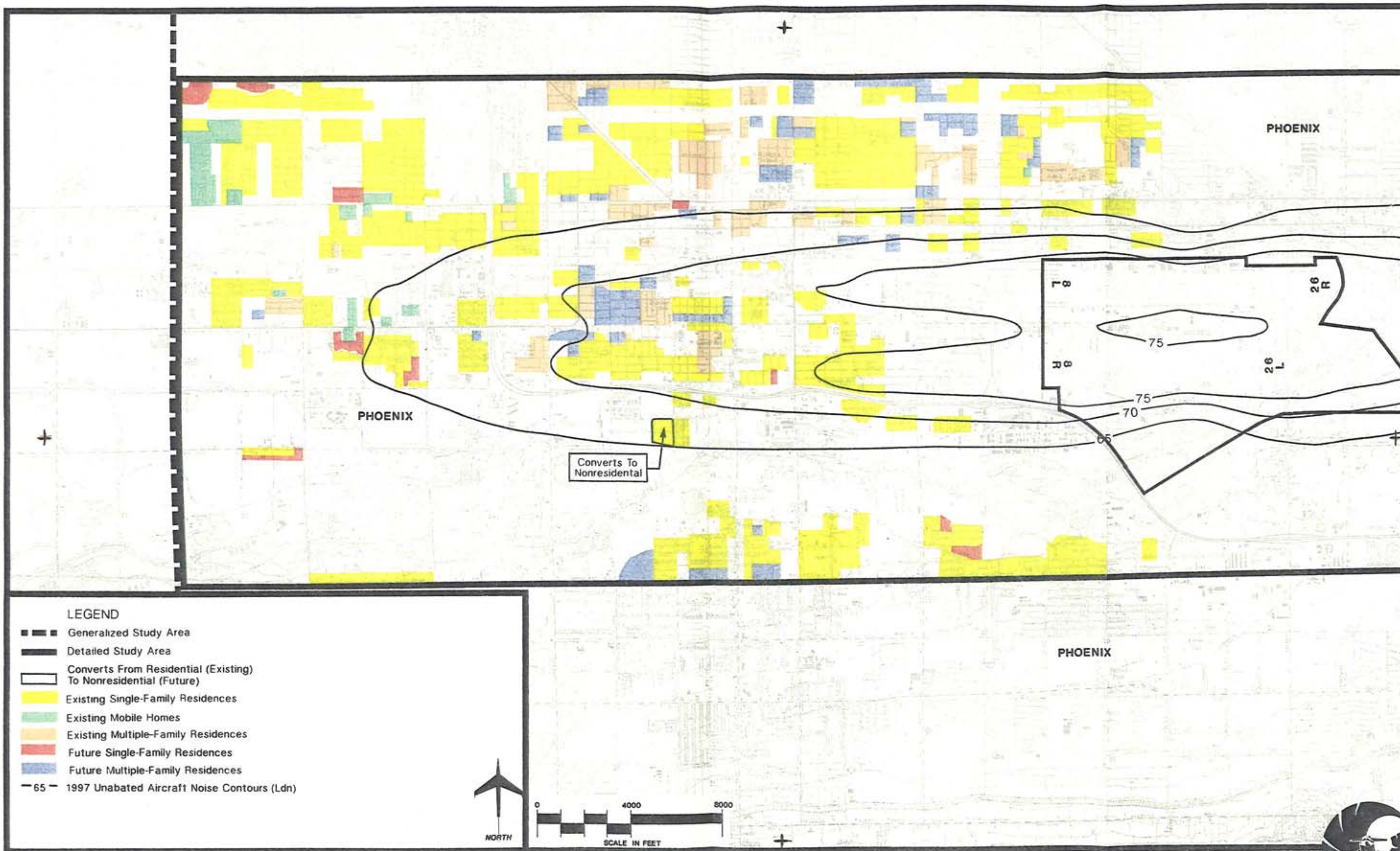


Exhibit 4E (WEST)
1997 NOISE LEVELS OVER
1997 RESIDENCES

Sky Harbor INTERNATIONAL AIRPORT

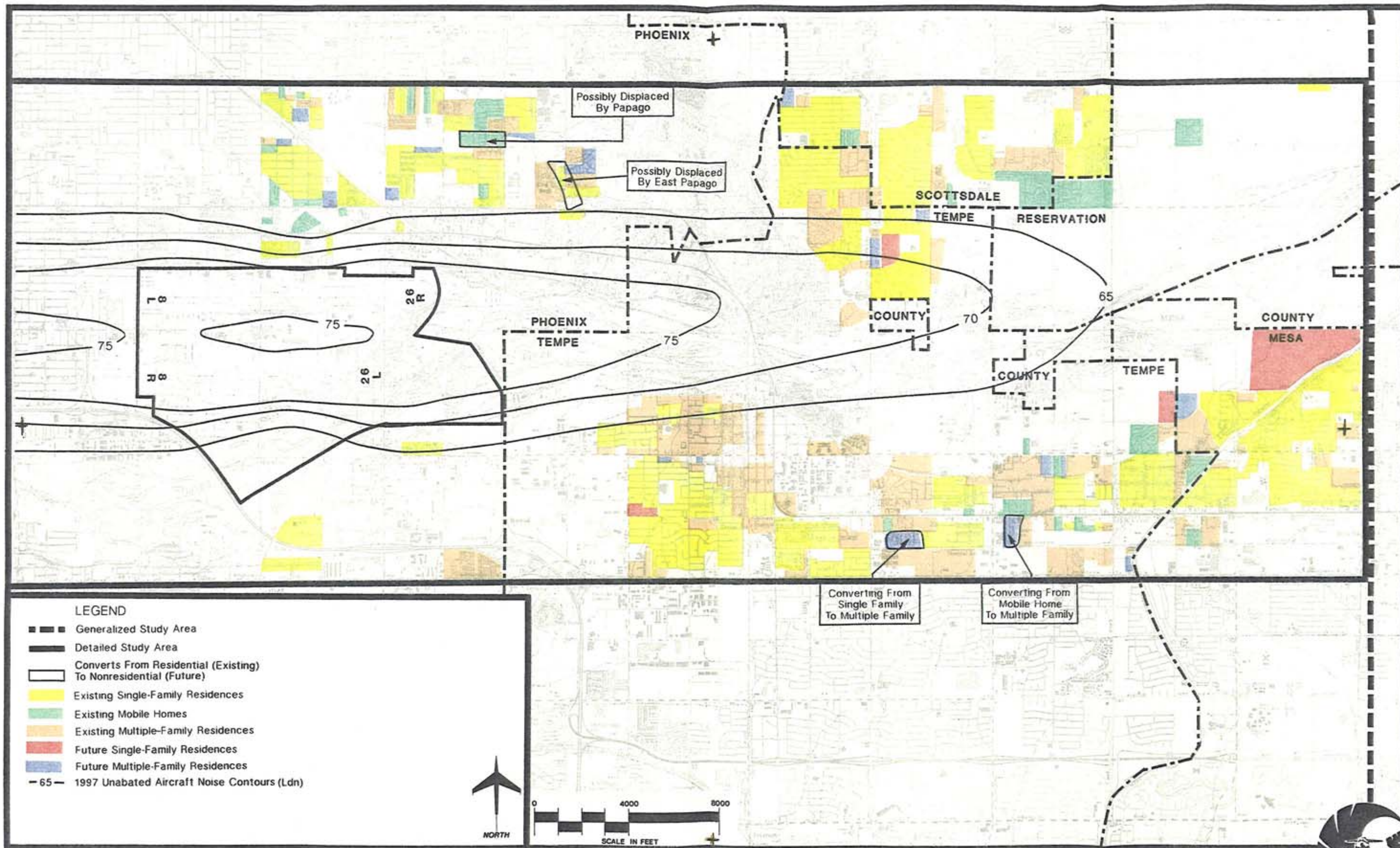


Exhibit 4E (EAST)
1997 NOISE LEVELS OVER
1997 RESIDENCES

Sky Harbor
INTERNATIONAL AIRPORT

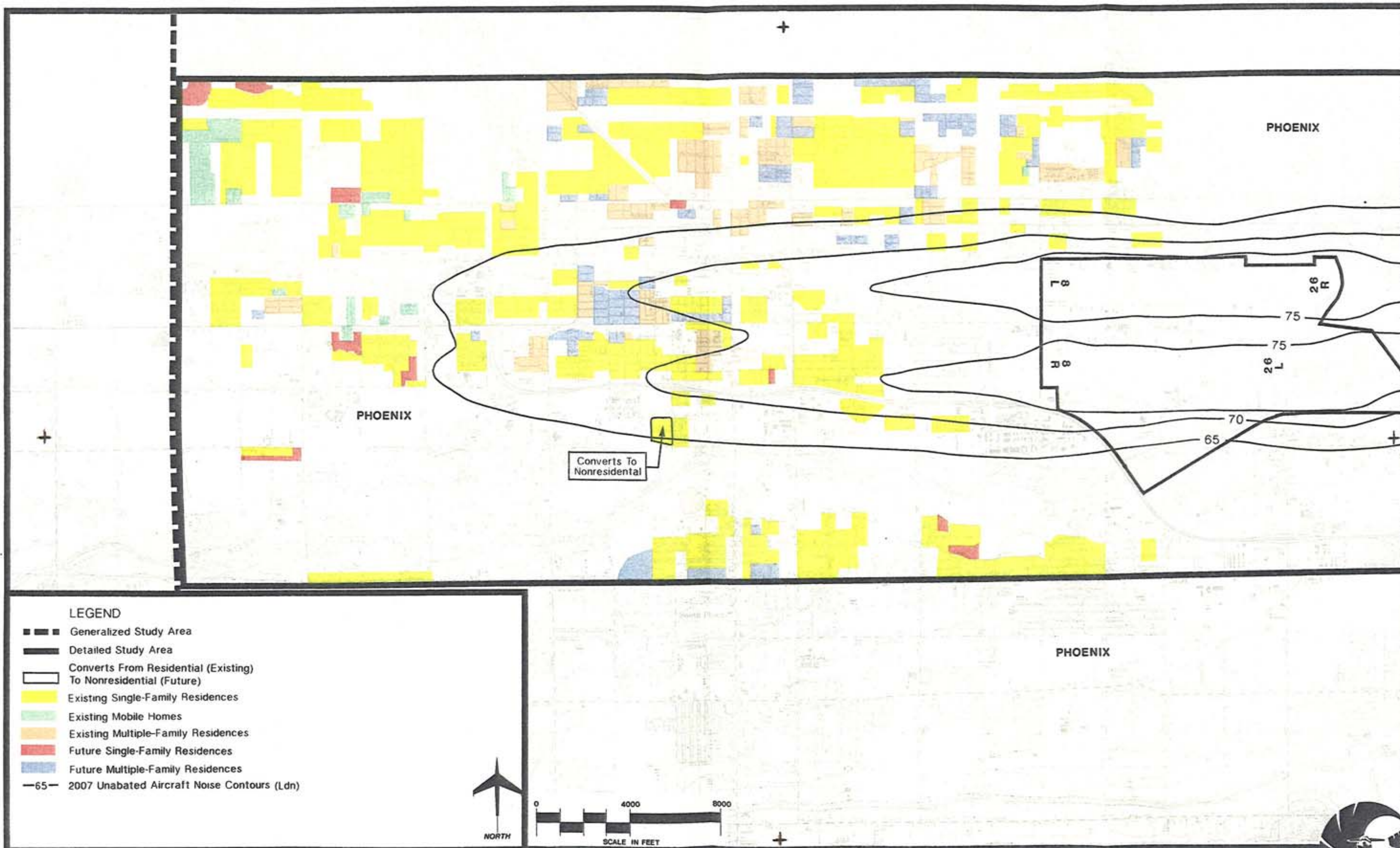


Exhibit 4F (WEST)
2007 NOISE LEVELS OVER
2007 RESIDENCES

Sky Harbor International Airport

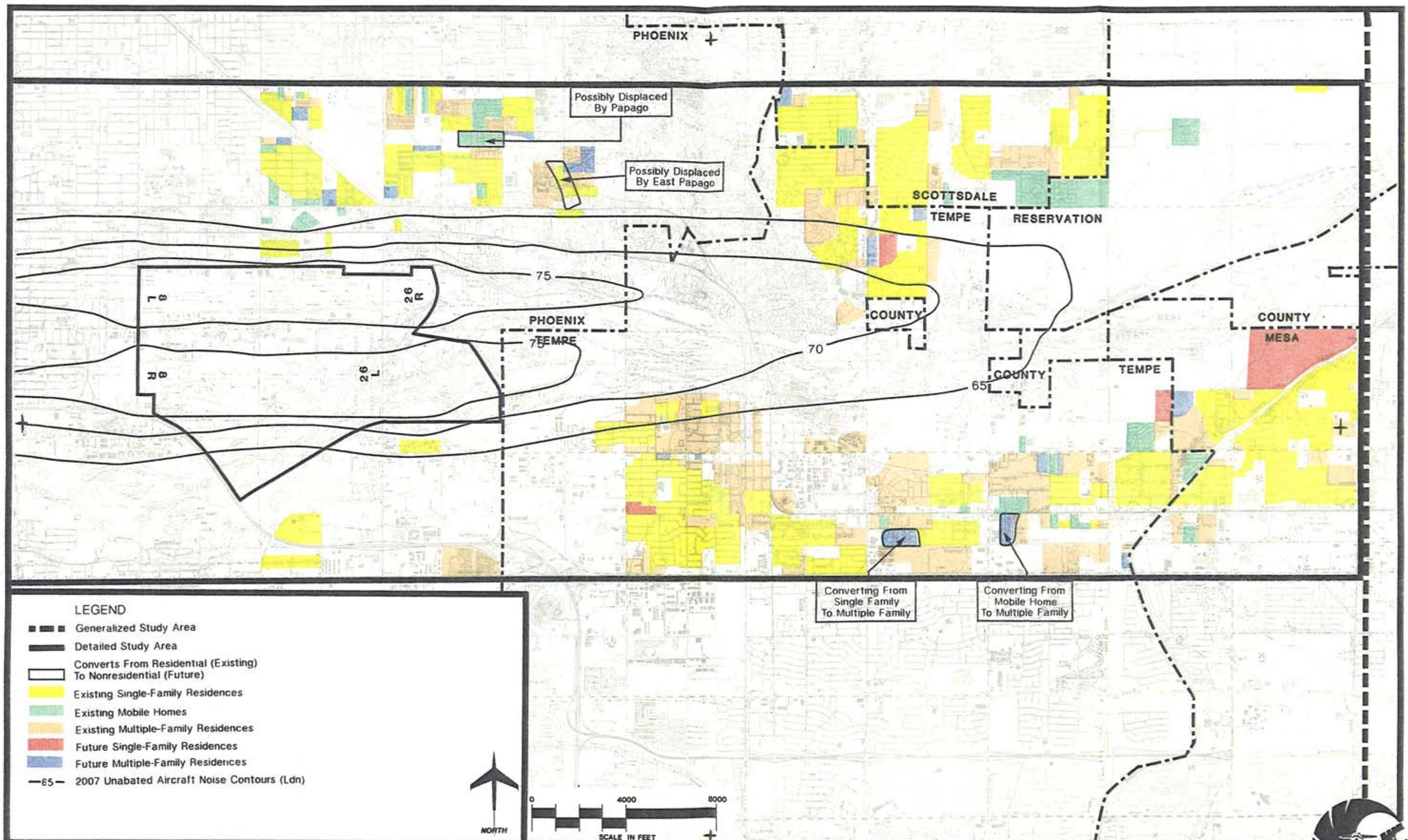


Exhibit 4F (EAST)
2007 NOISE LEVELS OVER
2007 RESIDENCES

Sky Harbor
INTERNATIONAL AIRPORT

The total impact on the forecast population is shown in Table 4H to increase significantly from 1987 to 1992 (up 10%), then rise slightly to 1997 (up 6%). Impacts should then decline significantly to 2007 (down 8%) to a level of 33,025 (2,032 above current levels, up 6%). Referring back to Table 4G, in which impacts on current population are expected to drop significantly, it is apparent that the increased impacts over forecast population are due to the large population growth, since the noise contours are the same for the two scenarios.

Based on the forecast population growth, the increases in impacted population should be most pronounced in Tempe (up over 1,600). Fortunately, these new impacts are in the Ldn 65-70 range and there is an actual major reduction in impacts at levels above Ldn 70 in Tempe. A similar effect is found in Phoenix, where the impacts above Ldn 75 should drop from over 4,200 to nearly zero.