Appendix F

Radar Data Analysis

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APPENDIX F
Radar Data Analysis

This appendix describes the radar data that were collected to update the Airport Land Use Compatibility Plan (ALUCP) for San Diego International Airport (SDIA or the Airport). It presents the data sample and provides the results of the data analysis, which will be used to validate or adjust the safety zone boundaries (see Technical Report 4) and the overflight area (see Technical Report 5) from the 2014 ALUCP.

F.1 AIRPORT NOISE AND OPERATIONS MONITORING SYSTEM

San Diego County Regional Airport Authority (SDCRAA) uses an Airport Noise and Operations Monitoring System (ANOMS) that integrates aircraft noise monitoring and radar flight track data. Currently, SDCRAA has 23 noise monitoring terminals within the SDIA vicinity that monitor noise daily and transmit the data to the ANOMS processing center at the Airport. The radar data are downloaded from the Federal Aviation Administration (FAA) facility. The radar data are in three dimensions: latitude, longitude, and height above airport field elevation (AAFE), which is 16.8 feet above mean sea level at SDIA.[1] The data are time-stamped and include flight information, including airline flight number (for commercial flights) and aircraft type.

The ANOMS noise data can be used in preparing the quarterly noise contour maps required by the California Department of Transportation. The combined noise and radar data enable the study of flight routes and air traffic movements and the investigation of noise complaints and curfew violations.

F.2 RADAR DATA SAMPLE

Radar data were gathered for selected periods in 2022 and 2023 for aircraft operations (arrivals and departures) at SDIA. The Airport has only one runway, which necessitates that all aircraft arrive and depart either east or west, depending, in part, on the surface wind direction. At SDIA, approximately 98 percent of aircraft operate on Runway 27, with arrivals from the east and departures to the west. Arrivals and departures on Runway 9 account for only 2 percent of annual operations, mostly arrivals using the instrument landing system.[2]

As presented in **Table F-1**, the sample period for west flow comprised 7 to 8 days in each season of the year, totaling 31 days and included 16,380 unique flight tracks on Runway 27.

Operations on Runway 9 occur much less frequently than on Runway 27. To secure enough data to discern patterns, a larger sample period was selected for Runway 9 operations than for Runway 27. As presented in **Table F-2**, the east flow sample period covered 153 days within a 9-month period, including all days during a period that SDIA operated in east flow, even if only for a brief time during the day.[3] The sample included 9,078 flight tracks for Runway 9.

[1] AirNav.com, https://www.airnav.com/airport/KSAN (accessed June 15, 2023).
[2] San Diego County Regional Airport Authority, *14 CFR Part 150 Update, Noise Exposure Maps and Noise Compatibility Program, Final Report*, May 2022, p. 4.12.
[3] The sample also included periods of contraflow, with arrivals on Runway 9 and departures on Runway 27.

Table F-1 West Flow Sample Period

SEASON	DATES	NUMBER OF DAYS
Summer	July 24-31, 2022	8
Fall	October 10-16, 2022	7
Winter	January 16-23, 2023	8
Spring	April 2-9, 2023	8
Total Days Sampled		31

NOTE: During the sampling period, data were collected for 16,380 Runway 27 flight tracks.
SOURCE: Ricondo & Associates, Inc., June 2023.

Table F-2 East Flow Sample Period

MONTH AND YEAR	DATES	NUMBER OF DAYS
August 2022	4, 10, 16-20, 26, 30-31	10
September 2022	1, 6, 8-9, 13, 15-16, 22-23, 27-29	12
October 2022	5-6, 9, 14, 16, 18-21, 23, 25-28	14
November 2022	1-3, 5, 8-10, 14-15, 19, 21, 24, 28-29	14
December 2022	1, 5-11, 13-14, 19-24, 27-28, 31	19
January 2023	1, 3-5, 7, 9-12, 14-20, 24-30	23
February 2023	3, 5, 7-11, 14-16, 21-26, 28	17
March 2023	1-2, 5, 8-30	25
April 2023	6-13, 17-23, 27-30	19
Total Days Sampled		153

NOTE: During the sampling period, data were collected for 9,078 Runway 9 flight tracks.
SOURCE: Ricondo & Associates, Inc., June 2023.

F.3 DATA ANALYSIS

The data set was sorted and mapped by aircraft type (commercial jet, business jet, and propeller) at four different altitude ranges (up to 3,000 feet, 5,000 feet, 7,000 feet, and 10,000 feet AAFE) for operations on each runway. Maps of combined commercial and business jet flight tracks at those altitudes were also prepared. Among the 36 maps produced, 10 were selected as examples for inclusion in this appendix.

F.3.1 Flight Tracks

Exhibit F-1 displays the commercial jet flight tracks for Runway 27 up to 10,000 feet AAFE. The blue tracks depict the arrivals, and the orange tracks depict the departures. Some approach tracks are visible on the west side of the Airport. These are missed approaches to Runway 27, which follow published routes or directed based on Air Traffic Control (ATC) provided vectors to return to the Runway 27 approach. The pattern of departure tracks corresponds with the published instrument departure procedures that either direct departures to climb on runway heading or turn right approximately 15 degrees north of runway heading to intercept navigational fixes over the ocean. The pattern of arrival tracks at the northern and eastern edges of the map reflects the Standard Terminal Arrival Routes (STARs) directing arrivals to the final approach to Runway 27, where the aircraft fly straight to the runway in accordance with published non-precision instrument approach procedures.

Exhibit F-2 displays the business jet flight tracks for Runway 27 up to 10,000 feet AAFE. The dark green tracks depict the arrivals, and the yellow tracks depict the departures. Because business jets operate under instrument flight rules (IFR),[4] as do commercial jets, and are fast enough to blend into the flows of commercial jets, the business jet arrival and departure patterns mirror those of the commercial jets.

Exhibit F-3 displays the propeller aircraft arrival and departure flight tracks for Runway 27 up to 10,000 feet AAFE. The purple tracks depict the arrivals, and the light green tracks depict the departures. Many propeller aircraft follow the published STARs and instrument approach and departure procedures. The exhibit also depicts some propeller departures turning more widely to the right and left, much closer to the Airport than the standard routes. FAA ATC directs slower propeller aircraft to turn away from the standard departure routes to clear the way for takeoffs by jet aircraft high performance propeller aircraft in the departure queue. Exhibit F-3 also depicts some propeller aircraft arrivals turning onto the final approach closer to the Airport than most jet arrivals. This also reflects a common procedure when ATC sequences the smaller, slower propeller aircraft into the arrival stream near the Airport to keep these aircraft away from the extended jet arrival queue.

Exhibit F-4 displays commercial jet arrival and departure flight tracks for Runway 9 up to 10,000 feet AAFE. The blue tracks depict the arrivals, and the orange tracks depict the departures. As previously noted, arrivals and departures on Runway 9 account for only 2 percent of annual operations. The relatively large number of flight tracks depicted on this exhibit reflect a proportionately larger data sample for Runway 9 operations than for Runway 27 operations. The arrival tracks reflect the STARs, which define routes transitioning from the enroute environment to the final approach to Runway 9. The departure tracks reflect the published standard departure procedures. The tightly clustered departure tracks heading east and northeast reflect procedures directing aircraft to turn at designated navigational fixes and continue on to other designated fixes. The widely dispersed departure tracks heading to the northwest reflect procedures directing aircraft to turn after reaching an altitude of 4,000 feet above mean sea level. Aircraft reach this altitude at widely varying points, depending on the climb performance of the aircraft.

[4] Instrument flight rules are the rules governing the procedures of conducting instrument flight.

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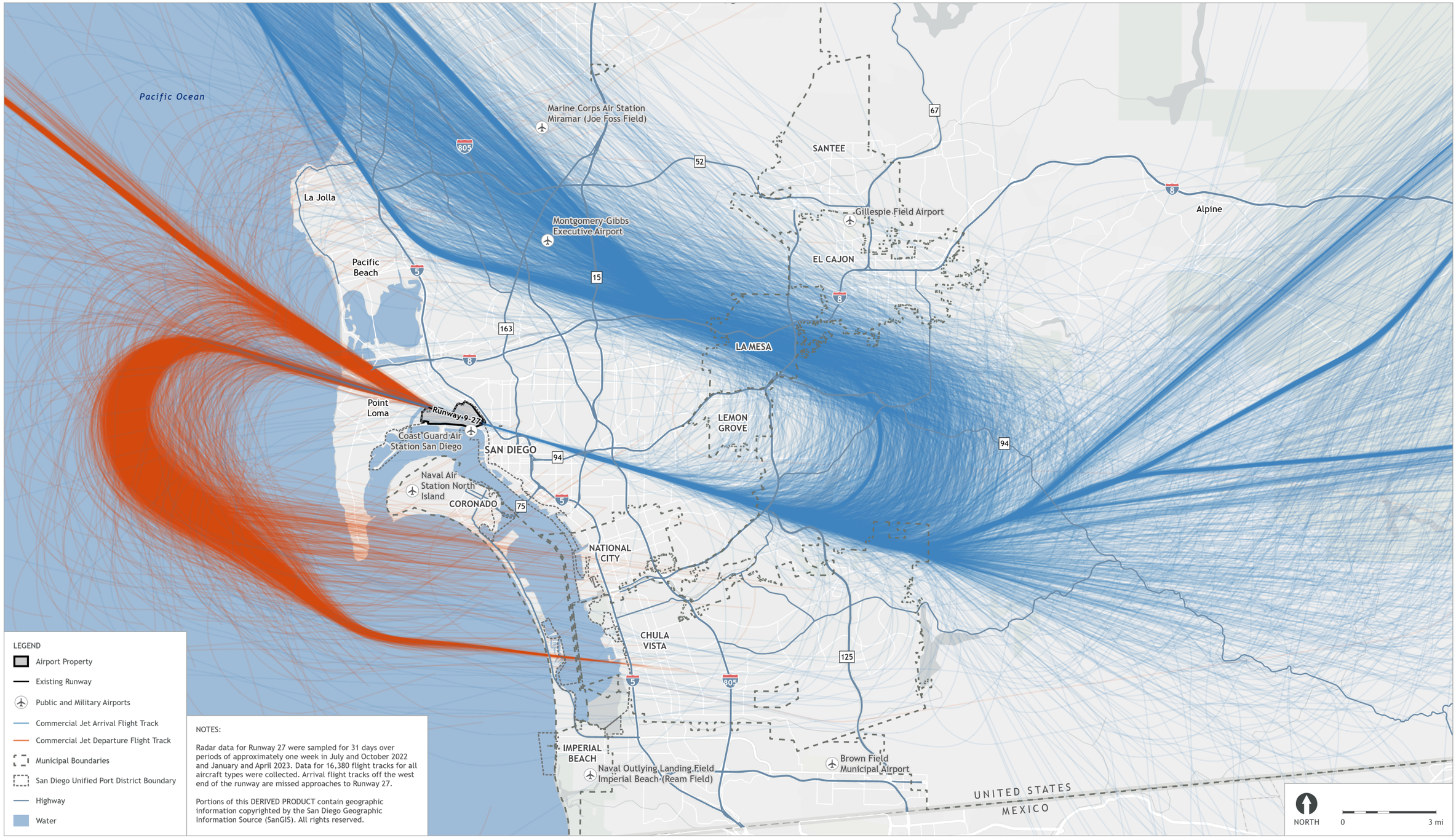

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SOURCES: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, April 2024 (basemap); San Diego Geographic Information Source (SanGIS), 2023 (municipal boundary); San Diego County Regional Airport Authority, Airport Noise and Operations Monitoring System (ANOMS), 2022 (radar tracks); Jacobsen|Daniels, *San Diego International Airport*, *Airport Layout Plan*, June 2021 (Airport property, runway); US Department of Transportation, Federal Aviation Administration, Aeronautical Information Services, 2022 (airports); US Census Bureau, 2023 (roads); San Diego County Regional Airport Authority, 2023 (San Diego Unified Port District Boundary).

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EXHIBIT F-1

COMMERCIAL JET FLIGHT TRACKS -
RUNWAY 27 UP TO 10,000 FEET ABOVE AIRPORT FIELD ELEVATION

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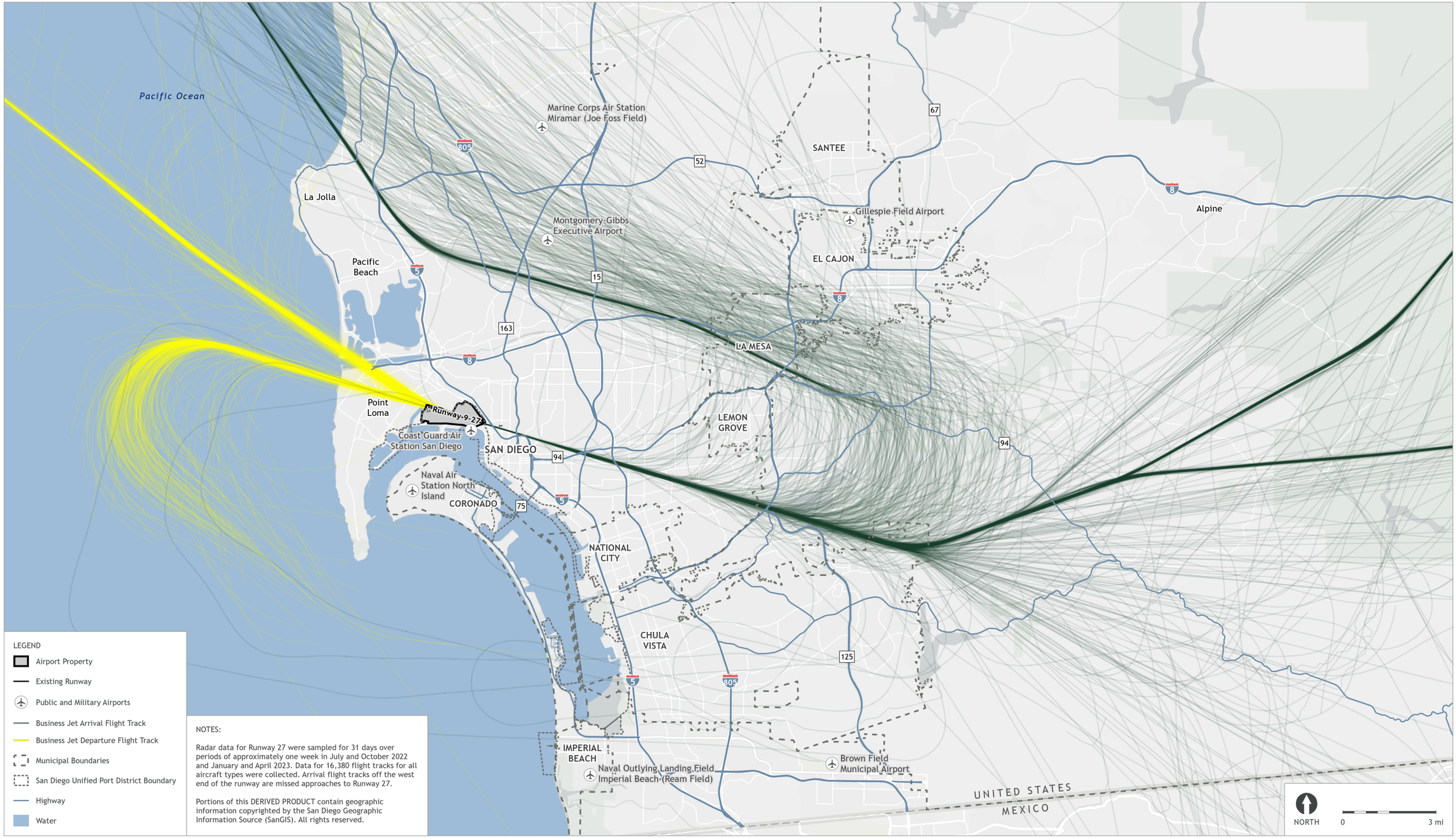

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EXHIBIT F-2

BUSINESS JET FLIGHT TRACKS -
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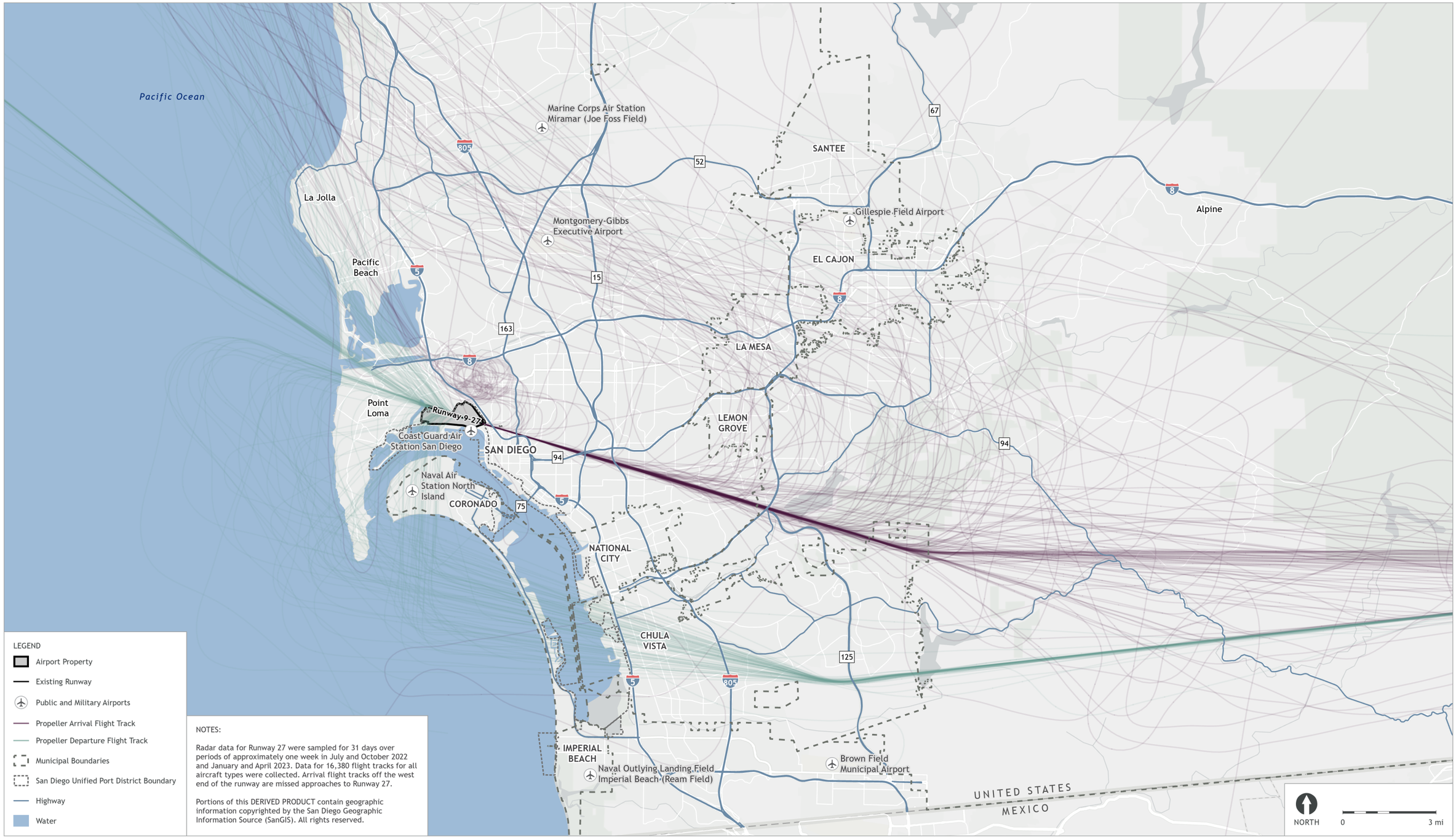

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EXHIBIT F-3

PROPELLER AIRCRAFT FLIGHT TRACKS -
RUNWAY 27 UP TO 10,000 FEET ABOVE AIRPORT FIELD ELEVATION

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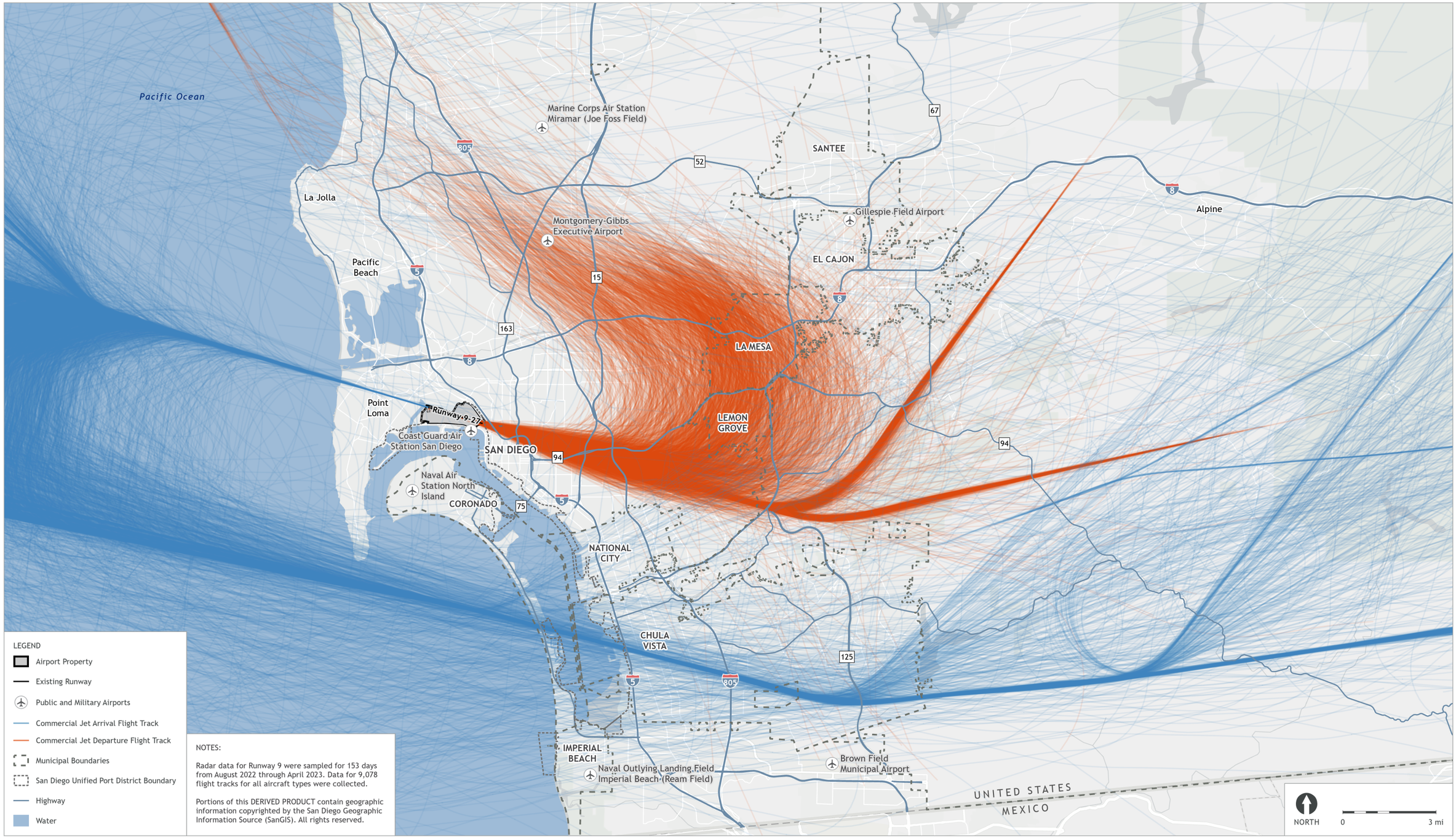

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EXHIBIT F-4

COMMERCIAL JET FLIGHT TRACKS -
RUNWAY 9 UP TO 10,000 FEET ABOVE AIRPORT FIELD ELEVATION

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Exhibit F-5 displays the flight tracks of business jets for Runway 9 up to 10,000 feet AAFE. The dark green tracks depict the arrivals, and the yellow tracks depict the departures. This exhibit reveals that business jets follow the same arrival and departure routes as commercial jets, as they are operating under IFR and are similar in performance to commercial jets.

Exhibit F-6 displays propeller aircraft arrival and departure flight tracks for Runway 9 up to 10,000 feet AAFE. The purple tracks depict the arrivals, and the light green tracks depict the departures. As shown on Exhibit F-3 for operations on Runway 27, many propeller aircraft follow the standard instrument departure and arrival routes. Many others, however, are more widely dispersed through the airspace. This reflects ATC directions separating smaller, slower propeller aircraft from the standard departure and arrival routes dominated by jets. Some of the dispersion is also accounted for by propeller aircraft operating under visual flight rules (VFR).[5]

The following four exhibits depict jet and propeller aircraft flight tracks for Runway 27 and Runway 9 up to 5,000 feet AAFE. The exhibits reveal that a considerable share of air traffic in the greater Airport environs is operating at altitudes of 5,000 feet AAFE and lower.

Exhibit F-7 depicts the combined flight tracks of commercial and business jet aircraft for Runway 27 up to 5,000 feet AAFE, because both aircraft types observe the same standard arrival and departure procedures. The blue tracks depict the arrivals, and the orange tracks depict the departures. The patterns of arrival and departure tracks are the same as on Exhibits F-1 and F-2; however, because of the lower altitude cap, they do not extend as far from the Airport. Nevertheless, arrival tracks on the downwind leg north and northeast of the Airport are visible as aircraft descend below 5,000 feet AAFE.

Exhibit F-8 displays propeller aircraft flight tracks for Runway 27 up to 5,000 feet AAFE. The purple tracks depict the arrivals, and the light green tracks depict the departures. The exhibit reflects the same arrival and departure patterns as Exhibit F-3. While the tracks do not extend as far from the Airport as those up to 10,000 feet AAFE, they do extend several miles from SDIA. Arrival tracks extend east of Chula Vista, as far north as El Cajon, and to the north and northwest over Montgomery-Gibbs Executive Airport and La Jolla. The tight cluster of circular arrival tracks immediately north of SDIA and east of Interstate 5 and south of Interstate 8 indicate aircraft are holding until they can be sequenced into the arrival stream. Departures extend over La Jolla to the northwest and over the Peninsula Community Planning Area to the west.

Exhibit F-9 displays the combined flight tracks of commercial and business jets for Runway 9 up to 5,000 feet AAFE. The blue tracks represent arrivals, and the yellow tracks represent departures. As previously stated, arrivals and departures on Runway 9 account for approximately 2 percent of all operations during the year. The patterns of arrival and departure tracks are the same as on Exhibits F-4 and F-5; however, they do not extend as far from the Airport. The primary downwind arrival leg, south of SDIA, depicts a cluster of flight tracks from east to west over Chula Vista. Scattered arrivals from the east are dispersed north of the Airport over Montgomery-Gibbs Executive Airport and La Jolla.

[5] Visual flight rules govern the procedures for conducting flights under visual conditions.

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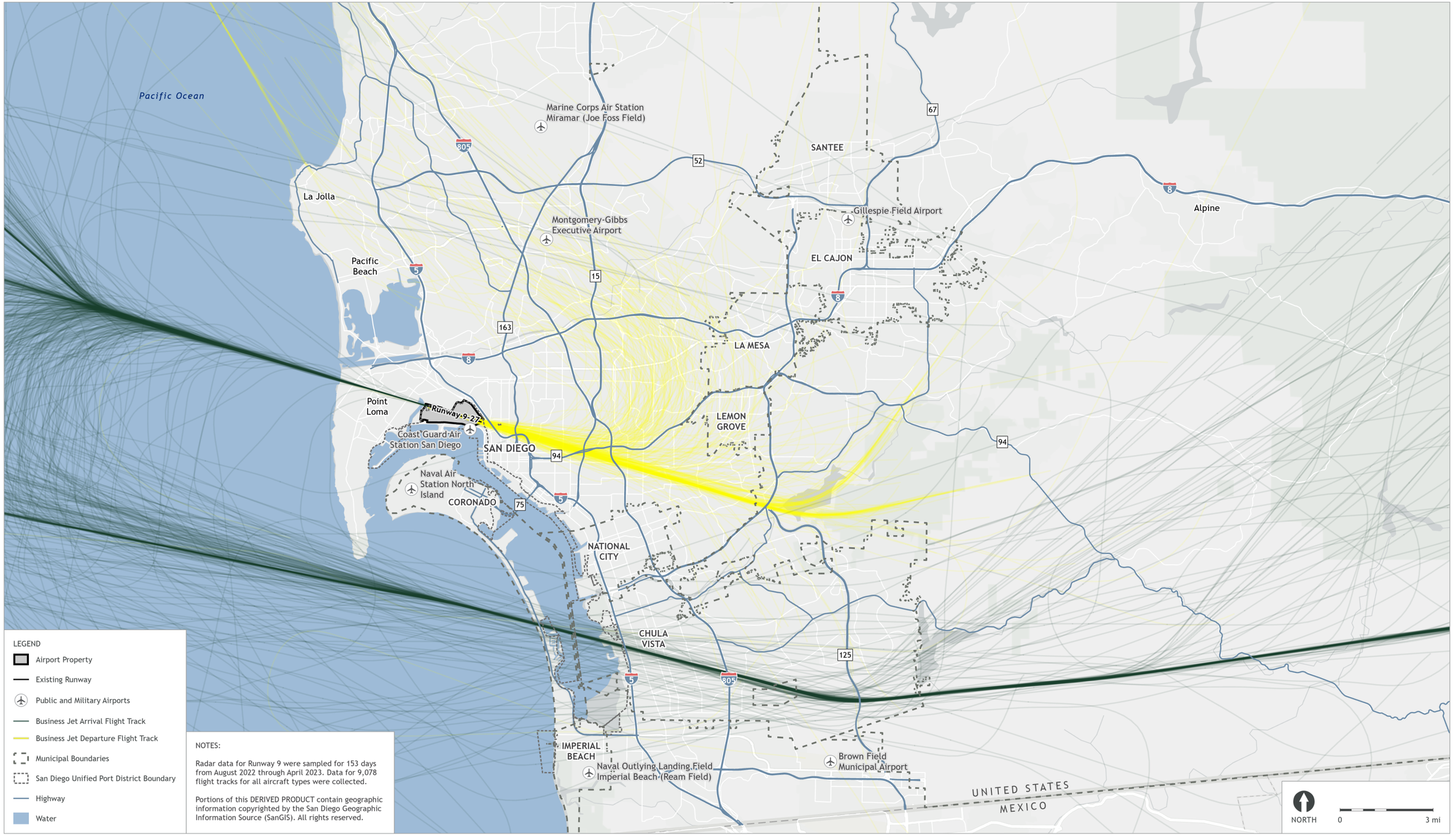

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EXHIBIT F-5

BUSINESS JET FLIGHT TRACKS -
RUNWAY 9 UP TO 10,000 FEET ABOVE AIRPORT FIELD ELEVATION

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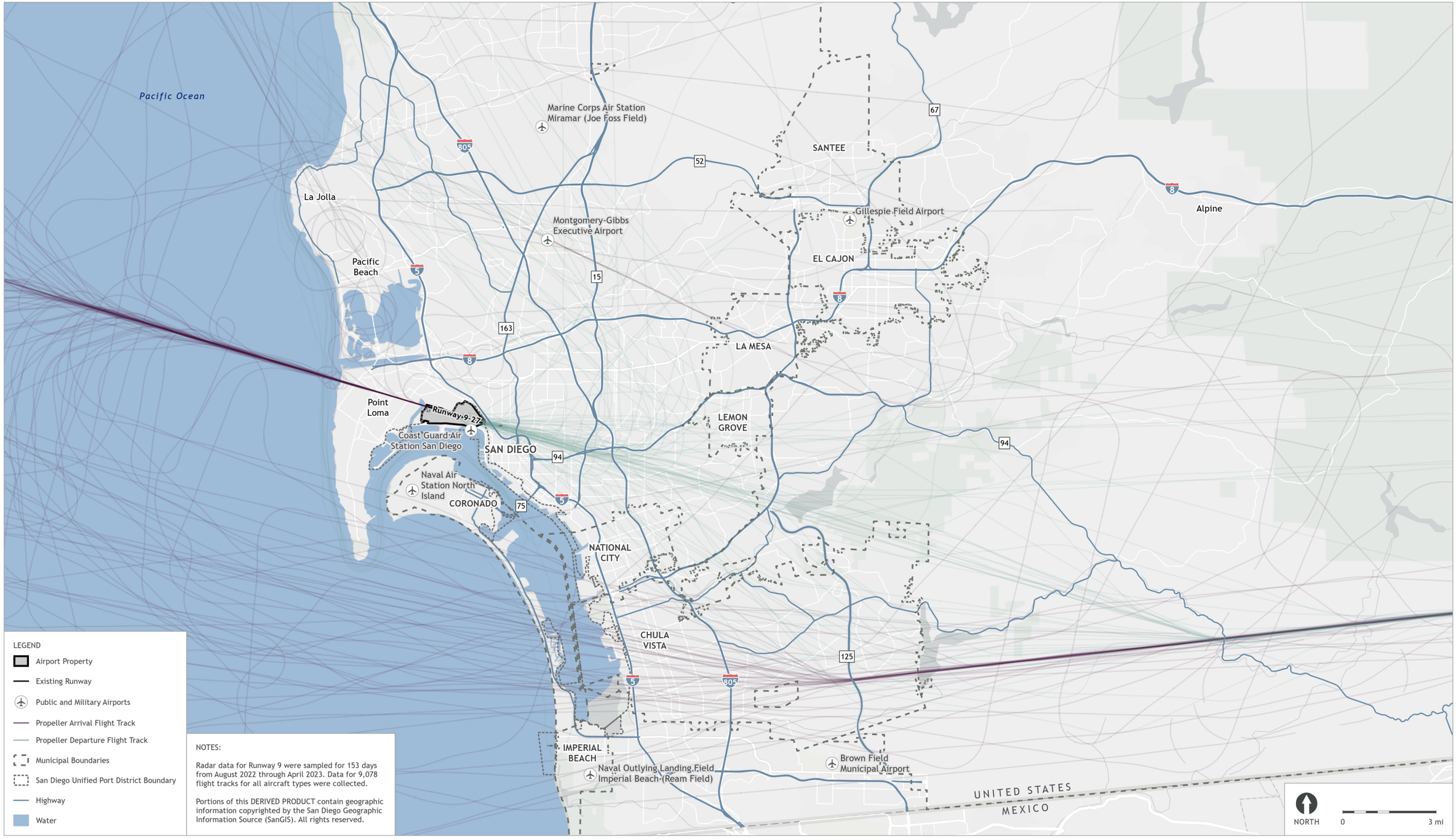

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EXHIBIT F-6

PROPELLER AIRCRAFT FLIGHT TRACKS -
RUNWAY 9 UP TO 10,000 FEET ABOVE AIRPORT FIELD ELEVATION

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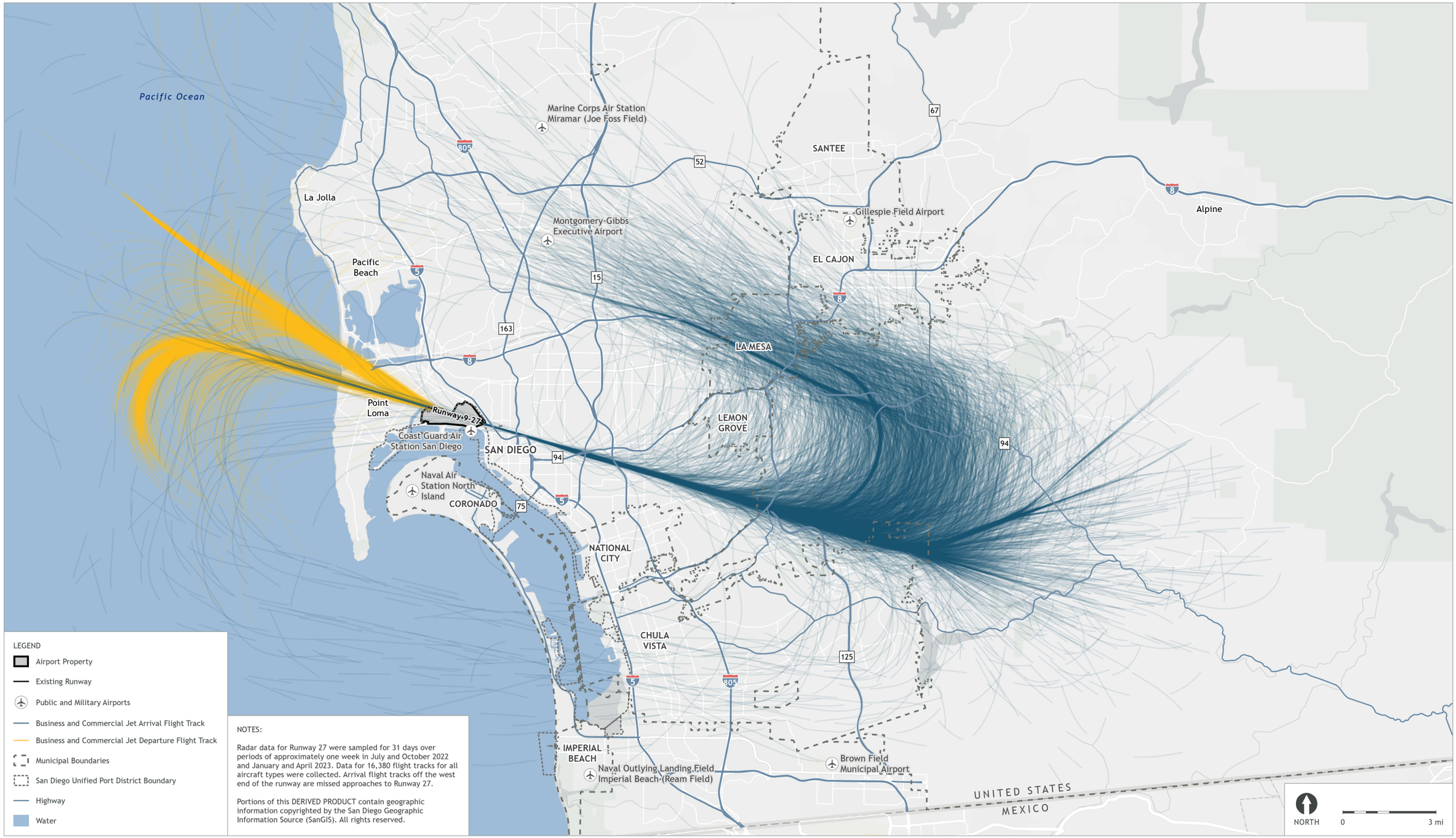

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EXHIBIT F-7

ALL JET FLIGHT TRACKS -
RUNWAY 27 UP TO 5,000 FEET ABOVE AIRPORT FIELD ELEVATION

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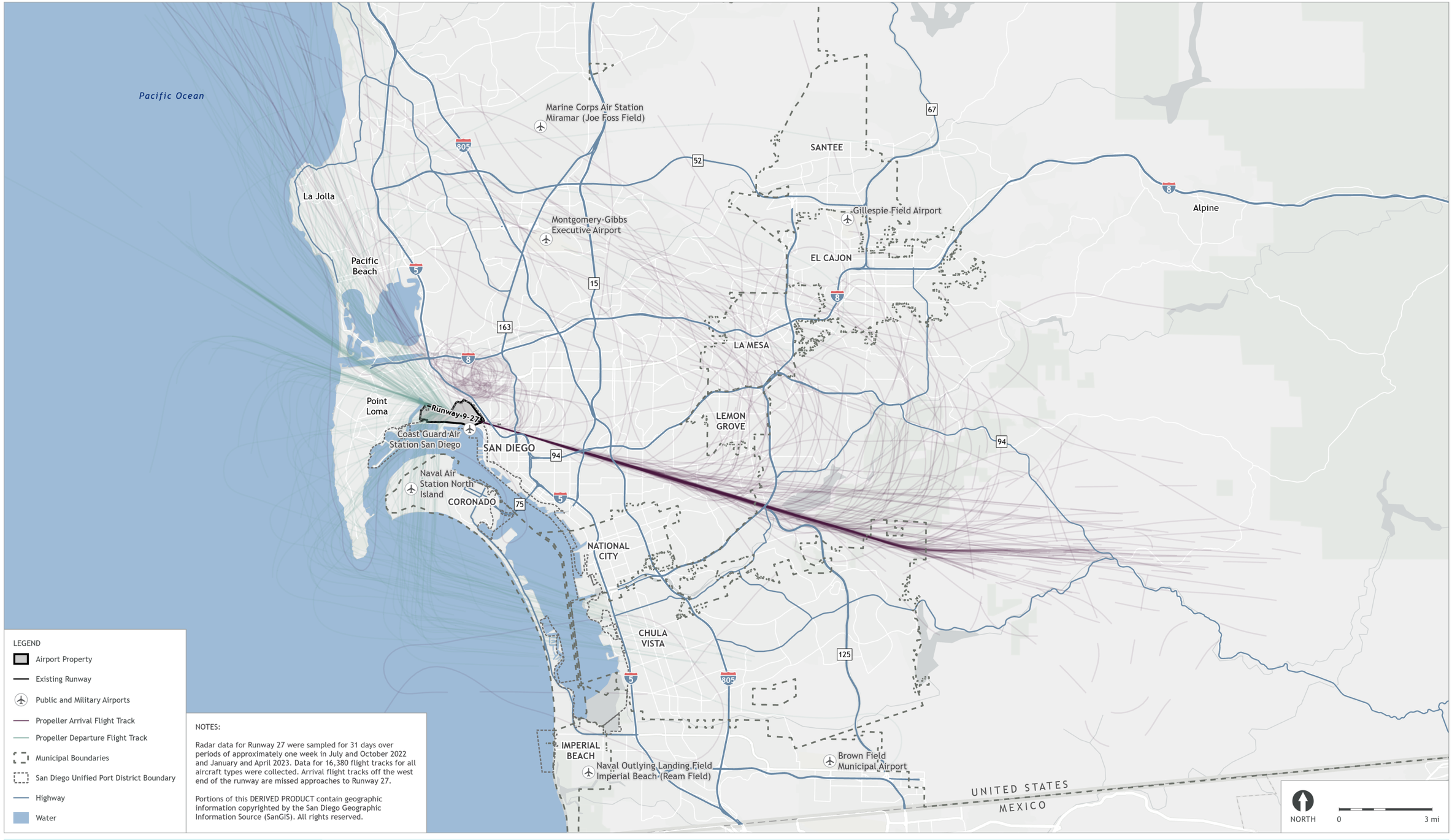

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EXHIBIT F-8

PROPELLER AIRCRAFT FLIGHT TRACKS -
RUNWAY 27 UP TO 5,000 FEET ABOVE AIRPORT FIELD ELEVATION

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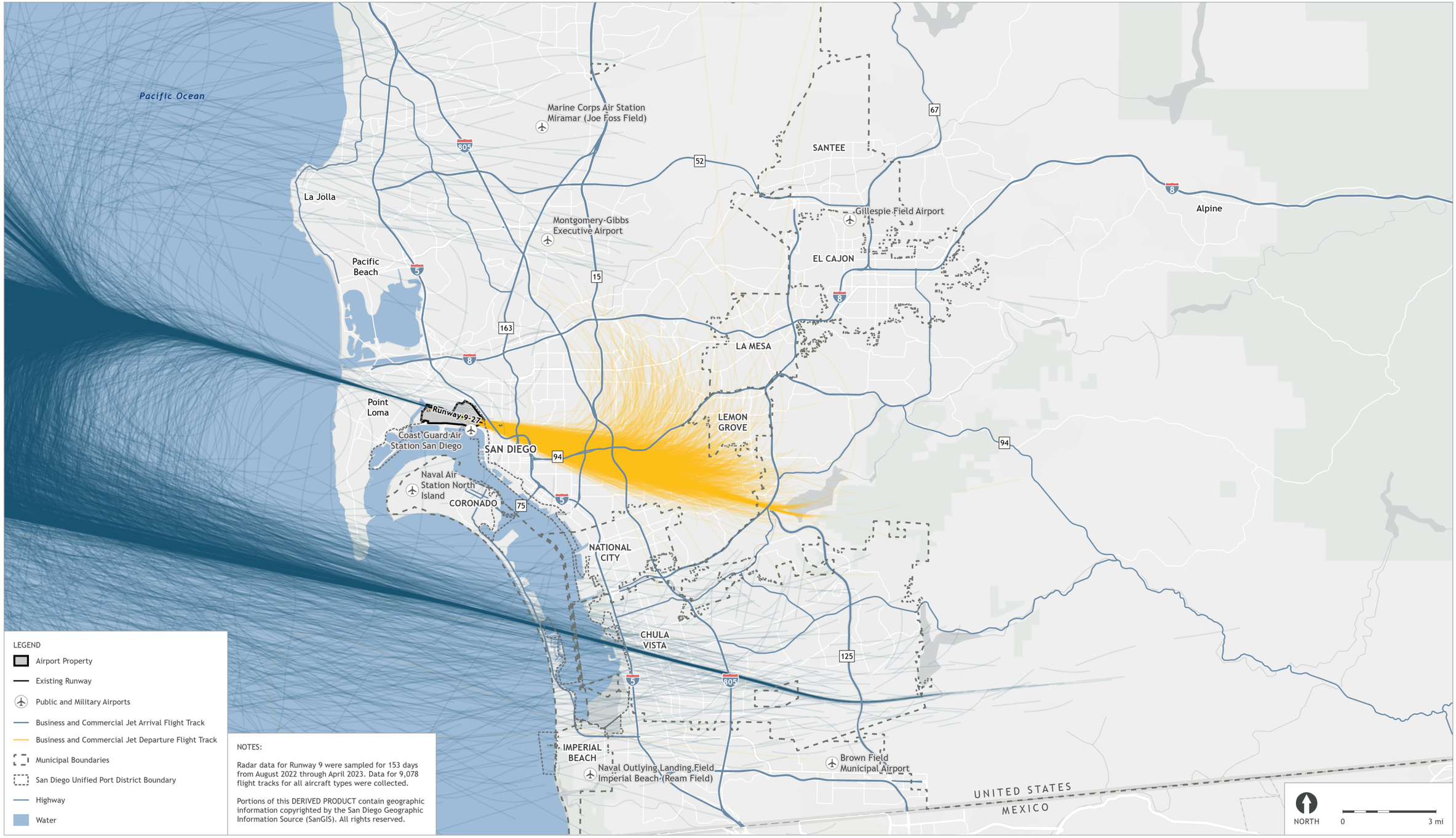

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EXHIBIT F-9

ALL JET FLIGHT TRACKS -
RUNWAY 9 UP TO 5,000 FEET ABOVE AIRPORT FIELD ELEVATION

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Exhibit F-10 displays propeller aircraft arrival and departure flight tracks for Runway 9 up to 5,000 feet AAFE. The purple tracks depict the arrivals, and the light green tracks depict the departures. Arrival tracks are observed to the northwest over La Jolla, east over La Mesa, and southeast over Chula Vista. Departures occur over San Diego and National City to the east, turn north to Lemon Grove and La Mesa, and then turn northwest.

F.3.2 Flight Track Density

A flight track density analysis was undertaken to develop a quantitative portrayal of flight tracks throughout the study area. The flight track density maps indicate the number of flight tracks per average day during the sampling period at any location. The analysis accounts for all aircraft types and operations in both directions on Runway 9-27. Because Runway 27 is used for 98 percent of operations, the flight track density pattern resembles the pattern for individual flight tracks on Runway 27, depicted on preceding exhibits.

Exhibit F-11 depicts the average number of daily operations, by all aircraft types, up to 10,000 feet AAFE. The areas of highest density, ranging from 20 to greater than 200 flights per day, are indicated in yellow, orange, and red. These areas occur in narrow paths reflecting the predominant instrument approach and departure routes. A wide swath of dark green north and northeast of SDIA, representing 1 to 5 operations per day, reflects the downwind, base, and final legs of the Runway 27 approach. The blue and gray shadings represent areas with 0.14 (1 per week) to 1.0 flights per day and extend from the coast north of La Jolla, southeast to El Cajon, and east of Chula Vista.

Exhibit F-12 depicts the average number of daily operations up to 7,000 feet AAFE. The areas with 20 or more flights per day extend west of the Airport to the coast and east nearly to the edge of the map and back to the northwest near Montgomery-Gibbs Executive Airport. Areas overflown by more than 1 flight per day (indicated in green) extend from Montgomery-Gibbs Executive Airport southeast to the unincorporated area east of Chula Vista along the extended runway centerline.

Exhibit F-13 depicts the average number of daily operations up to 5,000 feet AAFE. Again, areas with 20 flights or more (yellow, orange, and red) extend directly west of the Airport to the coast and east along the extended runway centerline past Chula Vista. Another area with 20 flights per day extends along the base leg of the Runway 27 approach from east of La Mesa south to the extended runway centerline. Areas overflown by more than 1 operation per day (green) generally extend laterally from the areas of densest flight tracks, indicative of dispersed flight tracks.

Exhibit F-14 depicts the average number of daily operations up to 3,000 feet AAFE. At this altitude, operations are clustered to the west along the Runway 27 departure routes and to the east along the final approach to Runway 27. Along the Runway 27 approach, average operations of 20 or more per day are observed between Lemon Grove and Chula Vista.

F.4 SUMMARY

The flight track patterns in the SDIA vicinity reflect the routes designated in published departure and arrival procedures. Considerable flight track dispersion is observed north and northeast of the Airport along the downwind and base legs of the Runway 27 approach. Propeller flight tracks tend to be dispersed near the Airport, indicating ATC procedures separating them from faster jet aircraft.

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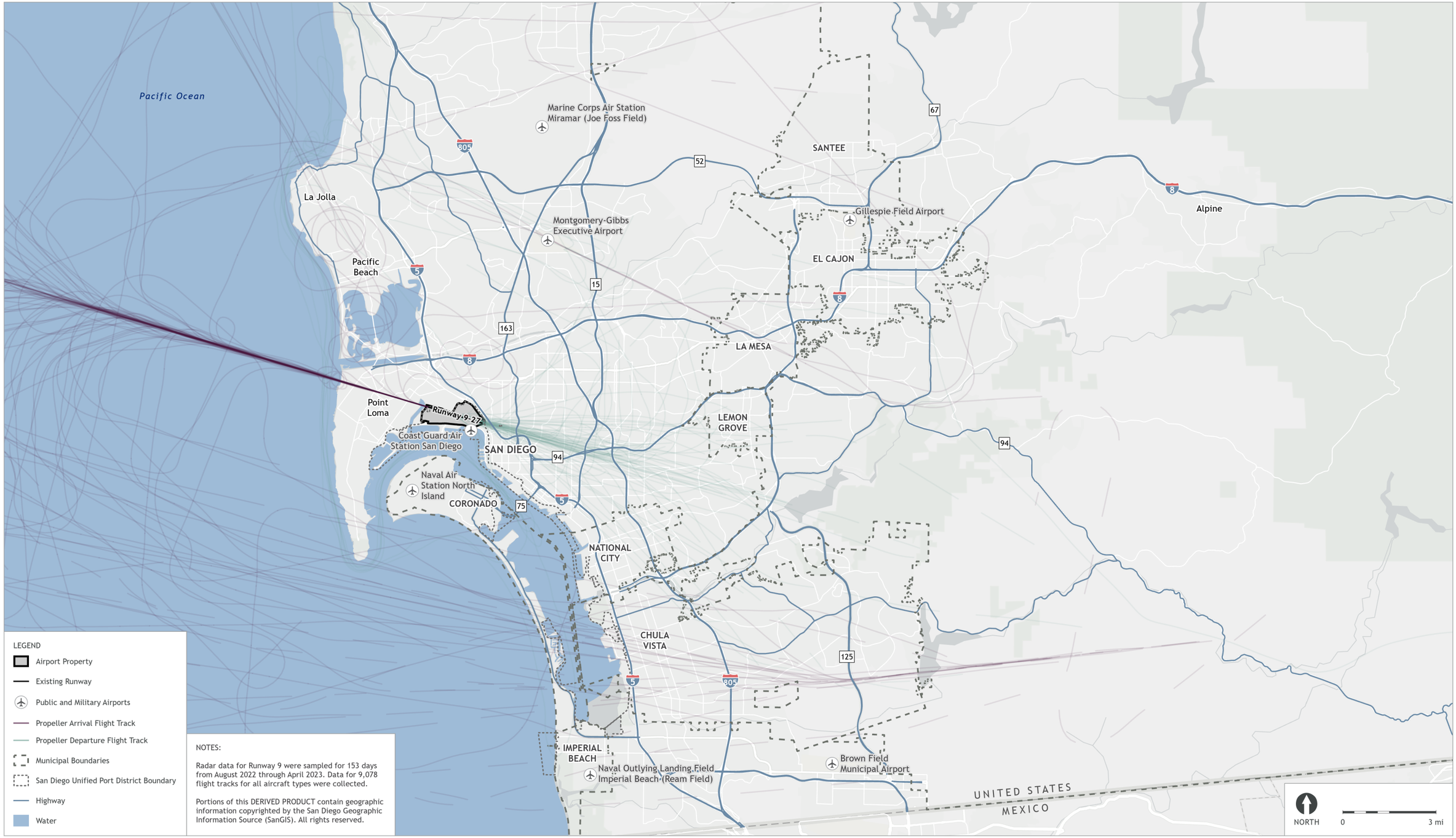

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EXHIBIT F-10

PROPELLER AIRCRAFT FLIGHT TRACKS -
RUNWAY 9 UP TO 5,000 FEET ABOVE AIRPORT FIELD ELEVATION

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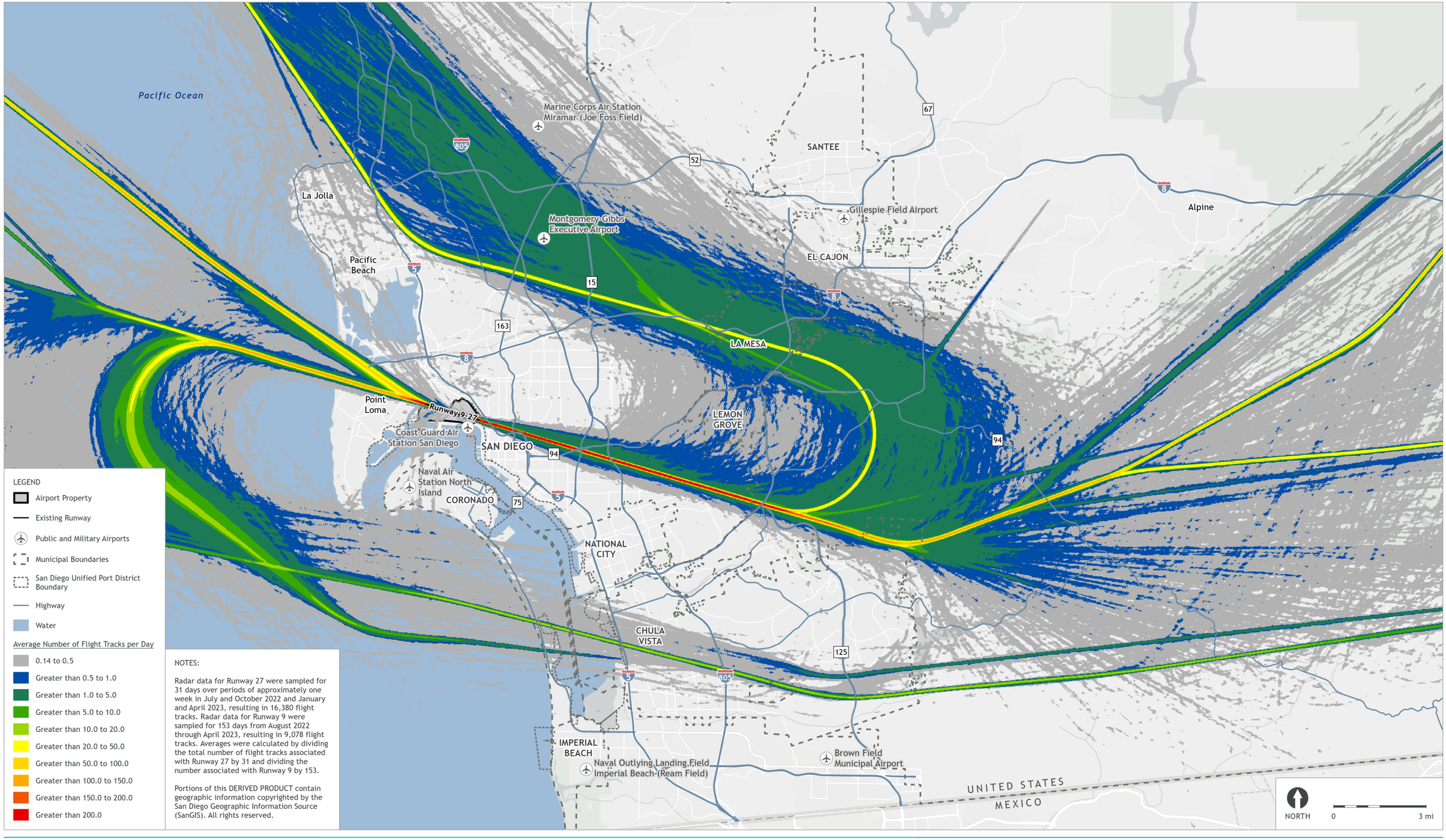

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SOURCES: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, April 2024 (basemap); San Diego Geographic Information Source (SanGIS), 2023 (municipal boundary); San Diego County Regional Airport Authority, Airport Noise and Operations Monitoring System (ANOMS), 2022 (radar tracks); Jacobsen|Daniels, *San Diego International Airport, Airport Layout Plan*, June 2021 (Airport property, runway); US Department of Transportation, Federal Aviation Administration, Aeronautical Information Services, 2022 (airports); San Diego County Regional Airport Authority, 2023 (San Diego Unified Port District Boundary); US Census Bureau, 2024 (roads); Ricondo & Associates, Inc., May 2023 (density).

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EXHIBIT F-11

AVERAGE DAILY DENSITY OF FLIGHT TRACKS UP TO 10,000 FEET ABOVE AIRPORT FIELD ELEVATION - ALL AIRCRAFT, BOTH RUNWAY ENDS

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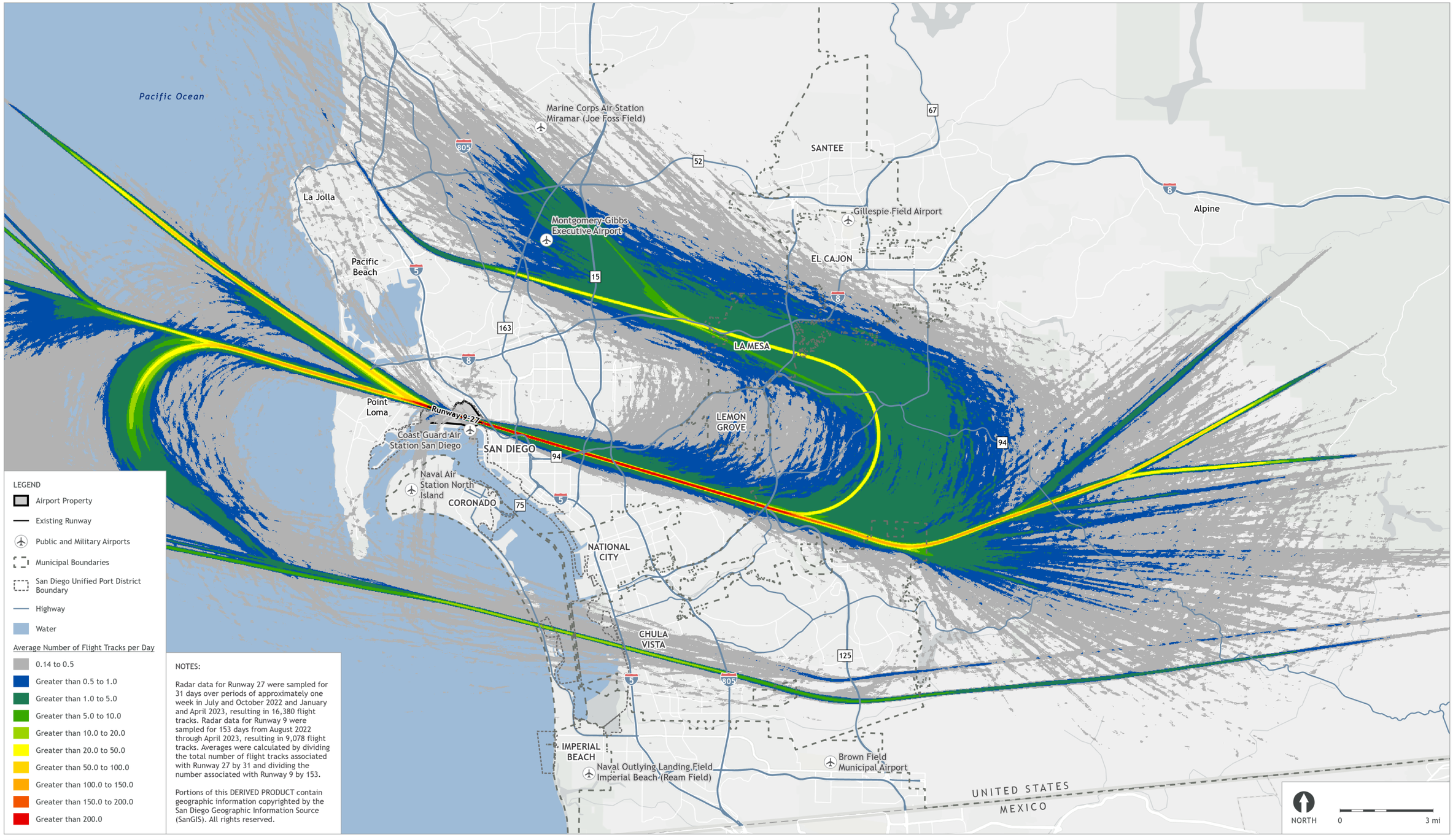

AIRPORT LAND USE COMMISSION

SOURCES: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, April 2024 (basemap); San Diego Geographic Information Source (SanGIS), 2023 (municipal boundary); San Diego County Regional Airport Authority, Airport Noise and Operations Monitoring System (ANOMS), 2022 (radar tracks); Jacobsen|Daniels, *San Diego International Airport, Airport Layout Plan*, June 2021 (Airport property, runway); US Department of Transportation, Federal Aviation Administration, Aeronautical Information Services, 2022 (airports); San Diego County Regional Airport Authority, 2023 (San Diego Unified Port District Boundary); US Census Bureau, 2024 (roads); Ricondo & Associates, Inc., May 2023 (density).

File Location: Project:P:\GIS\Projects\SAN\MXD\SAN_ALUCP_2024_Maps\SAN_ALUCP_AppendixF_20240520.aprx Layout: SAN_ALUCP_ExhF-12_FlightTrackDensity_UpTo7000_20240517

EXHIBIT F-12

AVERAGE DAILY DENSITY OF FLIGHT TRACKS UP TO 7,000 FEET ABOVE AIRPORT FIELD ELEVATION - ALL AIRCRAFT, BOTH RUNWAY ENDS

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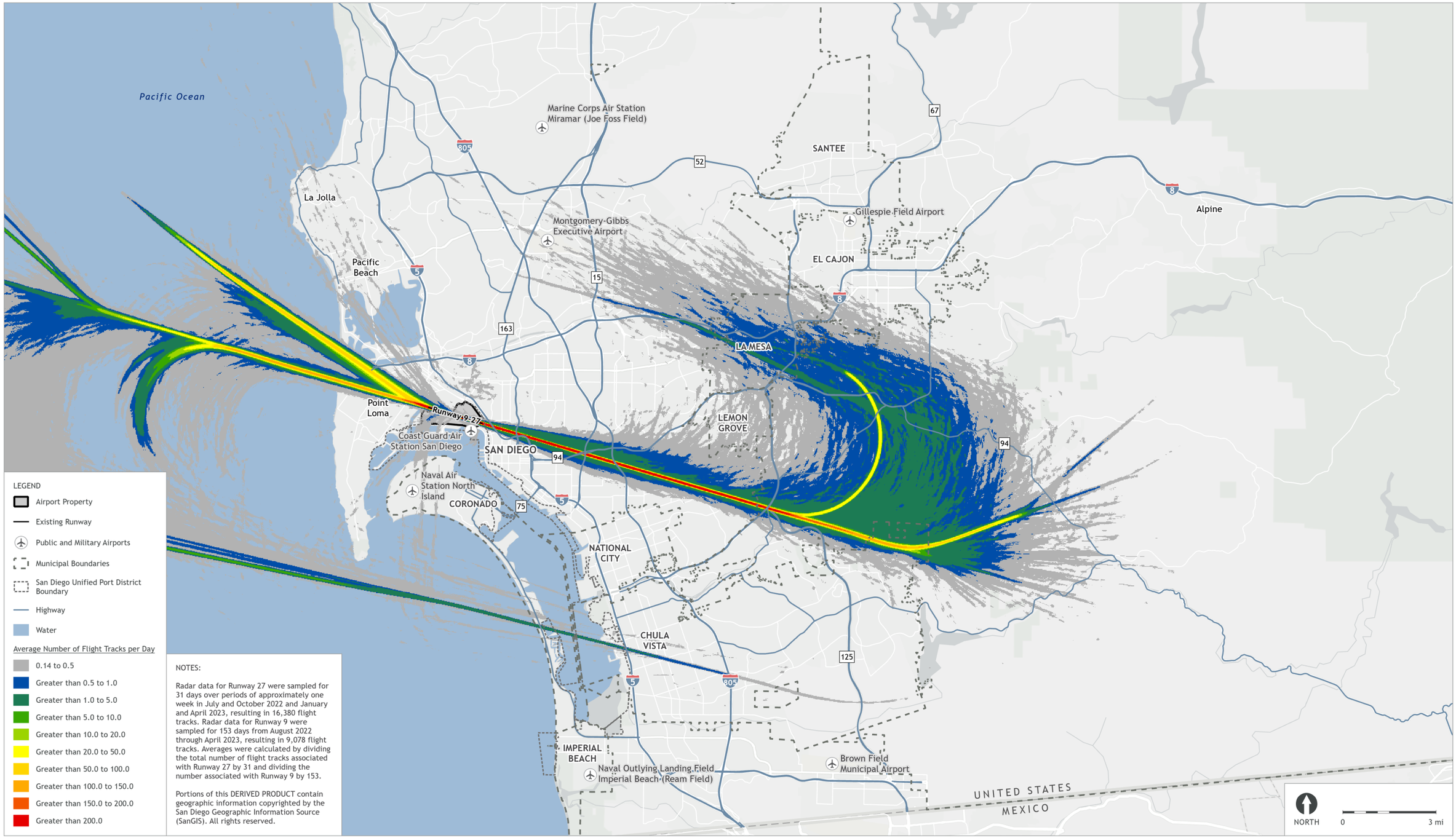

AIRPORT LAND USE COMMISSION

SOURCES: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, April 2024 (basemap); San Diego Geographic Information Source (SanGIS), 2023 (municipal boundary); San Diego County Regional Airport Authority, Airport Noise and Operations Monitoring System (ANOMS), 2022 (radar tracks); Jacobsen|Daniels, *San Diego International Airport, Airport Layout Plan*, June 2021 (Airport property, runway); US Department of Transportation, Federal Aviation Administration, Aeronautical Information Services, 2022 (airports); San Diego County Regional Airport Authority, 2023 (San Diego Unified Port District Boundary); US Census Bureau, 2024 (roads); Ricondo & Associates, Inc., May 2023 (density).

File Location: Project:P:\GIS\Projects\SAN\MXD\SAN_ALUCP_2024_Maps\SAN_ALUCP_AppendixF_20240520.aprx Layout: SAN_ALUCP_ExhF-13_FlightTrackDensity_UpTo5000_20240517

EXHIBIT F-13

AVERAGE DAILY DENSITY OF FLIGHT TRACKS UP TO
5,000 FEET ABOVE AIRPORT FIELD ELEVATION - ALL AIRCRAFT, BOTH RUNWAY ENDS

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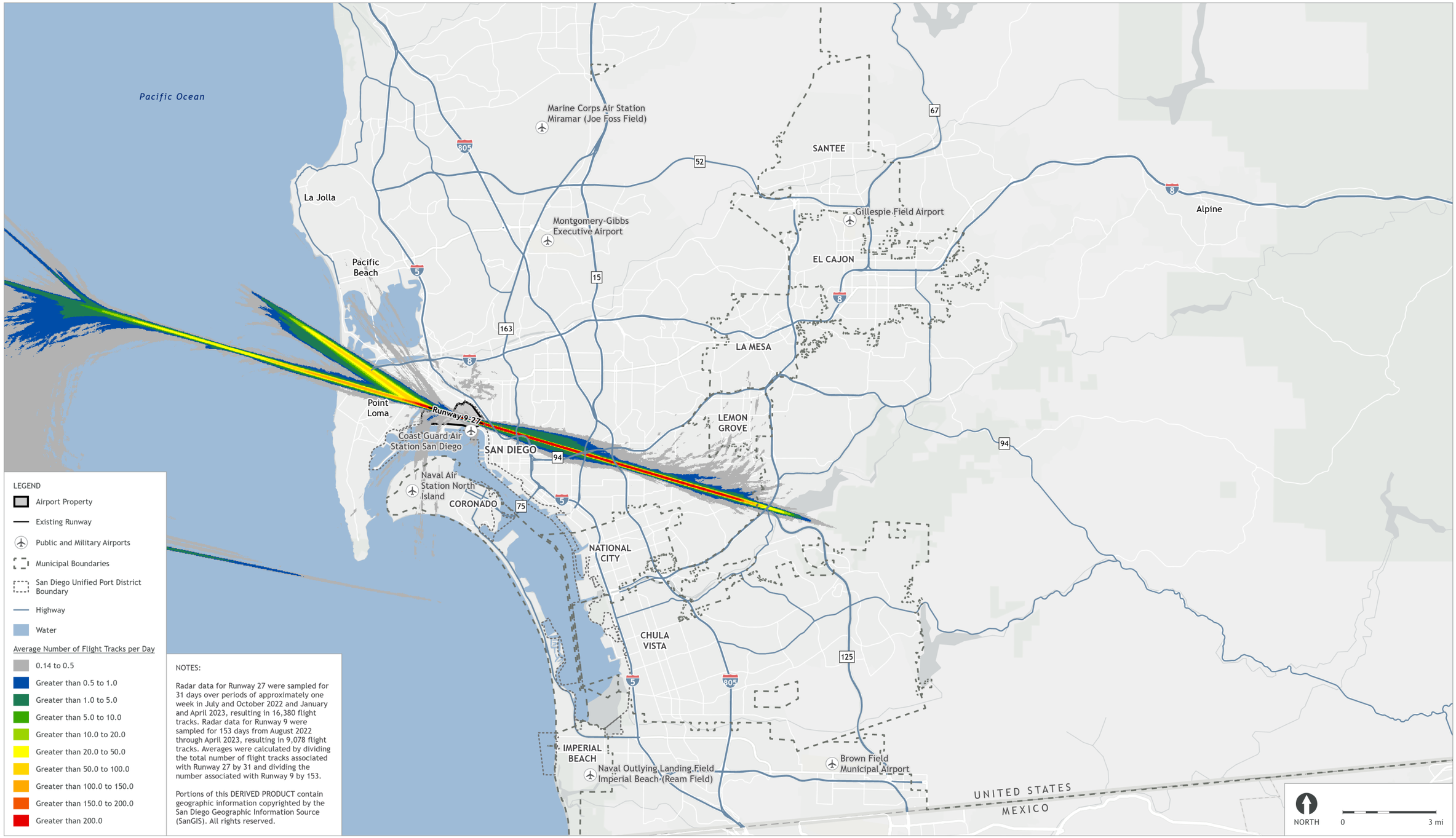

NOTES:

Radar data for Runway 27 were sampled for 31 days over periods of approximately one week in July and October 2022 and January and April 2023, resulting in 16,380 flight tracks. Radar data for Runway 9 were sampled for 153 days from August 2022 through April 2023, resulting in 9,078 flight tracks. Averages were calculated by dividing the total number of flight tracks associated with Runway 27 by 31 and dividing the number associated with Runway 9 by 153.

AIRPORT LAND USE COMMISSION

SOURCES: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community, April 2024 (basemap); San Diego Geographic Information Source (SanGIS), 2023 (municipal boundary); San Diego County Regional Airport Authority, Airport Noise and Operations Monitoring System (ANOMS), 2022 (radar tracks); Jacobsen|Daniels, *San Diego International Airport*, *Airport Layout Plan*, June 2021 (Airport property, runway); US Department of Transportation, Federal Aviation Administration, Aeronautical Information Services, 2022 (airports); San Diego County Regional Airport Authority, 2023 (San Diego Unified Port District Boundary); US Census Bureau, 2024 (roads); Ricondo & Associates, Inc., May 2023 (density).

File Location: Project:P:\GIS\Projects\SAN\MXD\SAN_ALUCP_2024_Maps\SAN_ALUCP_AppendixF_20240520.aprx Layout: SAN_ALUCP_ExhF-14_FlightTrackDensity_UpTo3000_20240517

EXHIBIT F-14

AVERAGE DAILY DENSITY OF FLIGHT TRACKS UP TO 3,000 FEET ABOVE AIRPORT FIELD ELEVATION - ALL AIRCRAFT, BOTH RUNWAY ENDS

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