2020 UC Davis
Aviation Noise & Emissions Symposium

Quantifying Aviation Noise

Presented by:

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ESA

ESA is where solutions and service meet.

Quantifying Aviation Noise Exposure

- Aircraft noise can be measured and modeled
- Measurements and modeling can describe historical noise levels, but only modeling can predict *future* noise levels
- Measured and modeled noise levels can be compared
- Federal regulations require the use of noise models, not measurements, to quantify aircraft noise exposure
- California regulations require the use of noise measurements to validate the aircraft noise impact boundary

Quantifying Aviation Noise Exposure

- Aircraft noise exposure can be quantified using:
  - Measurements
  - Modeling

Quantifying Aviation Noise Exposure

- Measuring sound levels will accurately tell us:
  - The sound levels at a specific location for the time period the measurements were made
  - The historical record of the sound levels at a specific location
  - Historical trends; but measurements do not predict future noise levels

Quantifying Aviation Noise Exposure

- Modeling sound exposure accurately tells us the sound levels:
  - Over broad geographic areas as well as at specific locations for a specific time period
  - Modeling can produce a historical record
  - Modeling can be predictive by showing expected trends in aircraft noise exposure
  - Modeling can be used to prepare “What If?” scenarios

Noise Measurement Standards

- Noise monitoring equipment and the field measurements must be made in accordance with all applicable standards
  - Federal
  - State
  - Local

Noise Measurement Standards

- 14 CFR FAR Part 150 establishes the noise measurement methods and metrics for conducting aircraft noise measurements

- Local municipalities often specify noise measurement standards in noise ordinances or general plans

Noise Measurement Equipment

- Permanent noise monitors cover a limited area, but provide long-term noise measurement data for analyzing trends
  - Operation is automated requiring very little staff labor
- Portable noise monitors can be moved from location to location for short periods of time and may be returned to the same location to analyze trends
  - Very labor intensive for noise office staff

Noise Measurement Equipment

- Measured noise events can be correlated with aircraft flight track and identification data in an airport's airport Noise and Operations Management System (NOMS)
  - Both portable and permanent noise measurement sites can be entered into an airport's NOMS
  - Noise levels can be tracked over time and can be analyzed by:
    - aircraft type, type of operation, time of day, and noise measurement site

Noise Measurement Equipment

Portable Noise Monitor

Permanent Noise Monitor

Aircraft Noise Modeling Concepts

- Mathematical models are used everyday to depict a variety of real-life situations such as:
  - Bridge loading, aerodynamic performance, fuel economy, and computer animation
- Model accuracy is a function of the modeling algorithms, the empirical databases, and user sophistication
- When used properly, aircraft noise models have proven to be highly accurate

Aircraft Noise Modeling Tools

- Commonly used aircraft noise modeling tools:
  - FAA's Aviation Environmental Design Tool (AEDT)
  - FAA's Integrated Noise Model (INM) (Superseded by AEDT)
  - FAA's Noise Integrated Routing System (NIRS) (Superseded by AEDT)
  - US Air Force's NOISEMAP
  - US Air Force's BOOMAP
- Modeling tools quantify aircraft noise exposure in the vicinity of airports as well as at more distant locations

Aircraft Noise Modeling Tools

- The AEDT is the FAA approved model for use in preparing:
  - Noise elements of airport master plans
  - Noise exposure maps for 14 CFR Part 150 and 14 CFR Part 161 studies
  - Noise elements of federal environmental assessments and environmental impact statements
  - Noise contours for state environmental impact reports

Aircraft Noise Modeling Tools

- NIRS was formerly approved for use in assessing changes in aircraft noise exposure resulting from changes in air traffic procedures over large geographic areas. NIRS has been superseded by AEDT
- NOISEMAP is approved for noise studies involving predominately military aircraft operations
- BOOMAP is for use in modeling sonic booms in military special use areas

Integrated Noise Model (INM)

- FAA's standard tool since 1978 for determining the predicted noise impacts around airports
- INM handled fixed wing and rotary wing aircraft and is the FAA's state-of-the-art aircraft noise model
- Model produced noise exposure contours that are used for determining land use compatibility

Integrated Noise Model (INM)

- INM had been in use for over 35 years and was continually updated to improve its accuracy
- INM contained an extensive aircraft performance and noise level database derived from actual noise measurements of aircraft in flight
- INM results have been validated on several occasions with overall modeled and measured levels falling within a couple of decibels of each other

Aviation Environmental Design Tool (AEDT)

- INM was replaced by the AEDT at the end of May 2015
- AEDT combines the capabilities of the Emissions Dispersion Modeling System (EDMS) and INM in a single model
- AEDT allows for assessing the trade offs between air emissions and noise impacts
- AEDT is the FAA-approved tool for aircraft noise modeling

AEDT

- AEDT can also predict noise at a specific location that may be sensitive to noise impacts (school, hospital, noise measurement sites, etc.)

- 16 predefined noise metrics are supported, including:
  - DNL
  - CNEL
  - Lmax
  - Leq
  - SEL
  - SENEL

AEDT Process: Input

- AEDT uses the following inputs:
  - Annual average temperature
  - Airport elevation
  - Airport layout
    - runways, landing areas, run-up locations
  - Surrounding terrain

AEDT Process: Input

- AEDT uses the following inputs:
  - Number of annual-average day operations
    - by aircraft type and time of day
  - Runway use
    - by aircraft type and time of day
  - Approach, departure, and training flight paths
  - Flight path usage
    - by aircraft type and time of day

AEDT Process: Computation

- Each aircraft type "flies":
  - off the runways as they are used
  - departure profiles based on aircraft weight, annual average temperature, and airport altitude
  - the flight tracks as they are used during the year
  - approach profiles as they are flown

AEDT Process: Computation

- AEDT computes the exposure of each operation:
  - as it would be measured in the airport environs accounting for the annual-average use
- The noise exposure of each aircraft operation is:
  - energy-summed over a user-specified grid to determine the annual average noise exposure
- Values of equal noise exposure are connected using “contour lines”

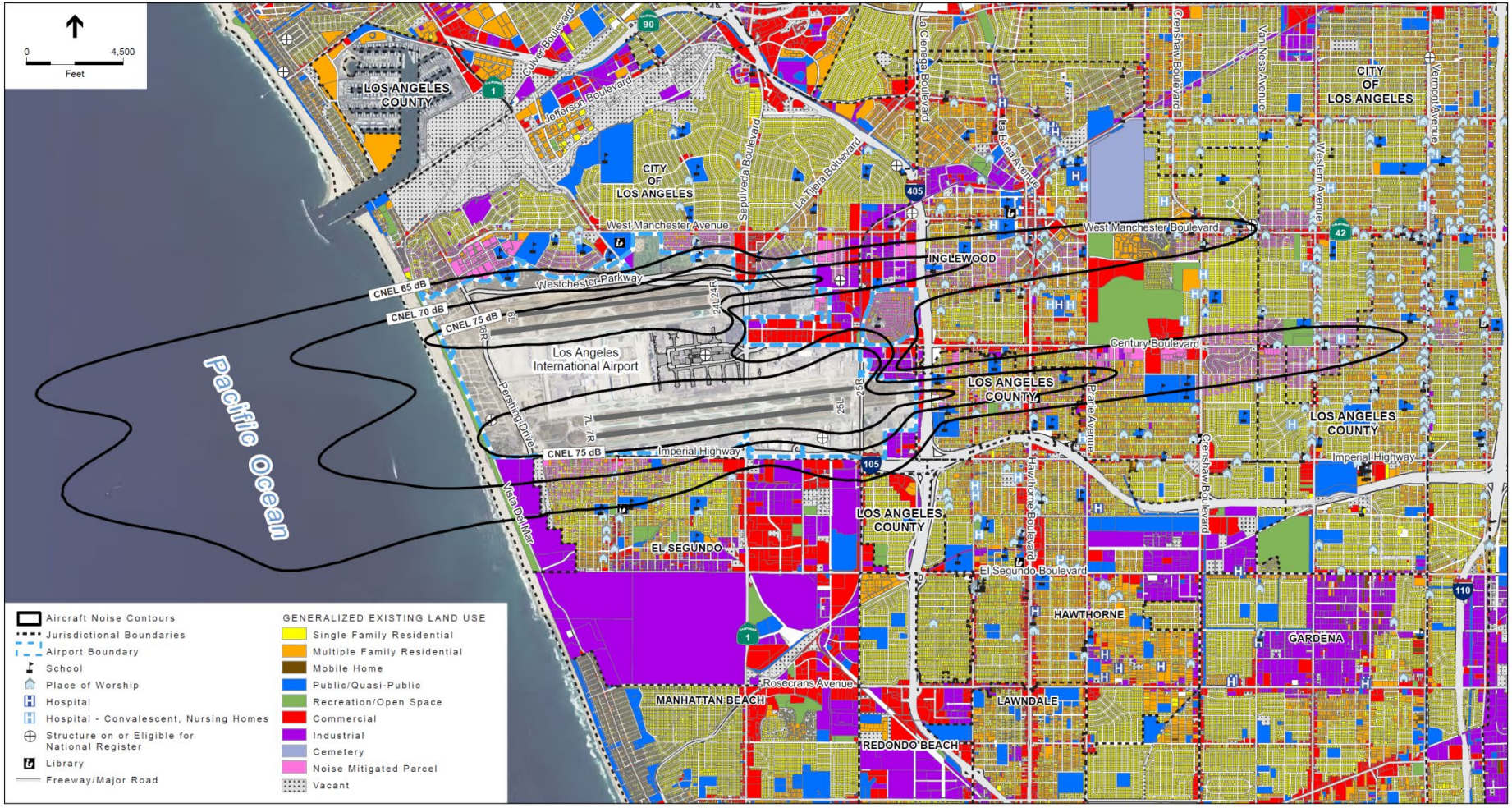
AEDT Process: Output

- Depictions of aircraft noise exposure
  - DNL or CNEL contours
  - SEL or Lmax contours
  - DNL values over a grid
- Noise levels at specific points such as a:
  - home
  - noise monitor
  - school
  - church

Aircraft Noise Model Application

- Aircraft noise modeling tools have many analytical uses:
  - Depicting annual aircraft noise exposure
  - Depicting single-event noise exposure
  - Predicting future aircraft noise exposure
  - Assessing changes in noise impacts resulting from runway configuration changes or new runways
  - Assessing changes in fleet mix and/or number of operations
  - Evaluating operational procedures

Noise Model Output: CNEL Contours



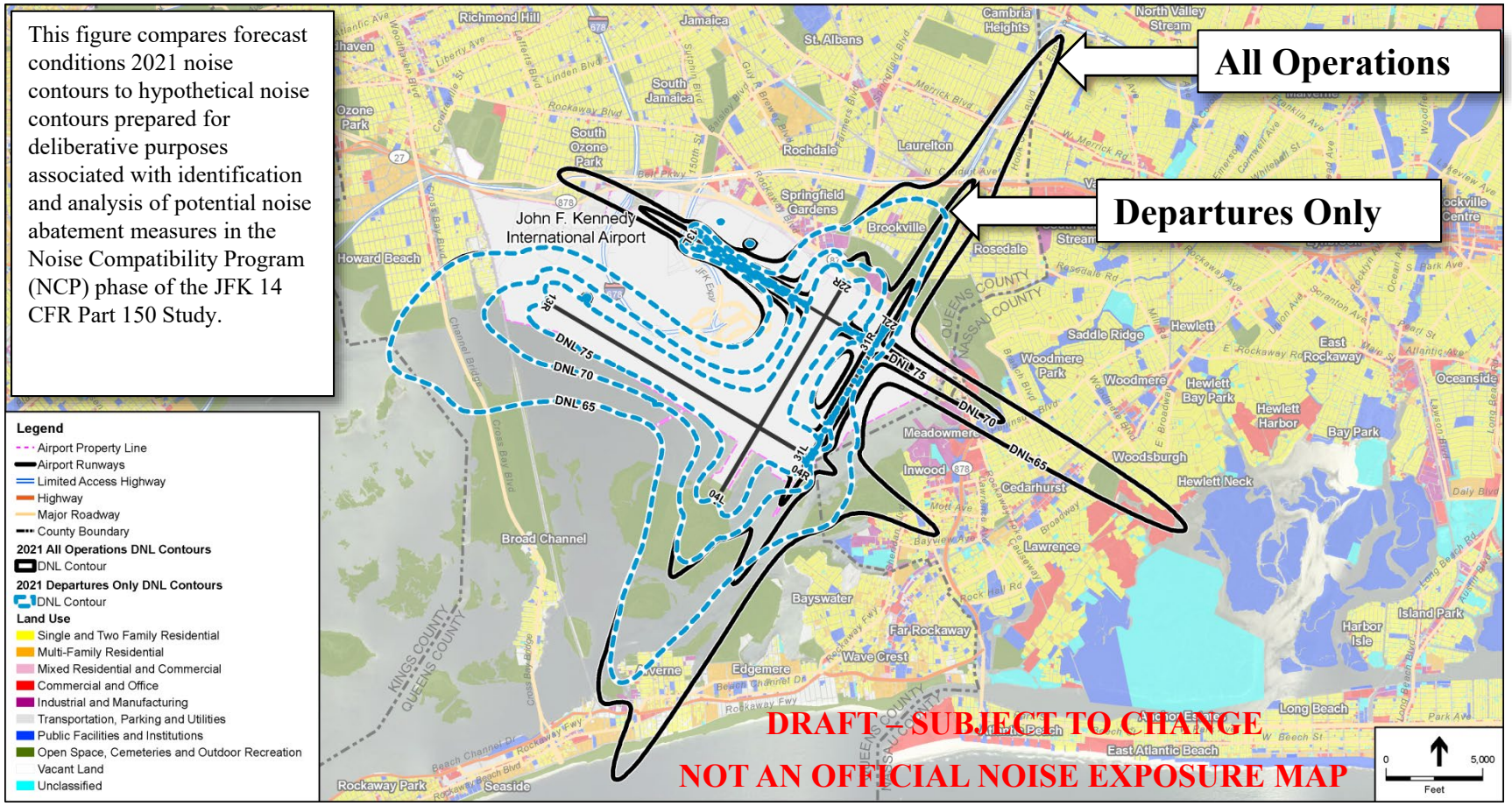
SOURCES: LAWA, 2014; ESA Airports, 2014; ESRI ArcGIS Online, 2011; ESRI World Imagery - Aerial; PCR Services Corporation, 2012
NOTES: CNEL = Community Noise Equivalent Level; dB = Decibel.

Los Angeles International Airport 14 CFR Part 150 Study . 130072.03
Exhibit 5-1
2015 Noise Exposure Map – Los Angeles International Airport

Quantifying Aviation Noise

Noise Contributions: 2021 Departures Only (Excluding Arrivals)

This figure compares forecast conditions 2021 noise contours to hypothetical noise contours prepared for deliberative purposes associated with identification and analysis of potential noise abatement measures in the Noise Compatibility Program (NCP) phase of the JFK 14 CFR Part 150 Study.



SOURCE: New York City Department of City Planning, MapPLUTO 15V1-Tax lot/land use geographic information database, March 2015-June 2015 (adapted by ESA); Nassau County Department of Public Works Planning Division; Property classification and geographic information database, September 2015; ESRI Mapping Services; Environmental Science Associates, 2016; Planning Technology, Inc. 2016.

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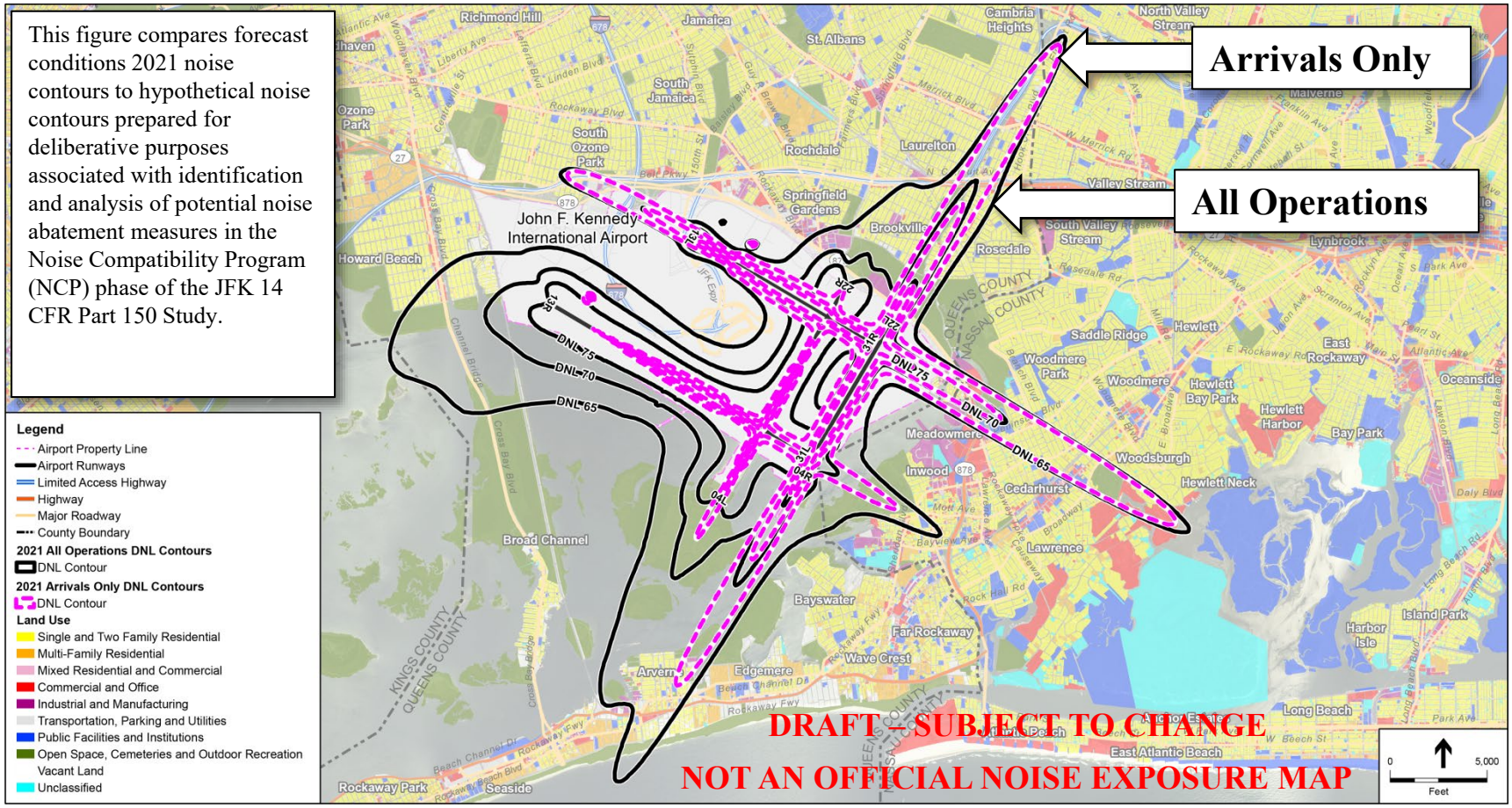

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Comparison of Common Aircraft Types at JFK

EMB-190

CRJ9-ER

A320

737-800

MD-88

757-200

787-8

767-400

A380-800

777-300ER

A340-600

747-8

A Diverse Airline Aircraft Fleet at JFK

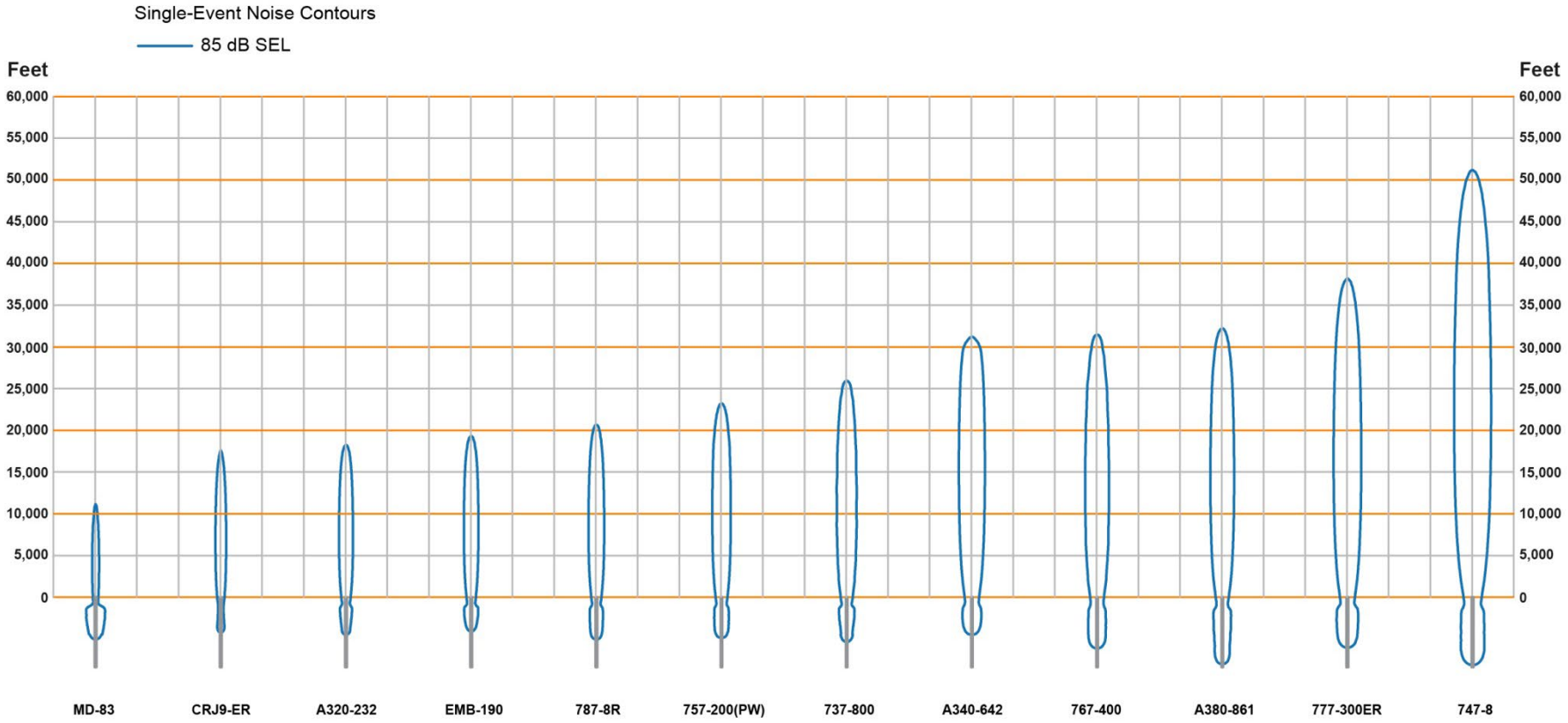
A380-800

EMB-190

	A-380	EMB-190
Seats (two-classes)	644	94
Length	239’	119’
Wingspan	262’	94’
MTOW	1,268,000 lbs	105,000 lbs
MLW	869,000 lbs	95,000 lbs
Range	8,200 nmi	1,850 nmi
Source: Airbus and Embraer		

Quantifying Aviation Noise

JFK Arrival Sound Exposure Level (SEL) Contour Comparison



Source: INM 7.0d

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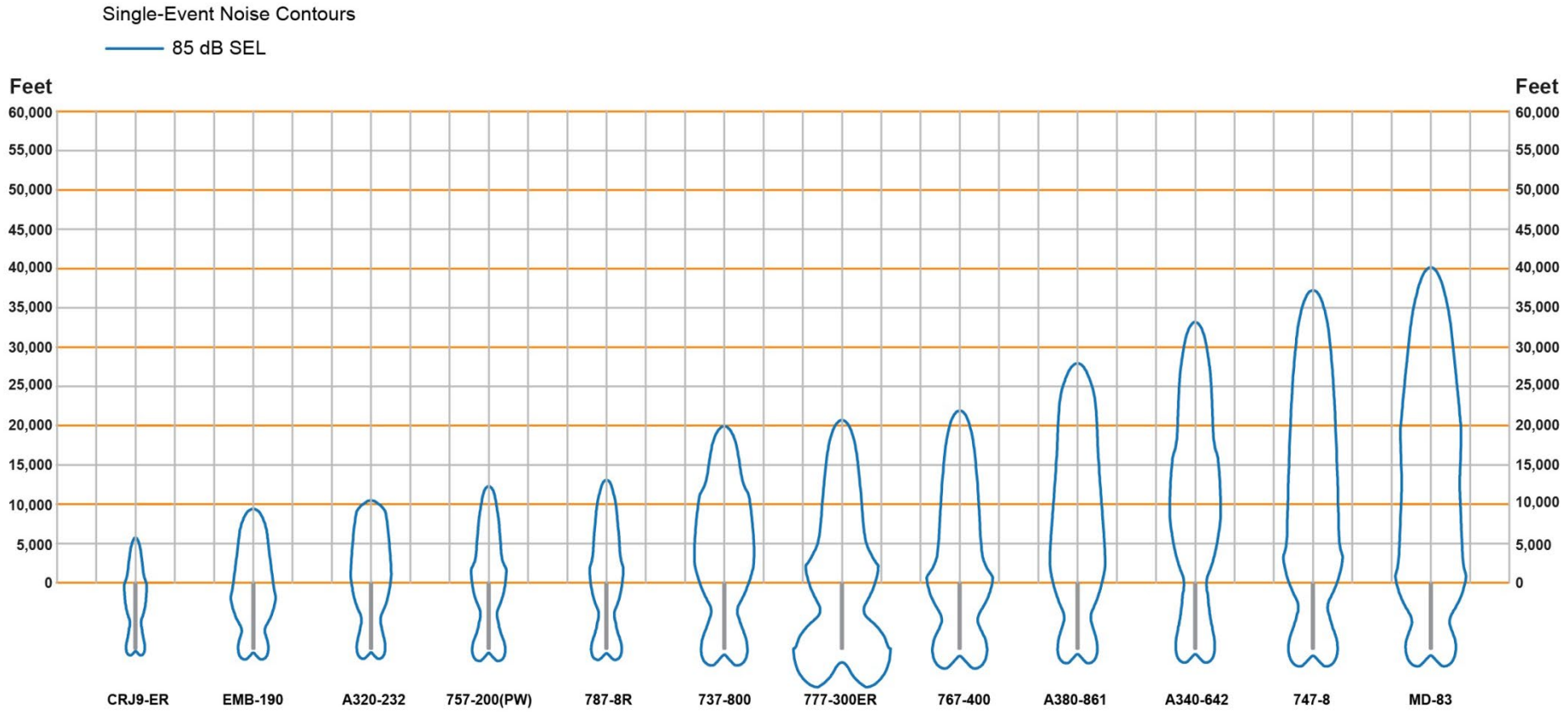
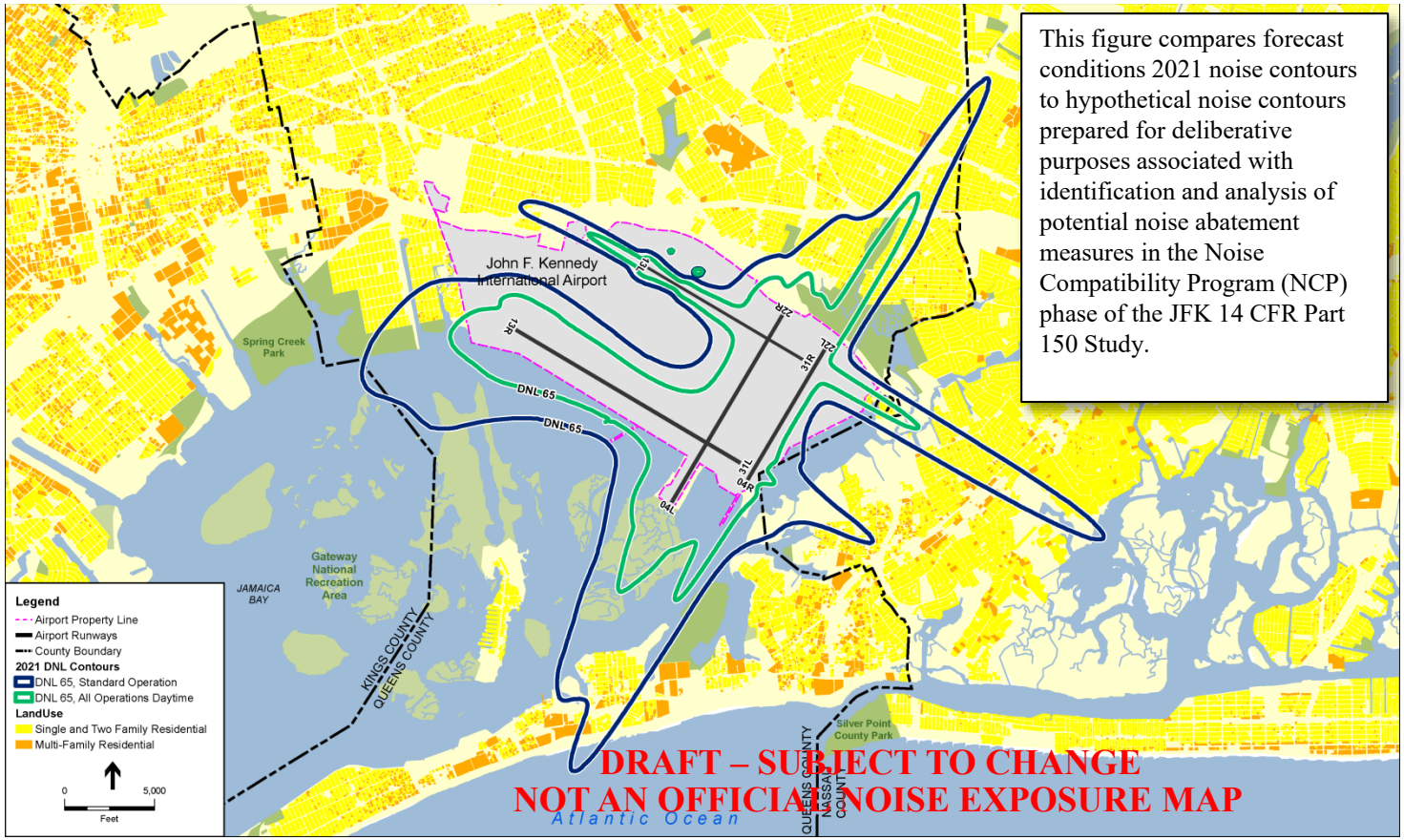
JFK Departure Sound Exposure Level (SEL) Contour Comparison



Source: INM 7.0d

Quantifying Aviation Noise

What if all JFK nighttime flights occurred in the daytime?



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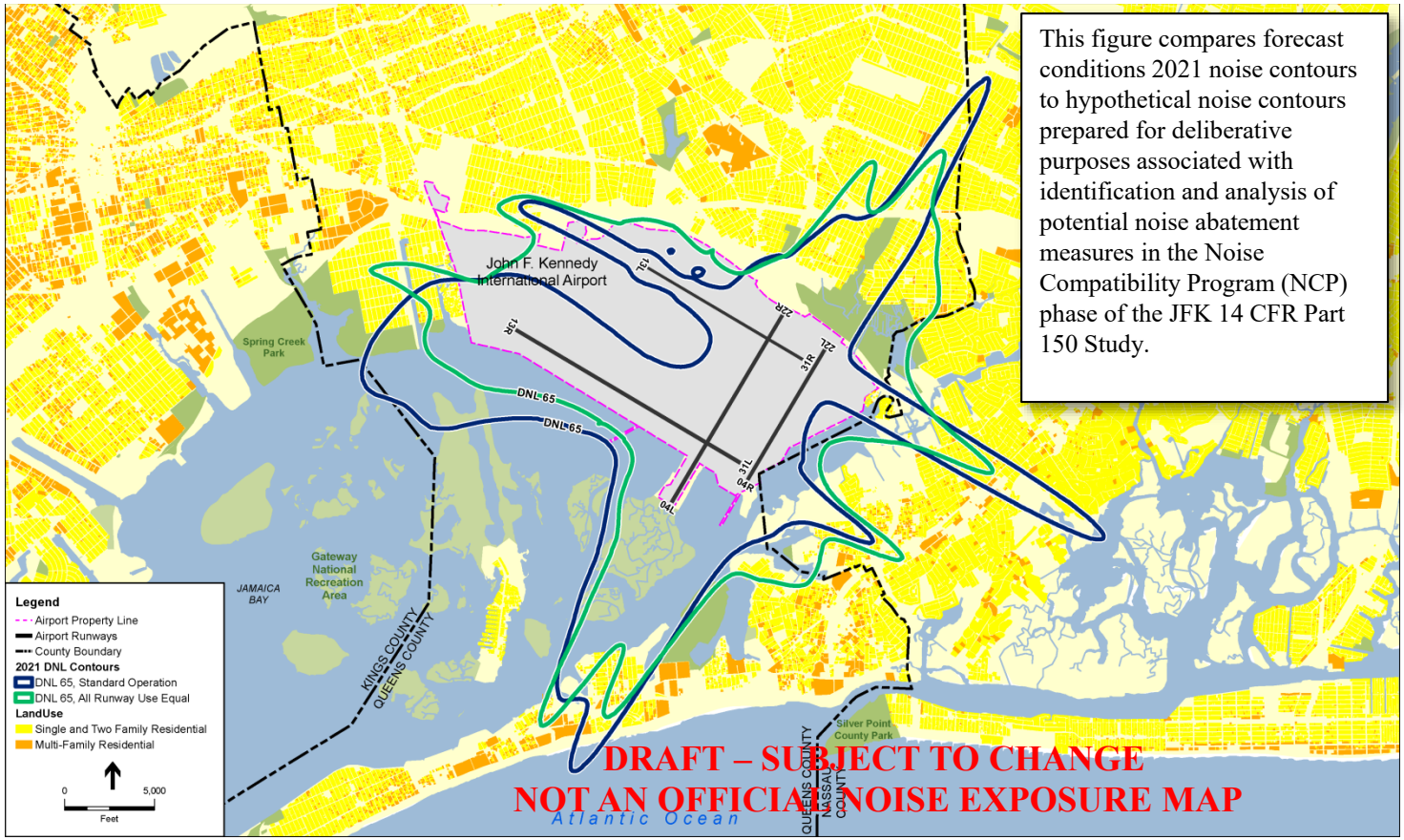
What if each runway end is used equally?



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Aircraft Noise Model Application

- FAA Orders 1050.1F and 5050.4B require the use of noise models for the quantification of aircraft noise impacts in environmental assessments (EAs) and environmental impact statements (EISs)

- Noise measurements may be made for 14 CFR Part 150 studies, EAs, and EISs to provide supplemental information, but they may not be used to “calibrate” the noise models

Comparing Measured and Modeled Levels

- Measured single event levels (Lmax and SEL) can be compared to the single event levels predicted by the model
  - Measurements should be observed or correlated with radar data and of sufficient quantity
- Measured cumulative noise levels (DNL or CNEL) can be compared to modeled cumulative levels
  - Ideally, compare one year of aircraft noise measurement data to the same year modeled

Comparing Measured and Modeled Levels

- Modeled annual-average day DNL contours will not always match short-term measured values due to variables such as:
  - Runway use
  - Fleet mix
  - Wind and weather conditions
  - Pilot/controller techniques
  - Ambient community noise levels

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Questions?