LINCOLN REGIONAL AIRPORT
MASTER PLAN

Appendix B
Aircraft Noise Assessment

AIRCRAFT NOISE ASSESSMENT

AIRPORT MASTER PLAN
LINCOLN REGIONAL AIRPORT
LINCOLN, CALIFORNIA

PREPARED FOR

Jim Wallace Environmental Consulting Services
233 North Andrew Avenue
Port Townsend, WA 98368

PREPARED BY

Brown-Buntin Associates, Inc.
Fair Oaks, California

REVISED
JULY 27, 2007

BBA
BROWN • BUNTIN
ASSOCIATES, INC.

INTRODUCTION

The project consists of a Master Plan for the Lincoln Regional Airport (LMH) in Placer County, California. The project considers construction of a new runway and an extension to the existing runway. It is the purpose of this report to document the potential changes in aircraft noise exposure that could result from the Master Plan and its alternatives. It is expected that the findings of this analysis will be incorporated into an Environmental Assessment for the project.

The noise-related implications of the project were analyzed using the Federal Aviation Administration (FAA) Integrated Noise Model (INM), based upon airport operations and airfield configuration information obtained from the Airport's Engineer and available environmental documentation.

Noise exposure information was quantified in terms of the Community Noise Equivalent Level (CNEL) for existing (2005) and forecast future (2030) operations. The CNEL is the noise metric required by the FAA and State of California for assessing potential noise impacts resulting from proposed airfield improvement projects and for planning for compatible land use around airports. Appendix A provides definitions of the acoustical terminology used in this report.

AIRCRAFT NOISE IMPACT ASSESSMENT

The Integrated Noise Model (INM):

Version 7.0 of the INM was used to prepare CNEL noise exposure maps for the Lincoln Regional Airport for existing and future conditions. The INM was developed for the FAA, and it represents the federally sanctioned and required method for assessing potential aircraft noise impacts resulting from airfield improvement projects. Version 7.0 is the current version of the INM.

The INM calculates aircraft noise exposure by mathematically combining aircraft noise levels and airport operations factors at a series of points on a map that defines the location of airport runways and generalized aircraft flight tracks. The model then interpolates between points to plot contours of equal noise exposure. User inputs to the INM include the following:

- Runway/helipad configuration
- Airport elevation and mean temperature
- Aircraft flight track definitions
- Distribution of aircraft to flight tracks
- Aircraft departure stage lengths
- Aircraft approach profiles
- Aircraft traffic volume and fleet mix
- Temporal distribution of flights (day, evening, night)

The INM database includes aircraft performance parameters and noise level data for most of the larger civilian aircraft presently in service at U.S. airports. Beginning with Version 7, the INM also includes data for several commonly-used helicopters, and incorporates the pertinent features of the FAA's Helicopter Noise Model (HNM). When a user specifies a particular aircraft type from the

INM database, the model automatically provides the necessary inputs concerning aircraft power settings, speed, arrival/departure profiles and noise levels. Since each airport is different in terms of the types of aircraft flown and local operating conditions, aircraft types and operating assumptions from the INM database must be carefully selected.

The INM can account for changes in the distance from the receptor to the aircraft noise source (slant range distance) due to variations in local terrain. Terrain is a minimal factor in the immediate vicinity of the Lincoln Regional Airport. The INM does *not* take into account reflections from nearby buildings or acoustical shielding provided by buildings or extensive vegetation. Such factors can be significant in areas located adjacent to an airport where noise levels generated by aircraft on the ground can make a significant contribution to overall aircraft noise exposure as defined by the CNEL. For many airports, the INM therefore will provide a conservative (or worst-case) assessment of aircraft noise exposure sideline to and in close proximity to the airfield.

Existing and Planned Airfield Facilities:

The Lincoln Regional Airport presently consists of a single runway with associated taxiways and other support facilities. Runway 15-33 is presently 6,001 feet long.

The Master Plan envisions construction of a new runway (15L-33R) approximately 700 feet east of the exiting runway, with a length of 3,350 feet. The Master Plan also envisions the addition of 1,000 feet to the north end of the existing runway 15-33, for a total length of 7,001 feet.

Aircraft Noise Modeling Assumptions:

The appropriate selection of noise modeling assumptions is of critical importance to achieving an accurate assessment of aircraft noise exposure using the INM. Inaccuracies in the location or use of generalized aircraft flight tracks, the selection of aircraft types from the INM database or the frequency or time of day of aircraft operations can compromise the accuracy of the resulting noise exposure maps.

Aircraft Operations and Fleet Mix

Existing (2005) and forecast future (2030) aircraft operations data were obtained from the Draft Airport Master Plan[1]. Annual average daily aircraft operations by aircraft type are summarized in Table 3-6 of the Master Plan for 2005 and 2030 conditions. Section 3-2 of the Master Plan describes the aircraft types anticipated to operate at the Airport for existing and future conditions, summarized by Tables I and II.

Tables I and II list the aircraft type designations from the INM Version 7.0 database selected to model aircraft noise exposure for the Lincoln Regional Airport. These type designations were matched to those used in the April 2004 draft of the Lincoln Regional Airport Master Plan.

1 Lincoln Regional Airport Master Plan, April 2007, prepared by Reinard S. Brandley.

TABLE I ANNUAL OPERATIONS BY AIRCRAFT TYPE EXISTING CONDITIONS (2005) LINCOLN REGIONAL AIRPORT							
Category	Annual Operations	Aircraft Type	INM Type	Factor	Annual Operations	Daily Operations	Departures per day
General Aviation	77,360	GA Single Fixed Prop	GASEPF	0.5	36680	100.5	50.2
		GA Single Variable Prop	GASEPV	0.38	27877	76.4	38.2
		GA Twin Prop Reciprocating	BEC58P	0.04	2934	8.0	4.0
		GA Twin Turboprop	CNA441	0.04	2934	8.0	4.0
		GA Jet	CNA750	0.03	2201	6.0	3.0
		H500 (typical)	H500D	0.01	734	2.0	1.0

TABLE II ANNUAL OPERATIONS BY AIRCRAFT TYPE FUTURE CONDITIONS (2030) LINCOLN REGIONAL AIRPORT							
Category	Annual Operations	Aircraft Type	INM Type	Factor	Annual Operations	Daily Operations	Departures per day
General Aviation	127,993	GA Single Fixed Prop	GASEPF	0.5	63997	175.3	87.7
		GA Single Variable Prop	GASEPV	0.26	33278	91.2	45.6
		GA Twin Prop Reciprocating	BEC58P	0.07	8960	24.5	12.3
		GA Twin Turboprop	CNA441	0.08	10239	28.1	14.0
		GA Jet	CNA750	0.08	10239	28.1	14.0
		H500 (typical)	H500D	0.01	1280	3.5	1.8

Annual Average Runway Use

Runway use depends upon the length and weight-bearing strength of available runways, prevailing wind conditions, supporting taxiways and the availability of navigational aids. Tables III and IV summarize the assumptions developed for annual average runway use at the Lincoln Regional Airport, based upon discussions with the Airport's Engineer.

TABLE III ANNUAL AVERAGE RUNWAY USE EXISTING CONDITIONS (2005) LINCOLN REGIONAL AIRPORT					
Runway	**% Runway Use**				
	Single Prop	**Twin Prop - Reciprocating**	**Turboprops**	**Jets**	**Helicopters**
Departures					
15	85	85	85	85	85 (at helipad)
33	15	15	15	15	15 (at helipad)
Arrivals					
15	85	85	85	85	85 (at helipad)
33	15	15	15	15	15 (at helipad)

TABLE IV ANNUAL AVERAGE RUNWAY USE FUTURE CONDITIONS (2030) LINCOLN REGIONAL AIRPORT					
Runway	**% Runway Use**				
	Single Prop	**Twin Prop - Reciprocating**	**Turboprops**	**Jets**	**Helicopters**
Departures					
15L	85	42.5	17	0	85 (at helipad)
33R	15	7.5	3	0	15 (at helipad)
15R	0	42.5	68	85	
33L	0	7.5	12	15	
Arrivals					
15L	85	42.5	17	0	85 (at helipad)
33R	15	7.5	3	0	15 (at helipad)
15R	0	42.5	68	85	
33L	0	7.5	12	15	

Aircraft Flight Tracks

Aircraft noise modeling requires the definition of generalized flight tracks to represent areas around the airport that are overflown by aircraft either arriving at or departing from the airport. For the Lincoln Regional Airport, generalized aircraft flight tracks were developed based upon discussions with the Airport's Engineer, and upon review of the April 2004 draft of the Lincoln Regional Airport Master Plan.

Aircraft flight tracks tend to disperse as aircraft move farther from the airport. This occurs as a result of variable wind conditions, air traffic control instructions and pilot technique. Air carrier, military jet and corporate jet aircraft generally follow a more predictable route when arriving at or departing from the airport than do smaller, propeller-driven aircraft or helicopters.

The generalized aircraft arrival and deparure flight tracks developed for noise modeling are shown by Figures 1, 2 and 3. The generalized flight tracks do not cover all areas around the airport where aircraft overflights may intermittently occur, but do represent areas that are subject to the greatest concentrations of overflights. (The scales of the figures are approximate.)

Time of Day of Aircraft Flight Operations

The assumptions for time of day of aircraft operations are significant because the CNEL is strongly influenced by nighttime and evening operational factors. Specifically, in calculating CNEL values, one aircraft operation during the nighttime hours (2200-0659) is equivalent on an energy basis to ten daytime operations. Similarly, one aircraft operation in evening hours (1900-2159) is equivalent on an energy basis to three daytime operations. For this analysis, the day/evening/night distribution of operations was taken from the April 2004 draft of the Lincoln Regional Airport Master Plan. Table V lists those assumptions.

TABLE V
ASSUMED TIME OF DAY FACTORS FOR AIRCRAFT FLIGHT OPERATIONS
LINCOLN REGIONAL AIRPORT

Aircraft Category	Day	Evening	Night
All	88%	8%	4%

NOISE EXPOSURE MAPS

The noise modeling assumptions described above were used to prepare noise exposure maps in terms of the annual average CNEL. The following alternatives were modeled:

- Existing Conditions (year 2005)
- 2030 with the new runway 15L-33R and the existing runway 15-33
- 2030 with the new runway 15L-33R and the extended runway 15R-33L

The 60, 65 and 70 dB CNEL contours for each scenario have been provided to the Airport in AutoCAD format for plotting on suitable base maps; examples are attached as Figures 4-6 on the following pages. (The scales of the figures are approximate.)

Respectfully submitted,
Brown-Buntin Associates, Inc.

Jim Buntin
Vice President

Figure 1
Existing Flight Tracks for Runway 15-33

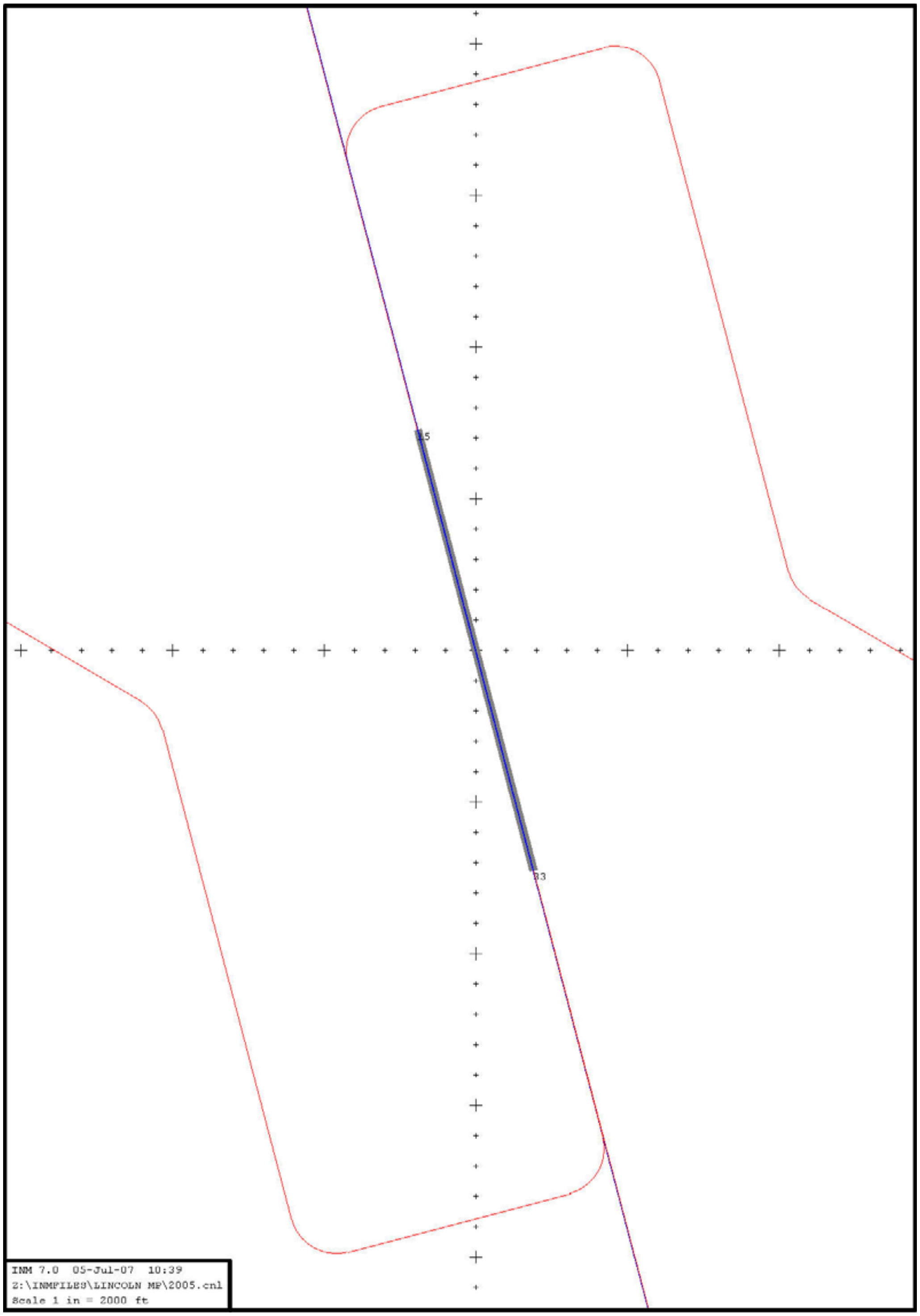


Figure 2
Future Flight Tracks for Runways 15-33 and 15L-33R
(No Runway Extension)

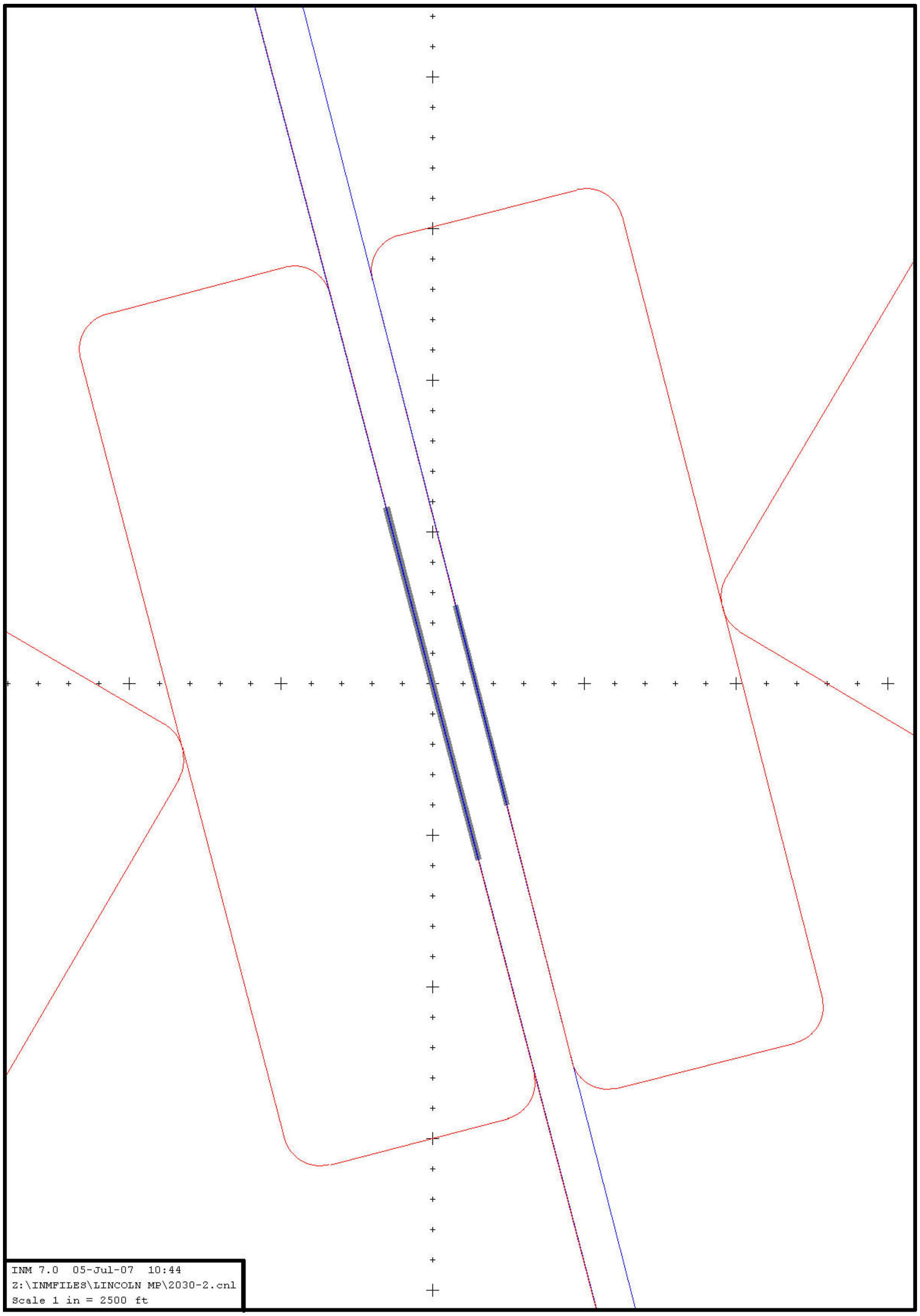


Figure 3
Future Flight Tracks for Runways 15R-33L and 15L-33R
(With Runway Extension)

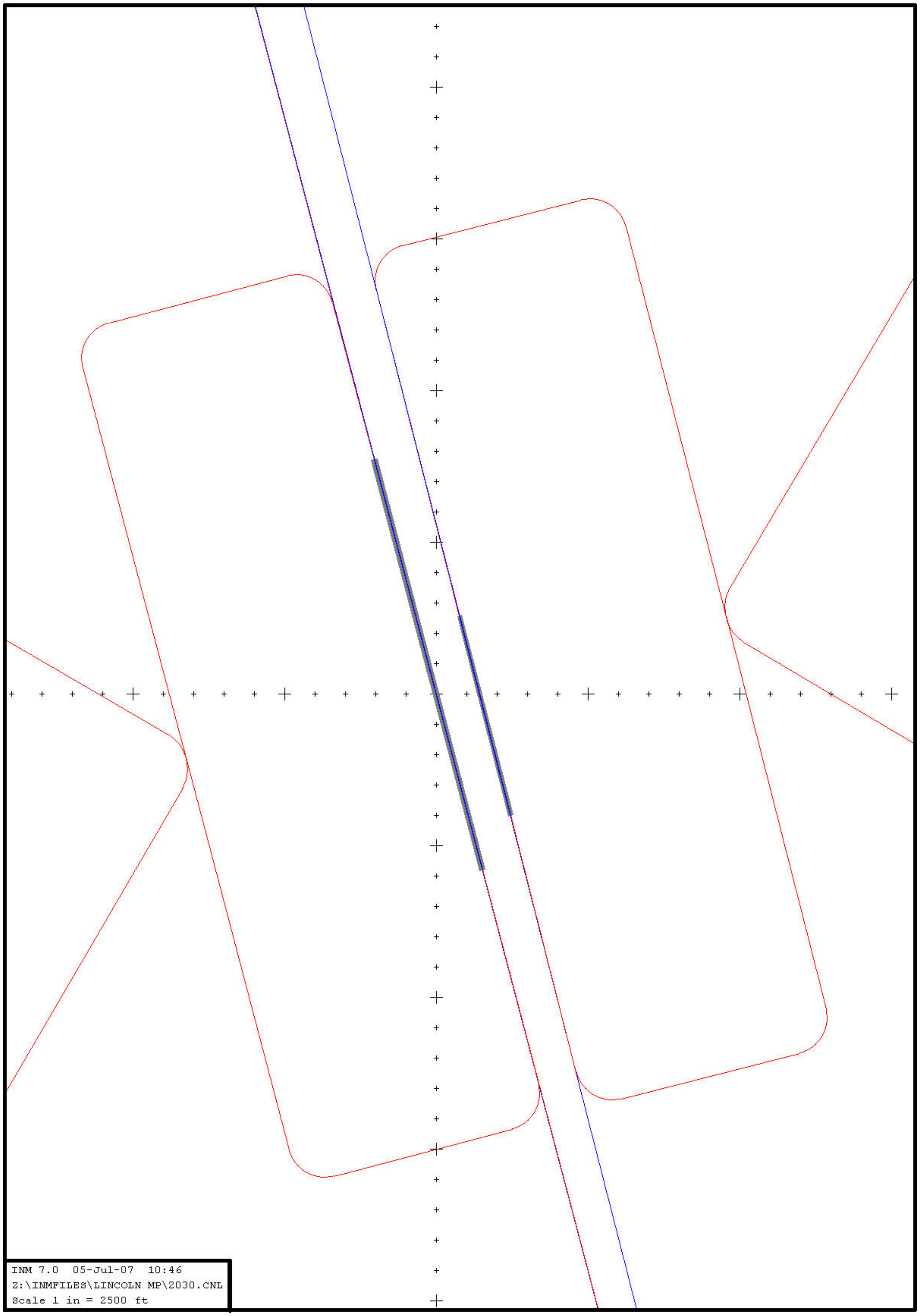


Figure 4
Existing (2005) CNEL Contours

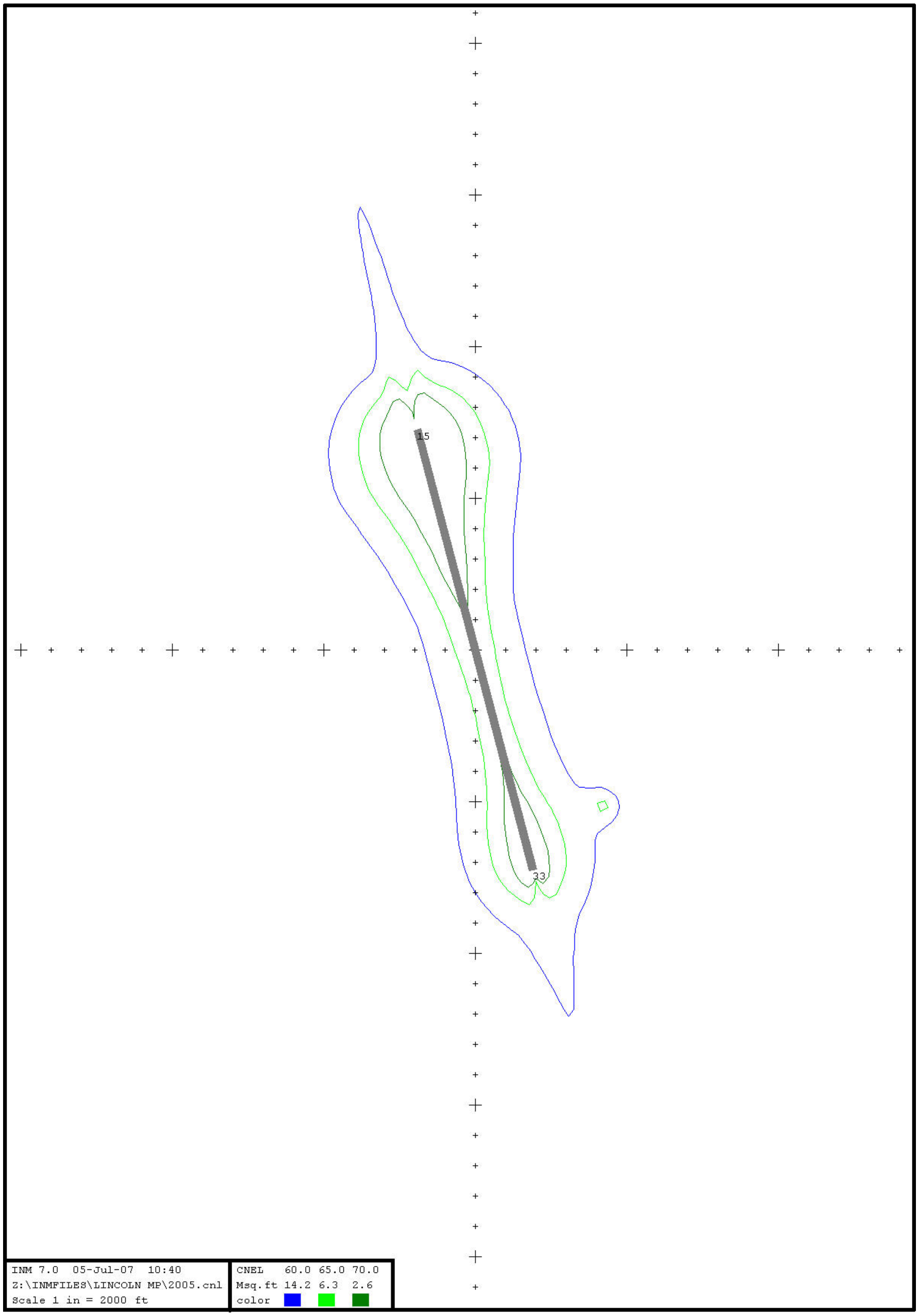


Figure 5
Future (2030) CNEL Contours Without Runway 15-33 Extension

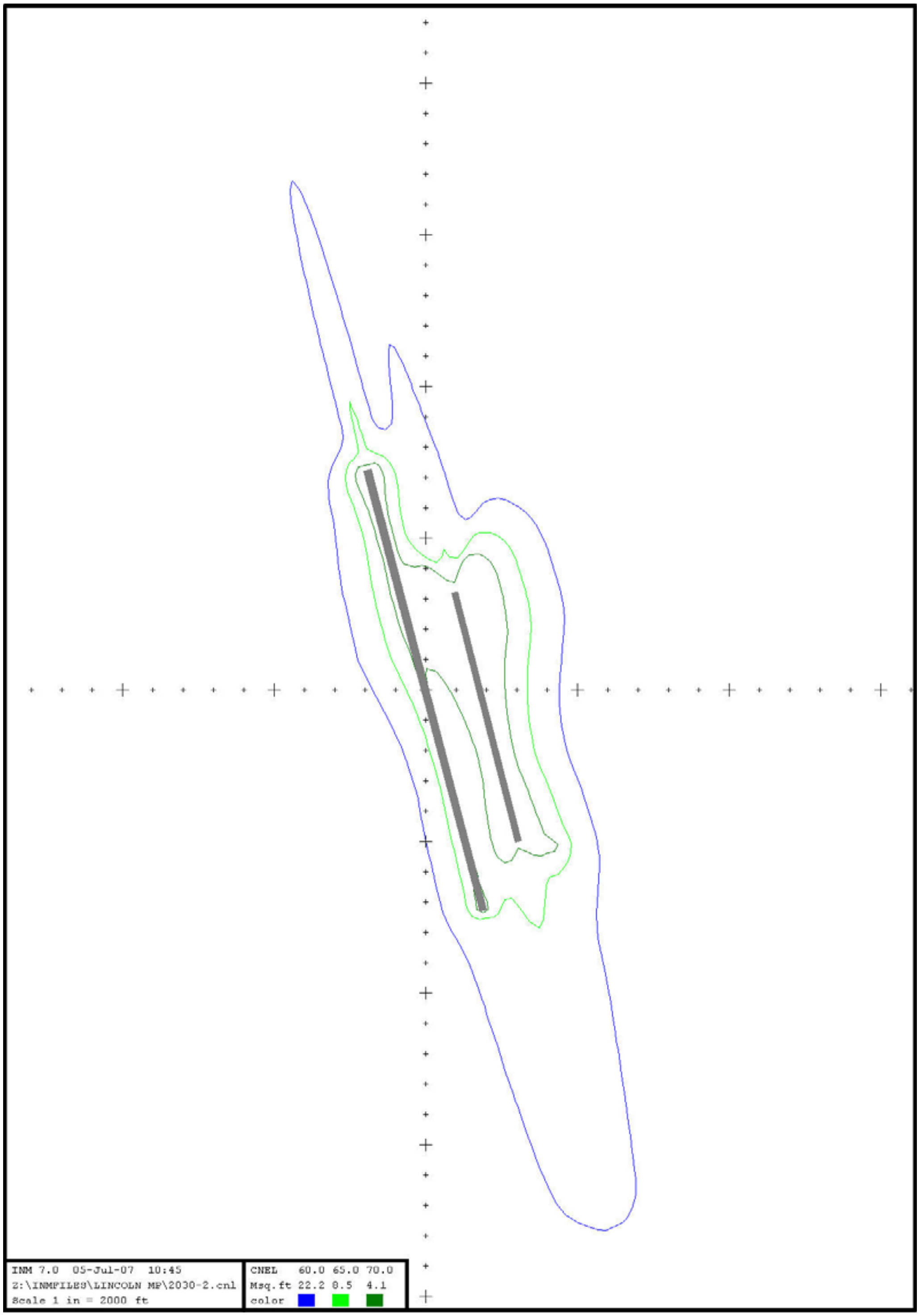
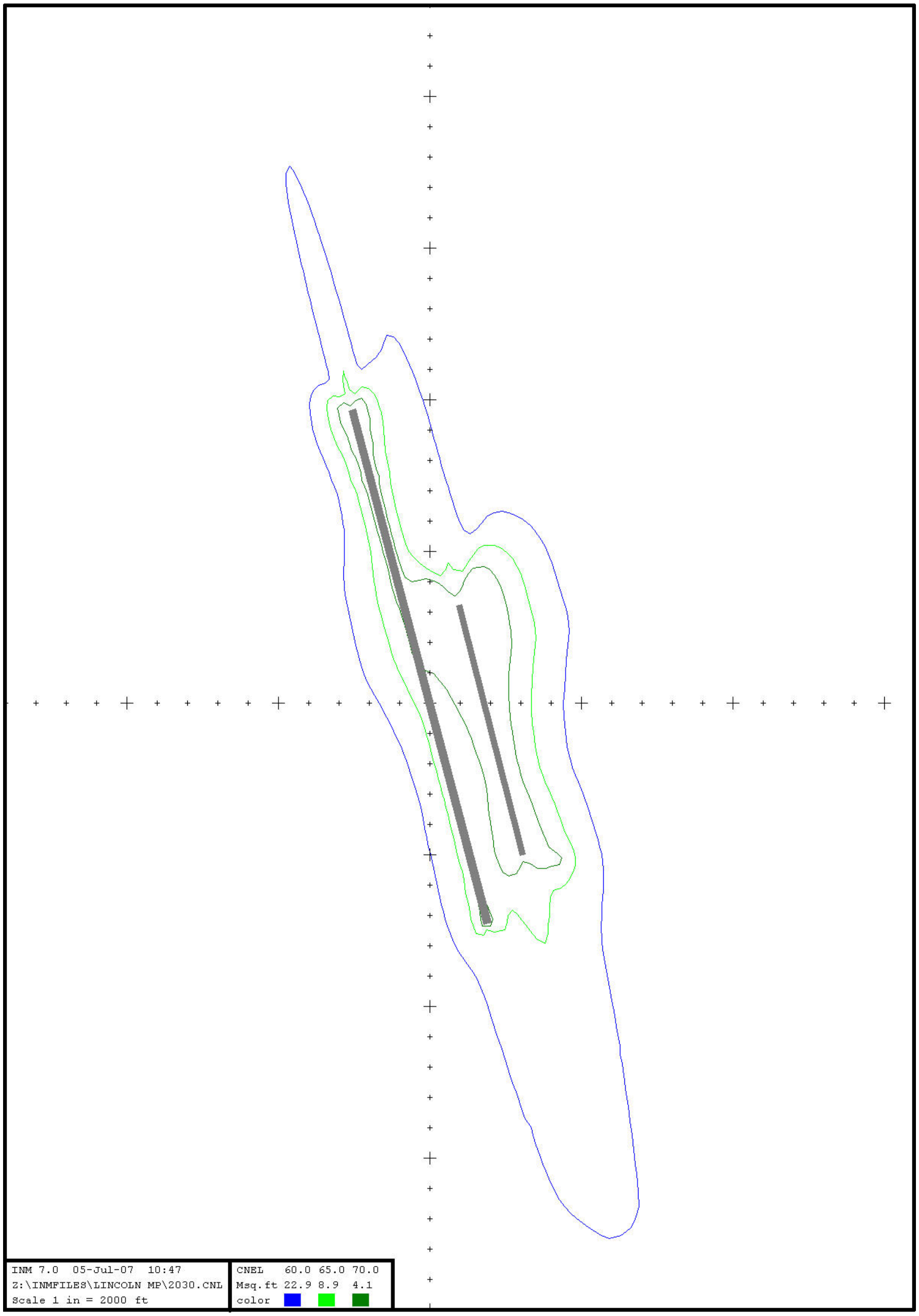


Figure 6
Future (2030) CNEL Contours With Runway 15-33 Extension



APPENDIX A
AIRCRAFT NOISE EXPOSURE METRICS

The Community Noise Equivalent Level (CNEL) is used by the State of California to evaluate land use compatibility around airports. The CNEL descriptor is similar to the Day Night Level (DNL) descriptor used by the FAA for noise compatibility planning around airports in states other than California.

The only difference between the CNEL and DNL is that the CNEL incorporates an evening penalty of 4.77 dB for noise levels occurring between 7:00 p.m. and 10:00 p.m., whereas the DNL does not. Both the CNEL and DNL apply a 10 dB penalty to noise levels occurring between 10:00 p.m. and 7:00 a.m. The evening and nighttime penalties (weighting factors) are mathematically equivalent to multiplying the number of events by three and ten, respectively. The CNEL and DNL are generally considered to be equivalent descriptors of the community noise environment within $\pm$ 1.0 dB.

One of the more controversial aspects of quantifying aircraft noise exposure in terms of the CNEL is that persons react to *individual* aircraft noise events rather than to the annual average CNEL. For that reason, it is important to understand the relationship between single events and the CNEL. For the determination of the CNEL for a noise source characterized as series of discrete single events, such as aircraft operations, the following formula is often used.

$$\text{CNEL} = \overline{\text{SEL}} + 10 \text{ Log } N_{eq} - 49.4,$$

where:

> $\overline{SEL}$ *is the energy average SEL for all noise events,* N_{eq} *is the equivalent number of events that occur during an annual average day (determined by adding the actual number of events occurring between 7:00 a.m. and 7:00 p.m. to 3 times the number of events occurring between 7:00 p.m. and 10:00 p.m. and to 10 times the number of events occurring between 10:00 p.m. and 7:00 a.m.), and 49.4 is a time constant equal to 10 times the logarithm of the number of seconds in a 24-hour day.*

The above-described formula illustrates that the CNEL is calculated by mathematically combining the number of single events which occur during a 24-hour day with how loud the events are and what time of day they occur. The same formula is used to calculate the DNL, except that the evening penalty is not applied. Because of the interrelationship between the weighted number of daily noise events and the SEL's generated by the events, it is possible to have the same CNEL value for an area exposed to a few loud events as for an area exposed to many quieter events. This concept is illustrated by Figure A-1.

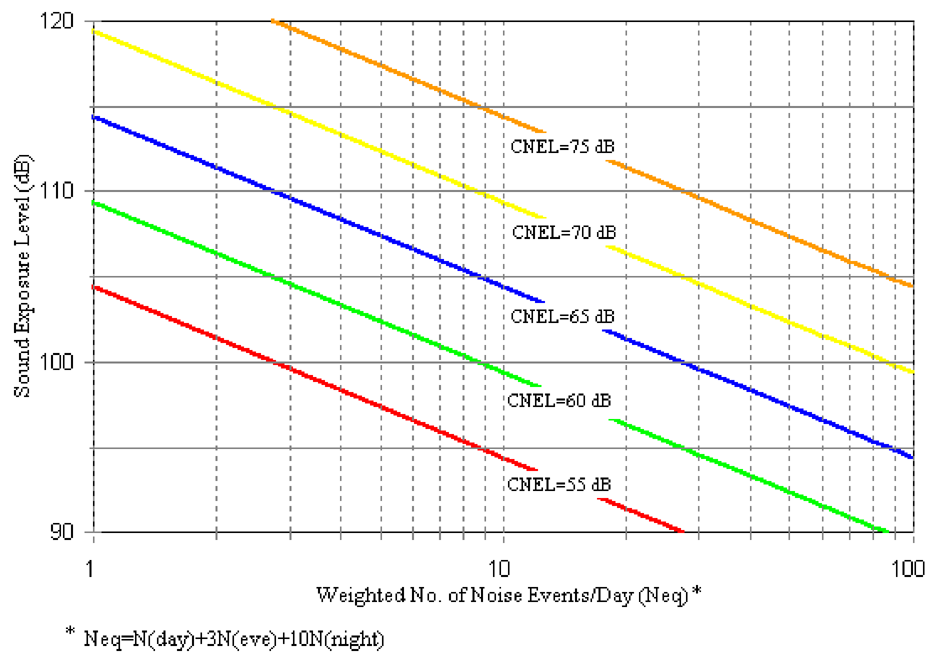


Figure A-1
Relationship of CNEL to Event SEL

Definitions of some of the more important terms used to define aircraft noise exposure summarized below.

A-weighted Sound Level:

The sound pressure level in decibels as measured on a sound level meter using an A-weighting filter. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the response of the human ear, and provides good correlation with subjective reactions to noise. CNEL and DNL values are expressed in terms of A-weighted sound levels.

CNEL:

Community Noise Equivalent Level. The average equivalent sound level during a 24-hour day, obtained after addition of 4.77 dB to sound levels during the evening hours (7:00 p.m. - 10:00 p.m.) and 10 dB to sound levels during the nighttime hours (10:00 p.m. - 7:00 a.m.).

Decibel, dB:

A unit for describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure, which is 20 micropascals (20 micronewtons per square meter). The threshold of human hearing (young healthy ear) is 0 dB.

DNL (or L_{dn}):

Day-Night Level. The average equivalent sound level during a 24-hour day, obtained after addition of 10 dB to sound levels during the nighttime hours (10:00 p.m. - 7:00 a.m.). The DNL and CNEL are generally considered to be equivalent descriptors of the community noise environment within $\pm$ 1.0 dB.

L_{eq}:

Equivalent Sound Level. The sound level containing the same total energy as a time varying signal over a given sample period. The L_{eq} is typically computed over 1, 8 or 24-hour sample periods.

L_{max}:

The maximum sound level recorded during a single noise event.

Noise Exposure Contours:

Lines drawn about a noise source indicating constant levels of noise exposure. CNEL or DNL contours are frequently utilized to describe community exposure to noise.

SEL:

The Sound Exposure Level is the level of noise accumulated during a single noise event, such as an aircraft overflight, with reference to a duration of one second. More specifically, it is the time-integrated A-weighted squared sound pressure for a stated time interval or event, based on a reference pressure of 20 micropascals and a reference duration of one second.