OaklandInternational Airport

A division of the Port of Oakland

Aircraft Over Flight and Noise Analysis

At

Norwood Drive
Hayward, CA

Prepared by

Noise/Environmental Management Office
Port of Oakland

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Aircraft Over Flight and Noise Analysis
Norwood Drive, Hayward, CA

The residents on Norwood Drive began registering their aircraft noise concerns with the airport during the fall of 2010. The residents expressed their belief that aircraft overflights and noise had increased dramatically over the past year or so. In response to these concerns, Oakland International Airport, the Noise/Environmental Management Office performed a comprehensive aircraft over flight and noise study.

Aircraft Noise Terminology/Metrics

Appendix A defines the aircraft noise terminology used in this report.

Location and Concerns

Norwood Drive, Hayward is located approximately 11 miles southeast of Oakland International Airport. (See Figure 1.) This neighborhood lies generally below the straight-in final approach course for Runway 27L/R and the Pacific Northwest arrivals into Runway 29, at Oakland International Airport. This final approach course has been used since the runway opened in 1962.

Aircraft Flight Information

Runway 29 is used for aircraft arrivals and departures when the Bay Area is being operated in the West Plan air traffic pattern. Air traffic patterns are a function of the wind conditions and the prevailing winds are blowing from the west and northwest in the Bay Area the majority of the time. The West Plan air traffic pattern is maintained by FAA Air Traffic Control about 90% of the time throughout the year; otherwise the Southeast Plan is in effect. When the Southeast Plan is in effect, Runway 11 is used and aircraft arrive from the north and northeast and depart to the south and southeast. Currently about 160 turbojet aircraft land on Runway 29 daily and about 4% of these aircraft fly in the vicinity (within one mile) of Norwood Drive.

Runway 27L/R is generally used for general aviation arrivals and departures when the Bay Area is being operated in the West Plan air traffic pattern. Currently about 70 aircraft land on Runway 27L/R daily and about 73% of these aircraft fly in the vicinity (within one mile) of Norwood Drive.

Fig. 1: Norwood Drive – Analysis Location

The flight track maps provided in Figures 2 and 3 below present three-months of correlated aircraft arrivals, departures and over flights in a graphic form. Figure 2 presents correlated flight tracks for all Bay Area Airports arrivals, departures and over flights for three-months. Figure 3 presents correlated OAK flight tracks for aircraft arrivals and departures that caused a noise event at Norwood Drive.

Data Collection

Table 1 below indicates that aircraft over flights in the Norwood Drive area are primarily from OAK landings, HWD departures and HWD landings.

Table 1. Correlated Noise to Flights by Airport

Airport ID	Operation Type	Nov 2011 to Feb 2012
Transit Aircraft Over Bay Area	Overflight	60
Oakland International (OAK)	Landings	511
Oakland International (OAK)	Departures	8
Hayward Airport (HWD)	Landings	84
Hayward Airport (HWD)	Departures	145
San Francisco International (SFO)	Landings	0
San Francisco International (SFO)	Departures	2
Palo Alto Airport (PAO)	Landings	3
Palo Alto Airport (PAO)	Departures	0
San Jose Airport (SJC)	Landings	0
San Jose Airport (SJC)	Departures	1
San Carlos Airport (SQL)	Landings	5
San Carlos Airport (SQL)	Departures	8
Total		827

Point of Closest Approach Analysis

Table 2 and Table 3 below indicate the average Point of Closest Approach (PCA) to Norwood Drive from Oakland International Airport and Hayward Executive Airport. The graph below will help you interpret the PCA data (Slant Distance, Altitude, Ground Distance).

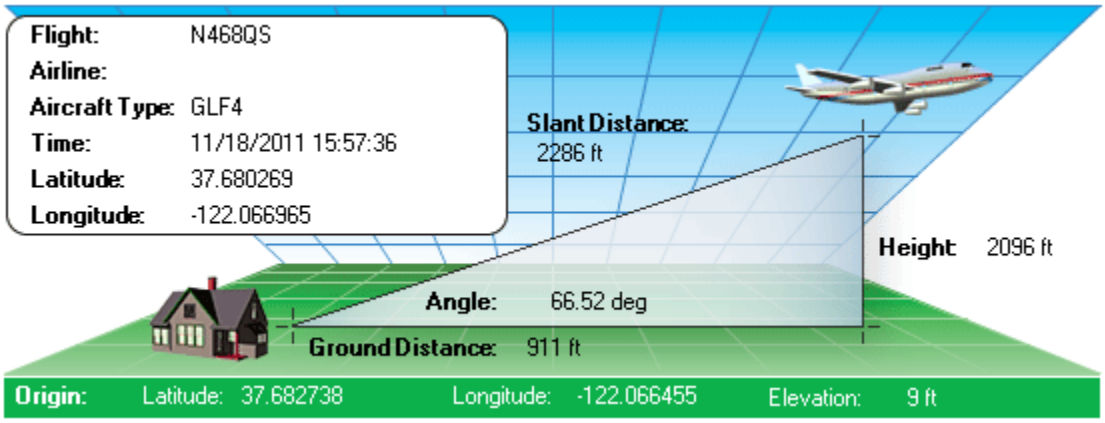


Table 2. Point of Closest Approach (PCA) Analysis
Correlated Noise Events for OAK Flights

Correlated Noise Events to Flights - OAK		
	Operation Type	
	Landings (511)	Departures 8)
Average of PCA Slant Dist (ft)	2,879	3,268
Average of PCA Alt (ft)	2,555	2,966
Average of PCA Ground Dist (ft)	1,210	1,268

Table 3. Point of Closest (PCA) Approach Analysis
Correlated Noise Events for HWD Flights

Correlated Noise Events to Flights - HWD		
	Operation Type	
	Landings (84)	Departures (145)
Average of PCA Slant Dist (ft)	1,899	2,228
Average of PCA Alt (ft)	1,319	1,586
Average of PCA Ground Dist (ft)	1,191	1,352

A permanent noise microphone (NMT #1) is located approximately four miles southeast of the airport, which is the closest permanent noise monitor to Norwood Drive. Since the neighborhood is about 11 miles away from the airport, a portable noise monitor was required. A Bruel & Kjaer (B&K) 2250 and 2270 portable noise monitor measured the noise environment at Norwood Drive for about three months. Based upon observations, a minimum threshold level for the neighborhood was established at 64 dBA with a minimum duration set at 5 seconds. That is, for a noise event to be recorded, it had to exceed the established threshold of 64 dBA for at least 5 seconds.

For each recorded event, the data collected by the B&K portable noise monitor consisted of event time, duration, Lmax, and calculated SEL.

All the noise event data collected by the portable noise monitor were stored in real time in the Airport Noise and Operations Monitoring System (ANOMS) and correlated with aircraft flight tracks in order to identify aircraft noise events from community noise events above 64 dBA. CNEL values for aircraft and community measurements were also calculated using ANOMS

ANOMS is a sophisticated computer system that integrates aircraft identification, aircraft flight track data and noise data, which is utilized to evaluate aircraft noise impacts on local communities. Data gathered by ANOMS was used to evaluate not only aircraft noise but also aircraft performance and operations statistics for this report.

Every OAK aircraft that that exceeded 64 dBA for at least 5 seconds over Norwood Drive was evaluated for noise events, and altitude.

Fig. 2: All Bay Area Airport Flights Correlated with Noise Events
November 18, 2011 to February 8, 2012

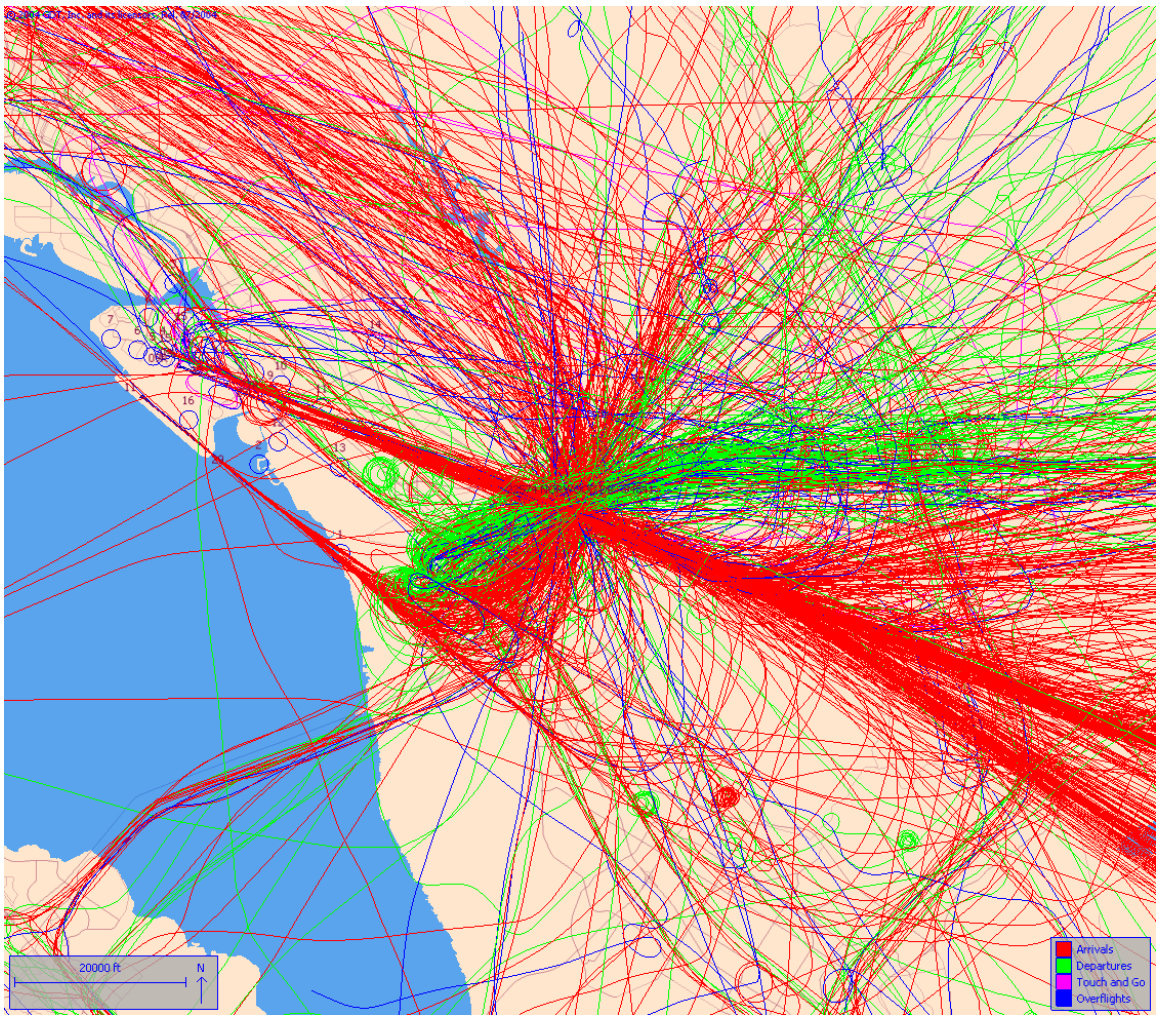
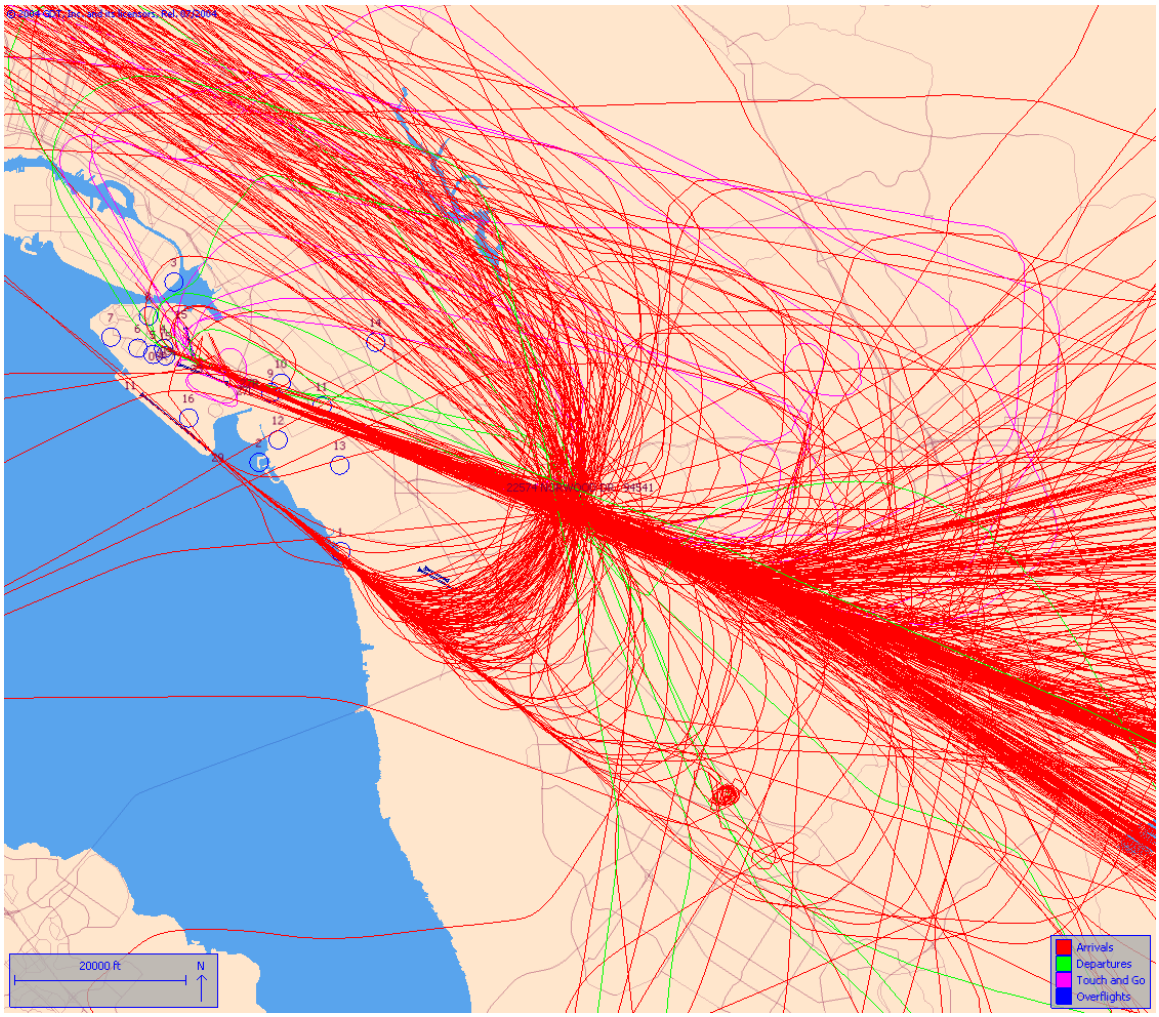


Fig. 3: Oakland International Airport Flights Correlated with Noise Events November 18, 2011 to February 8, 2012



Aircraft Noise Analysis

Noise measurements were taken for three months at Norwood Drive between November 18 2011 and February 8, 2012. Table 4 below provides a summary of the noise measurement study. Table 5, 6 & 7 provides a summary of the day, evening and night time noise measurement study. There were 827 identified correlated aircraft noise events associated with Bay Area Airports and 519 identified correlated aircraft noise events associated with Oakland International Airport over three-months.

For the 519 aircraft noise events, the average aircraft generated Lmax was 68 dBA (decibels, A-weighted), the average SEL was 76 dBA, and the average aircraft noise event duration was 12 seconds. The computed levels for the average **aircraft CNEL** was 39 dBA, the average **community CNEL** was 51 dBA, and the **total CNEL** was 52 dBA. For comparison purposes, the current cumulative aircraft noise level at the permanent

microphone RMT# 1, which is located approximately nine miles closer to the airport, is CNEL 65 dBA.

Table 4: OAK Aircraft Noise Data Summary

	Total Flights/ Correlated Noise Events	Lowest Value	Highest Value	Average Value
Aircraft Lmax	519	64 dBA	81dBA	68 dBA
Aircraft SEL	519	69 dBA	86 dBA	76 dBA
Noise Event Duration	519	6 seconds	57seconds	12 seconds
Aircraft CNEL	83 days	CNEL 42 dBA	CNEL 51 dBA	CNEL 39 dBA
Community CNEL	83 days	CNEL 47dBA	CNEL 57 dBA	CNEL 51 dBA
Total CNEL	83 days	CNEL 47 dBA	CNEL 58 dBA	CNEL 52 dBA

Table 5: OAK Aircraft Noise Data Summary
7:00 AM to 7:00 PM - Day

	Total Flights/ Correlated Noise Events	Lowest Value	Highest Value	Average Value
Aircraft Lmax	405	64 dBA	81 dBA	68 dBA
Aircraft SEL	405	69 dBA	86 dBA	76 dBA
Noise Event Duration	405	6 seconds	57 seconds	12 seconds

Table 6: OAK Aircraft Noise Data Summary
7:00 PM to 10:00 PM - Evening

	Total Flights/ Correlated Noise Events	Lowest Value	Highest Value	Average Value
Aircraft Lmax	76	64 dBA	77 dBA	68 dBA
Aircraft SEL	76	69 dBA	84 dBA	76 dBA
Noise Event Duration	76	6 seconds	36 seconds	12 seconds

Table 7: OAK Aircraft Noise Data Summary
10:00 PM to 7:00 AM - Night

	Total Flights/ Correlated Noise Events	Lowest Value	Highest Value	Average Value
Aircraft Lmax	38	64 dBA	73 dBA	67 dBA
Aircraft SEL	38	70 dBA	82 dBA	75 dBA
Noise Event Duration	38	6 seconds	26 seconds	12 seconds

Conclusions

Aircraft noise levels at Norwood Drive are at levels expected in a community that is 11 miles away from the airport but lies below the final approach course of a main commercial use runway at an airport the size of Oakland International. Actual aircraft noise measurements contribute 1 dBA additional noise to the total cumulative average total noise levels (CNEL). The average community CNEL was 51 dBA (83 days of measurements) and the aircraft CNEL was 39 CNEL dBA. When the aircraft noise was added to the community noise the total CNEL was 52 dBA.

The State of California airport noise regulations state: "The standard for the acceptable level of aircraft noise for persons living in the vicinity of airports is hereby established to be a community noise equivalent level of 65 decibels." Since the average aircraft community noise equivalent level (CNEL) was measured at 39 dBA for Norwood Drive, this residential area has an acceptable level of aircraft noise as defined by State law. Figure 4 below presents a current airport noise contour map that shows the extent of the 65 dBA CNEL noise contour at Oakland International Airport.

The amount of aircraft flight levels over Norwood Drive in Hayward has changed very little, if not at all, over the past few years. There was a drop in flight levels for several months after September 11, 2001 but air traffic has continued to increase since then and is expected to increase about 1-2% per year in the future as passenger demands increase.

In the winter of 2010 the residents at Norwood Drive complained of aircraft noise. During the winter in 2010/2011 Bay Area airports where operating in the Southeast flight pattern significantly more than in the winter of 2011/2012. Normally Southeast Plan occurs 9% of the time. From October 1, 2011 to February 24, 2012 OAK operated in the Southeast Plan 3.7% of the time, which is below the average. From October 1, 2010 to February 24, 2011 Oak operated in the Southeast Plan 11.5% of the time, which is higher than average. This could have resulted in additional aircraft noise events during winter 2010/2011.

Fig. 4: Oakland International Airport Noise Contours

Oakland International Airport

Oakland, California

Fourth Quarter 2010 Noise Contours

0 6,000 12,000 Feet

March 4, 2011

Southeast Plan
Over East Bay Communities

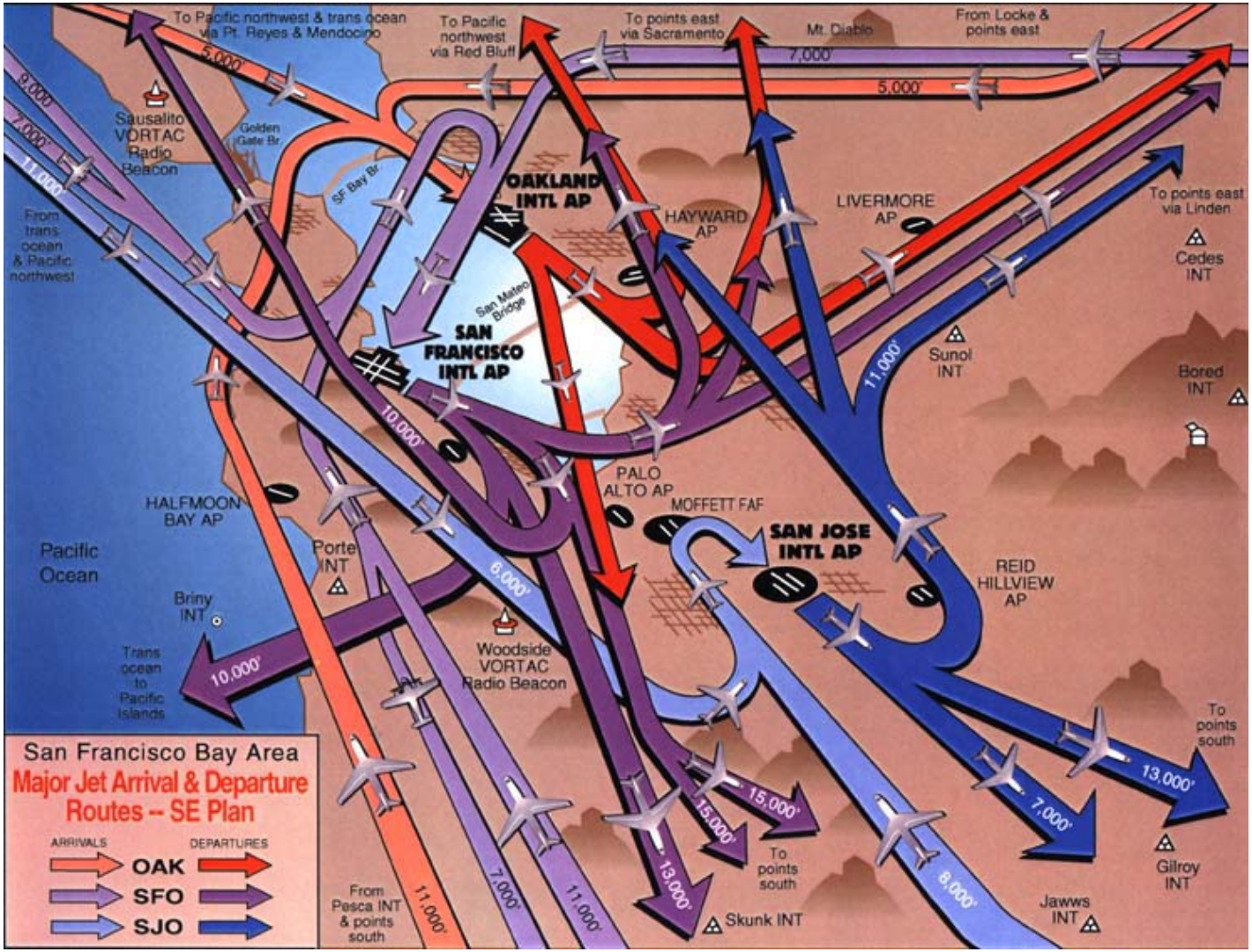
Winds in the Bay Area predominantly blow from the west to the east. With winds from the west, the North Flow air traffic pattern (referred to as the “West Plan”) is in effect. When wind direction in the Bay Area reverses and is from the southeast, the South Flow air traffic pattern (referred to as the “Southeast Plan”) is in effect. The FAA alters the traffic pattern to the Southeast Plan when weather conditions such as winter storms shift the wind direction. Historical data collected for the years 1999-2001 by the Airport Noise Management Office demonstrate that 91.5 percent of all arrivals and departures occur when the Airport is operating in the West Plan, which generally involves arrivals from the south and departures to the north.

Because arrival and departure patterns differ under the two plans, noise related to aircraft events is experienced differently depending on which plan is in effect. Under West Plan conditions, areas to the north of the Airport experience noise related to departing aircraft, whereas areas to the south experience aircraft arrival noise. Under the Southeast Plan, the opposite effects occur.

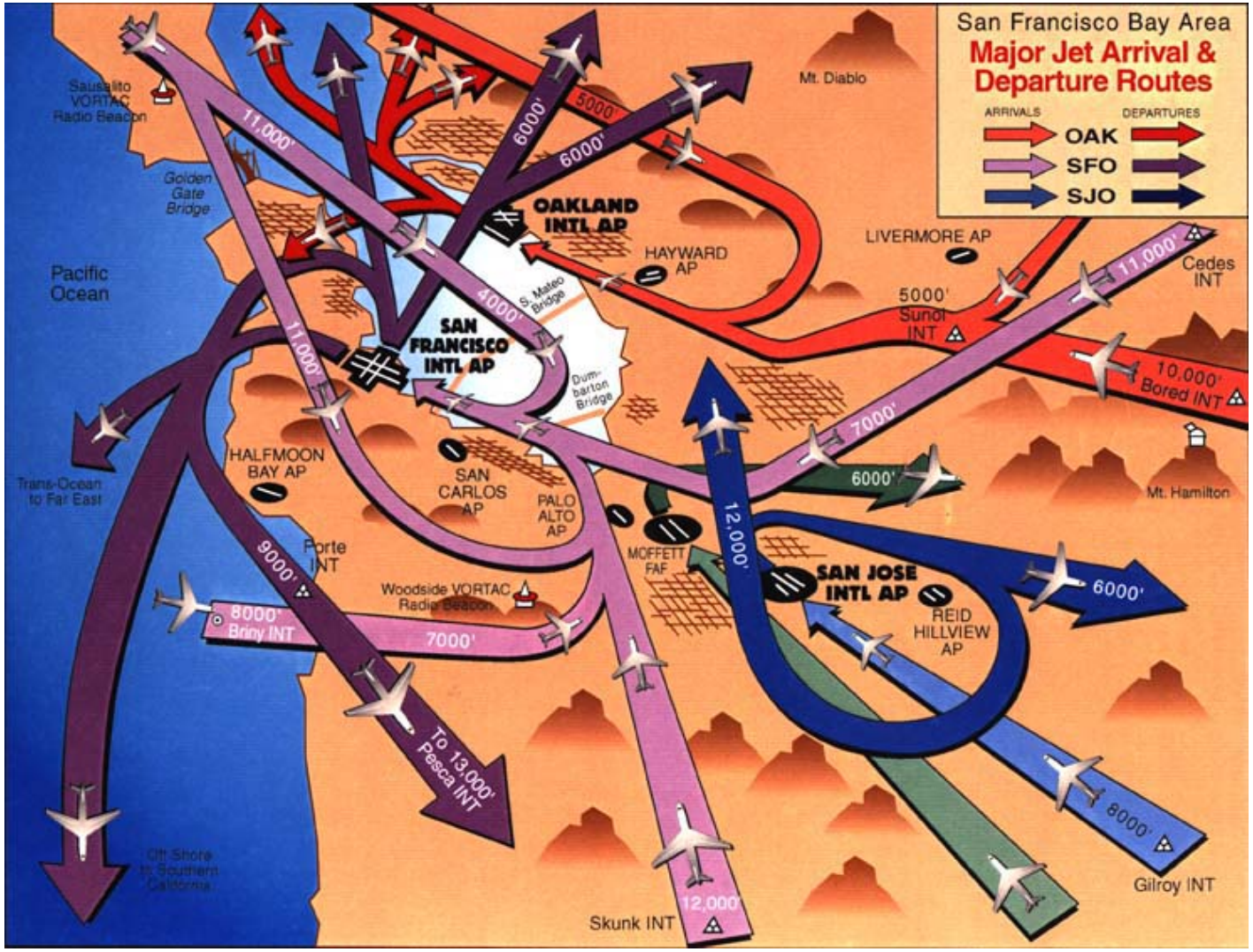
The Southeast Plan is perceived by the public as a dramatic change in the air traffic pattern and the change generates public reaction and aircraft noise complaints. Below, are flight track maps displaying Bay Area air traffic patterns associated with Oakland International Airport (OAK) and San Francisco International Airport (SFO) during the West Plan and the Southeast Plan.

Southeast Plan air traffic routes are frequently implemented during winter months. When these procedures are in place jets will fly over northern East Bay communities on arrival routes to both Oakland and San Francisco International Airport. As displayed by the flight track map, SFO aircraft arrival tracks intersect with OAK aircraft arrival tracks in the North Bay Area. In order to keep these aircraft safely separated, air traffic routes have been established to maintain the SFO arrivals above the OAK arrivals. These routes have long been used and the Federal Aviation Administration is unable to make changes to these procedures.

Southeast Plan Characterization Graphic



West Plan Characterization Graphic



Appendix 1: Aircraft Noise Terminology/Metrics

To assist in understanding the noise measurements and noise metrics used in evaluating airport noise, this fact sheet provides a brief introduction to noise terminology used in this report. Specifically, the noise metrics discussed are the decibel (dB), the A-weighted sound level, the maximum noise level (Lmax), the sound exposure level (SEL), and the Community Noise Equivalent Level (CNEL).

The decibel or dB is the unit of measure used to represent the change in sound pressure, which is detected by the human ear. Since the range between the slightest and greatest sounds that we hear is extremely large, the decibel uses the logarithmic scale to compress this range to a more meaningful scale with 0 dB representing the slightest sound we can hear. Most sounds we experience in our day-to-day lives vary somewhere between 30 dB and 100 dB. Figure 2 presents typical sound levels of several common transportation sources.

Aircraft sound measurements generally use the metric known as A-weighted sound level. This is the sound level that has been filtered or weighted to reduce the influence of high and low frequency extremes. This closely replicates the sensitivity of the human ear in the frequency range of 500 – 10,000 Hz and correlates well with perceptions of the loudness of sounds. Thus, an aircraft noise event with a higher A-weighted sound level is perceived to be louder than an aircraft noise event with a lower A-weighted sound level. This correlation with human's perception of loudness is the primary reason that A-weighted sound levels are used to evaluate environmental noise sources.

The sound level heard during an arrival or departure of an aircraft varies as a function of the distance from the aircraft to the person hearing the noise (or "receiver"), and as a function of the direction of the aircraft noise source. As the aircraft approaches the receiver, the sound level increases and, as the aircraft moves away from the receiver, the sound level decreases. The effect of noise exposure during such an event can be described in terms of either the maximum sound level (Lmax) or the sound exposure level (SEL) of individual aircraft noise events.

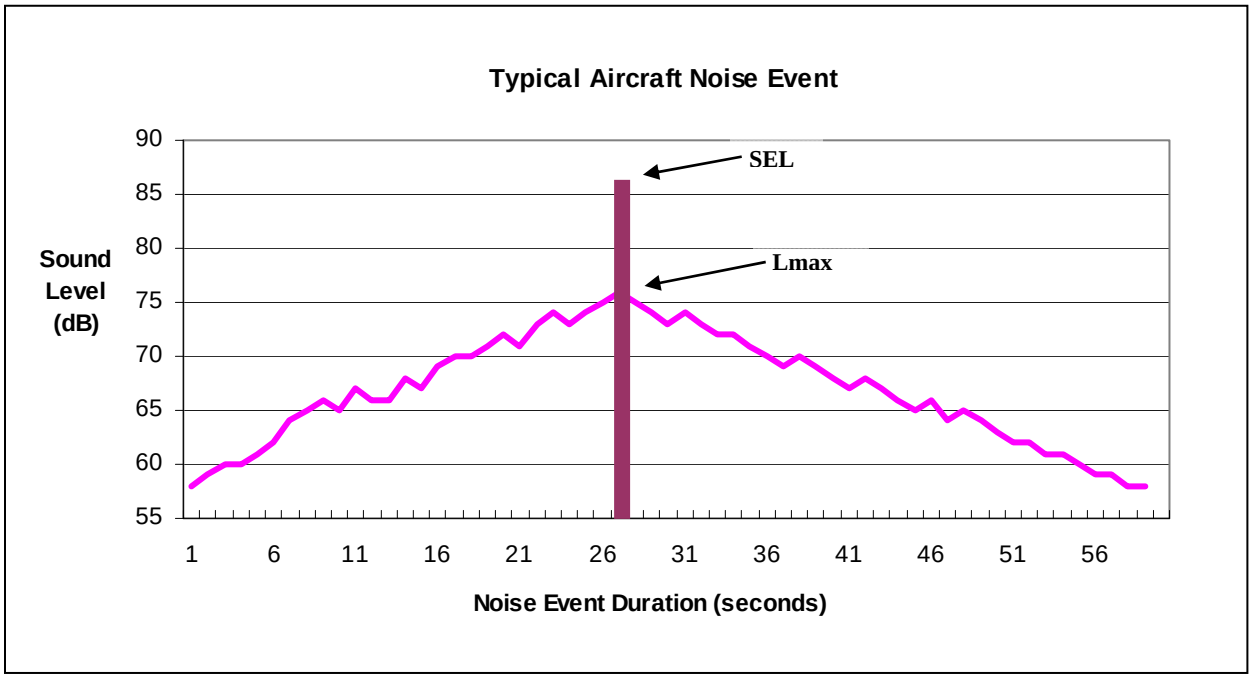
Noise Event Metrics

The **maximum sound level (Lmax)** metric represents the highest instantaneous noise level heard at a receiver site during a single aircraft event (arrival or departure). However, since this metric describes only the instantaneous maximum noise value, it provides no information on the duration of noise exposure. Human response to noise is not only a function of the maximum level, but also of the duration of the event. Therefore, a term or metric is needed that accounts for both intensity and duration and provides a uniform assessment of noise events with differing intensities and durations. This metric is the sound exposure level or SEL.

The **sound exposure level (SEL)** represents the cumulative sound energy detected above an established threshold for a single event considering both intensity and duration of the sound. The SEL represents the acoustical energy of the event once it surpasses a specified noise level, but as though it had occurred within one second. Thus, for

example, two events with the same intensity but different durations can be differentiated with the longer duration event having a higher SEL. For locations relatively close to an airport, the SEL for most aircraft departures will usually be about 10 decibels higher than the corresponding Lmax. For example, an aircraft departure producing a maximum sound level of 70 dB at a particular location would be expected to produce an SEL value of about 80 dB at the same location. Figure 1 is a graphic representation of a typical aircraft noise event. Thus, SEL gives us a common basis for comparing noise events that matches our instinctive impression – the higher the SEL, the more annoying it is likely to be.

Fig. 1: Time History of a Typical Aircraft Noise Event



The **Community Noise Equivalent Level (CNEL)** is a method of predicting, by a single number rating, cumulative aircraft noise that affects communities in airport environs. As defined in the California Airport Noise Standards, CNEL represents the average daytime noise level during a 24-hour day, adjusted to an equivalent level to account for the lower tolerance of people to noise during evening and nighttime periods relative to the daytime period. CNEL applies a weighting to aircraft events occurring during the evening and nighttime time periods. For evening (7:00 PM – 9:59 PM) and nighttime (10:00 PM – 6:59 AM) aircraft noise events, CNEL logarithmically multiplies each operation by 3 and 10, respectively. This effectively adds 4.8 dB to evening event SELs and 10 dB to nighttime event SELs.

The aircraft CNEL is then derived using the SELs from all aircraft generated events for the period. A total CNEL will include the aircraft generated events as well as other noise events generated in the community during the corresponding time period. Typically, total CNEL in our environment ranges from a low of 40-45 dB in very quiet locations to 80-85 dB immediately adjacent to an active noise source – busy traffic route or active airport. Figure 3 shows representative values of CNEL in typically different

environments. Aircraft CNEL is also used to depict noise contours of equal exposure levels around an airport to reflect long-term operations, usually one year.

Fig. 2: Common Transportation Sound Levels in dB

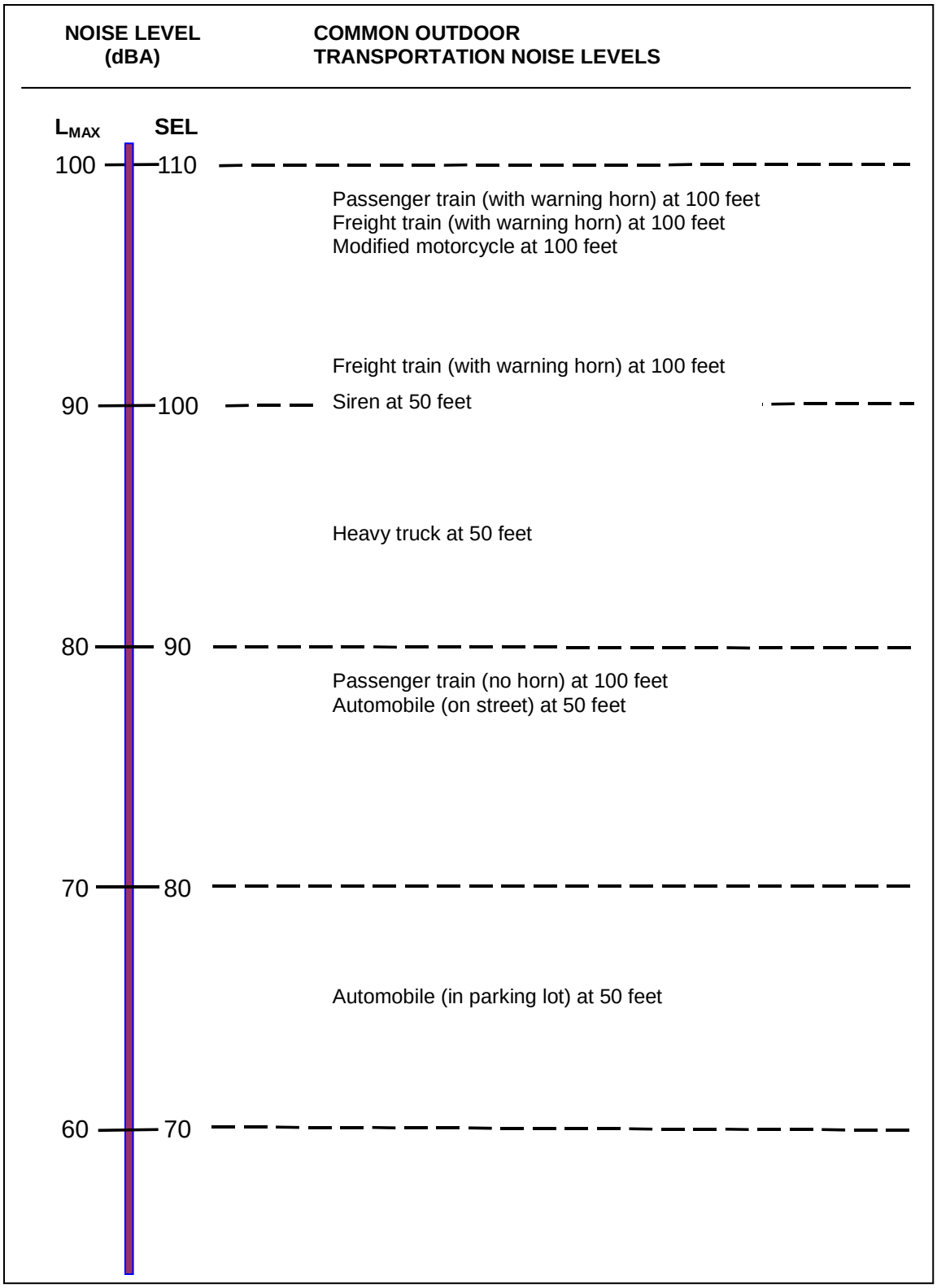


Figure 3: Representative Cumulative Sound Levels