# APPENDIX C
# AIRCRAFT NOISE AND EMISSIONS TECHNICAL REPORT

RS&H

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This technical report describes the aircraft noise exposure and emissions for the Charles M Schultz-Sonoma County Airport (STS) Focused Airport Layout Plan Update.

## 1.1 NOISE MODEL

The methodology for assessing noise exposure included preparing Community Noise Equivalent Leve (CNEL) contours using the Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT) Version 3d. The AEDT works by defining a network of grid points at ground level around an airport. It then selects the shortest distance from each grid point to each flight track and computes the noise exposure generated by each aircraft operation, along each flight track. Corrections are applied for atmospheric acoustical attenuation, acoustical shielding of the aircraft engines by the aircraft itself, and aircraft speed variations. The noise exposure levels for each aircraft are then summed at each grid location. The cumulative noise exposure levels at all grid points are then used to develop noise exposure contours for selected values (e.g. CNEL 65, 70 and 75).

## 1.2 AEDT INPUT DATA

In the development of CNEL contours, the AEDT uses both default and airport-specific factors. The default factors include engine noise levels, thrust settings, aircraft arrival and departure flight profiles, and aircraft speed. The airport-specific factors include the number of aircraft operations, the type of aircraft, runway use, the assignment of aircraft operations to flight tracks, local meteorological conditions, and operational time (day/evening/night) data. The following describe these airport-specific data.

### 1.2.1 Meteorological Data

The AEDT accounts for the influences of meteorological conditions on aircraft performance and atmospheric sound absorption. Meteorological conditions affect the transmission of aircraft noise through the air. The AEDT uses temperature and relative humidity to calculate atmospheric absorption coefficients, which in turn are used to adjust aircraft performance and noise propagation. The 10-year average meteorological conditions included in the AEDT for STS are:

- Temperature: 54.8° Fahrenheit
- Barometric pressure: 1010.8 millibars
- Relative humidity: 73.5%

### 1.2.2 Aircraft Operations

The Base and Ultimate scenarios annual operations by category are provided in **Table C1.** As shown, annual operations for the Base scenario total 95,523 (an average of 262 operations per day). The Ultimate scenario operations total 107,860 (an average of 296 per day). For the purposes of preparing CNEL contours, operational data need to be segregated by aircraft type. The Base and Ultimate aircraft fleet of itinerant and local operations are provided in **Tables C2** and **C3**, respectively.

***TABLE C1 - ANNUAL AIRCRAFT OPERATIONS***

| Scenario | Air Carrier | Air Taxi / Commuter | GA Itinerant | GA Local | Military | Total Operations |
|---|---|---|---|---|---|---|
| Base | 15,330 | 7,963 | 45,160 | 26,383 | 687 | 95,523 |
| Ultimate | 21,170 | 9,685 | 49,800 | 26,518 | 687 | 107,860 |

Source: Mead & Hunt, 2021

***TABLE C0 - ANNUAL AIRCRAFT OPERATIONS - ITINERANT***

| Representative Aircraft Type (s) | AEDT Equip ID | AEDT ANP | Base Operations | Ultimate Operations |
|---|---|---|---|---|
| Embraer 175 | 3815 | EMB175 | 5,840 | 9,490 |
| Boeing 737-800 | 203 | 737800 | 5,110 | 8,030 |
| Canadair RJ 700/900 | 2426 | CRJ9-ER | 4,380 | 2,920 |
| Airbus A320 | 2587 | A320-232 | - | 730 |
| Bombardier Challenger 300/350/600 | 1239 | CL600 | 1,894 | 2,185 |
| Cessna Citation CJ1/CJ2/CJ3 | 1288 | CNA500 | 1,415 | 1,632 |
| Cessna 525 Citation Jet | 6060 | CNA525C | 1,109 | 1,278 |
| Learjet 35/45/60, Hawker 800 | 2028 | LEAR35 | 1,094 | 1,262 |
| Cessna 560 Citation XLS | 6065 | CNA560XL | 1,033 | 1,192 |
| Cessna 750 Citation X, Falcon 2000 | 1307 | CNA750 | 975 | 1,124 |
| Gulfstream G400, Falcon 7X | 1920 | GIV | 970 | 1,119 |
| Citation II/Bravo | 1292 | CNA55B | 903 | 1,042 |
| Cessna Citation Sovereign/ Latitude | 3047 | CNA680 | 749 | 864 |
| Cessna Citation Mustang, Phenom 100 | 6062 | CNA510 | 680 | 784 |
| Raytheon Premier I, Beechjet400 | 6159 | MU3001 | 639 | 737 |
| Dassault Falcon 50/900 | 1320 | FAL900EX | 634 | 732 |
| Cessna 560 Citation V/Ultra | 1298 | CNA560U | 473 | 546 |
| Gulfstream GV / 500 | 1923 | GV | 422 | 487 |
| Bombardier Global Express | 1773 | BD-700-1A10 | 383 | 442 |
| Israel IAI-1125 Astra/1126 Galaxy | 1977 | IA1125 | 302 | 349 |
| Cessna Citation III | 1234 | CIT3 | 199 | 230 |
| Gulfstream G280 | 4198 | CL601 | 195 | 224 |
| Bombardier Global 5000 | 2573 | BD-700-1A11 | 123 | 142 |
| Eclipse 500 | 3159 | ECLIPSE500 | 112 | 130 |
| King Air 90, Super King Air 300/350 | 1503 | DHC6 | 5,259 | 5,873 |
| Pilatus PC12, Cessna 208, Socata TBM7 | 1489 | CNA208 | 5,192 | 5,798 |
| Cessna 441, Piper Cheyenne, TBM-850 | 2580 | CNA441 | 2,342 | 2,616 |
| Cessna 172/177/206 | 1261 | CNA172 | 5,043 | 5,706 |
| Beech 35/36, Cessna 210, DA-40 | 1276 | GASEPV | 4,809 | 5,440 |

| | | | | |
|---|---|---|---|---|
| Cirrus SR20/22 | 1325 | COMSEP | 3,347 | 3,787 |
| Cessna 206 | 3172 | CNA206 | 306 | 346 |
| Baron 55/58, Cessna 340/414/421P | 1196 | BEC58P | 6,712 | 7,402 |
| King Air 90, Super King Air 300/350 | 1546 | DHC6 | 989 | 994 |
| Rockwell OV-10 Bronco | 1457 | OV10A | 264 | 265 |
| Lockheed C-130 Hercules | 3170 | C130E | 66 | 66 |
| Airbus Helicopters H135 | 4097 | EC130 | 3,140 | 3,283 |
| Robinson R-44 | 3161 | R44 | 449 | 469 |
| Agusta A-109 | 28 | A109 | 449 | 469 |
| Bell 429 | 4125 | B429 | 449 | 469 |
| Eurocopter MH-65 Dolphin | 4120 | SA365N | 344 | 344 |
| UH-60 Black Hawk | 21 | S70 | 114 | 115 |
| Lockheed C-130 Hercules | 3170 | C130E | 229 | 229 |
| | | Total | 69,140 | 81,342 |

Source: Mead & Hunt; RS&H, 2021

***TABLE C3 - ANNUAL AIRCRAFT OPERATIONS – LOCAL***

| Representative Aircraft Type (s) | AEDT Equip ID | AEDT ANP | Base Operations | Ultimate Operations |
|---|---|---|---|---|
| Cessna 172/177/206 | 1261 | CNA172 | 7,882 | 7,922 |
| Beech 35/36, Cessna 210, DA-40 | 1276 | GASEPV | 7,515 | 7,554 |
| Cirrus SR20/22 | 1325 | COMSEP | 5,231 | 5,258 |
| Cessna 206 | 3172 | CNA206 | 479 | 481 |
| Baron 55/58, Cessna 340/414/421P | 1196 | BEC58P | 5,277 | 5,304 |
| | | Total | 26,383 | 26,518 |

Source: Mead & Hunt; RS&H, 2021

### 1.2.3 Time of Day

Aircraft operations modeled in the AEDT are assigned as occurring during daytime (7:00 a.m. to 6:59 p.m.), evening (7:00 p.m. to 9:59 p.m.) or nighttime (10:00 p.m. to 6:59a.m.). The calculation of CNEL includes an additional weight of 4.77 dBA added to those aircraft events that occur during the evening and 10.0 dBA for those occurring at night. The time-of-day percentages of operations modeled are summarized in **Table C4**.

***TABLE C4 - TIME OF DAY***

| Aircraft | Day (7:00am – 6:59pm) | Evening (7:00pm-9:59pm) | Night (10:00pm-6:59am) | Total |
|---|---|---|---|---|
| Departures | | | | |
| Embraer 175 | 89% | 11% | - | 100% |
| Boeing 737-800 | 33% | 17% | 50% | 100% |
| Canadair RJ 700/900 | 50% | 33% | 17% | 100% |
| Arrivals | | | | |
| Embraer 175 | 100% | - | - | 100% |
| Boeing 737-800 | 57% | 29% | 14% | 100% |
| Canadair RJ 700/900 | 50% | 33% | 17% | 100% |

| Departures and Arrivals | | | | |
|---|---|---|---|---|
| GA Jets and Turboprops | 91% | 7% | 2% | 100% |
| GA Piston / Helicopter | 83% | 12% | 5% | 100% |
| Cal Fire | 90% | 5% | 5% | 100% |
| Military | 91% | 7% | 2% | 100% |

Source: Mead & Hunt; RS&H, 2021

### 1.2.4 Departure Stage Length

Stage length data is used in the AEDT to represent the various weights of a departing aircraft. For example, a fully loaded aircraft departing on a long-haul flight weighs more on departure than the same aircraft departing on a short-haul flight, due to the weight of the additional fuel needed to travel a longer distance. A heavier aircraft uses more runway length and climbs at a slower rate than lighter aircraft. To account for this, the AEDT contains 10 departure climb profiles (corresponding to different departure weights), depending on the type of aircraft. These profiles represent aircraft origin to destination trip lengths from less than 500 nautical miles (nm) to over 8,500 nautical miles. At STS, the maximum distance traveled on a regular basis is up to 2,500nm. The distances of each stage length in the AEDT are shown in **Table C5**. The commercial aircraft departure stage lengths modeled for the Base and Ultimate scenarios are included in **Table C6**. All general aviation and military operations were modeled Stage Length 1.

***TABLE C5 - AEDT STAGE LENGTH DESCRIPTIONS***

| Stage Length | Distance (Nautical Miles) |
|---|---|
| 1 | 0-500 |
| 2 | 501-1,000 |
| 3 | 1,001-1,500 |
| 4 | 1,501-2,500 |

Source: FAA AEDT Tech Manual 3d, March 2021

***TABLE C6 - DEPARTURE STAGE LENGTH BY AIRCRAFT TYPE***

| Aircraft | Stage Length 1 | Stage Length 2 | Stage Length 3 | Stage Length 4 | Total |
|---|---|---|---|---|---|
| | | Base | | | |
| Embraer 175 | 89% | | 11% | | 100% |
| Boeing 737-800 | 50% | 33% | | 17% | 100% |
| Canadair RJ 700/900 | 33% | 67% | | | 100% |
| | | Ultimate | | | |
| Embraer 175 | 61% | 31% | 8% | | 100% |
| Boeing 737-800 | 40% | 20% | 10% | 30% | 100% |
| Canadair RJ 700/900 | 50% | 50% | | | 100% |
| Airbus A320 | | | 100% | | 100% |

Source: Mead & Hunt; RS&H, 2021

### 1.2.5 Runway Use

Runway use refers to the frequency with which aircraft utilize each runway end for departures and arrivals. The more often a runway is used, the more noise is generated in areas located off each end of that runway. Wind direction and speed dictate the runway directional use (or flow) of airports. From a safety and operational standpoint, it is preferable for aircraft to arrive and depart into the wind. Wind direction changes may also necessitate the need to switch an airport's flow. Overall modeled runway use is included in **Table C7**.

***TABLE C7 - MODELED RUNWAY USE***

| Category | 02 | 20 | 14 | 32 | Total |
|---|---|---|---|---|---|
| Departures | | | | | |
| Commercial | - | 2% | 58% | 40% | 100% |
| GA Jets and Turboprops | - | 10% | 55% | 35% | 100% |
| GA Piston | 3% | 14% | 55% | 28% | 100% |
| Cal Fire | 3% | 33% | 36% | 28% | 100% |
| Military | | | 60% | 40% | 100% |
| Arrivals | | | | | |
| Commercial | - | - | 55% | 45% | 100% |
| GA Jets and Turboprops | - | 1% | 42% | 57% | 100% |
| GA Piston | 1% | 4% | 50% | 45% | 100% |
| Cal Fire | 1% | 4% | 65% | 30% | 100% |
| Military | | | 60% | 40% | 100% |
| Touch-and-Go | | | | | |
| GA Piston | 3% | 12% | 57% | 28% | 100% |

Source: Mead & Hunt; RS&H, 2021

### 1.2.6 Modeled Aircraft Flight Tracks

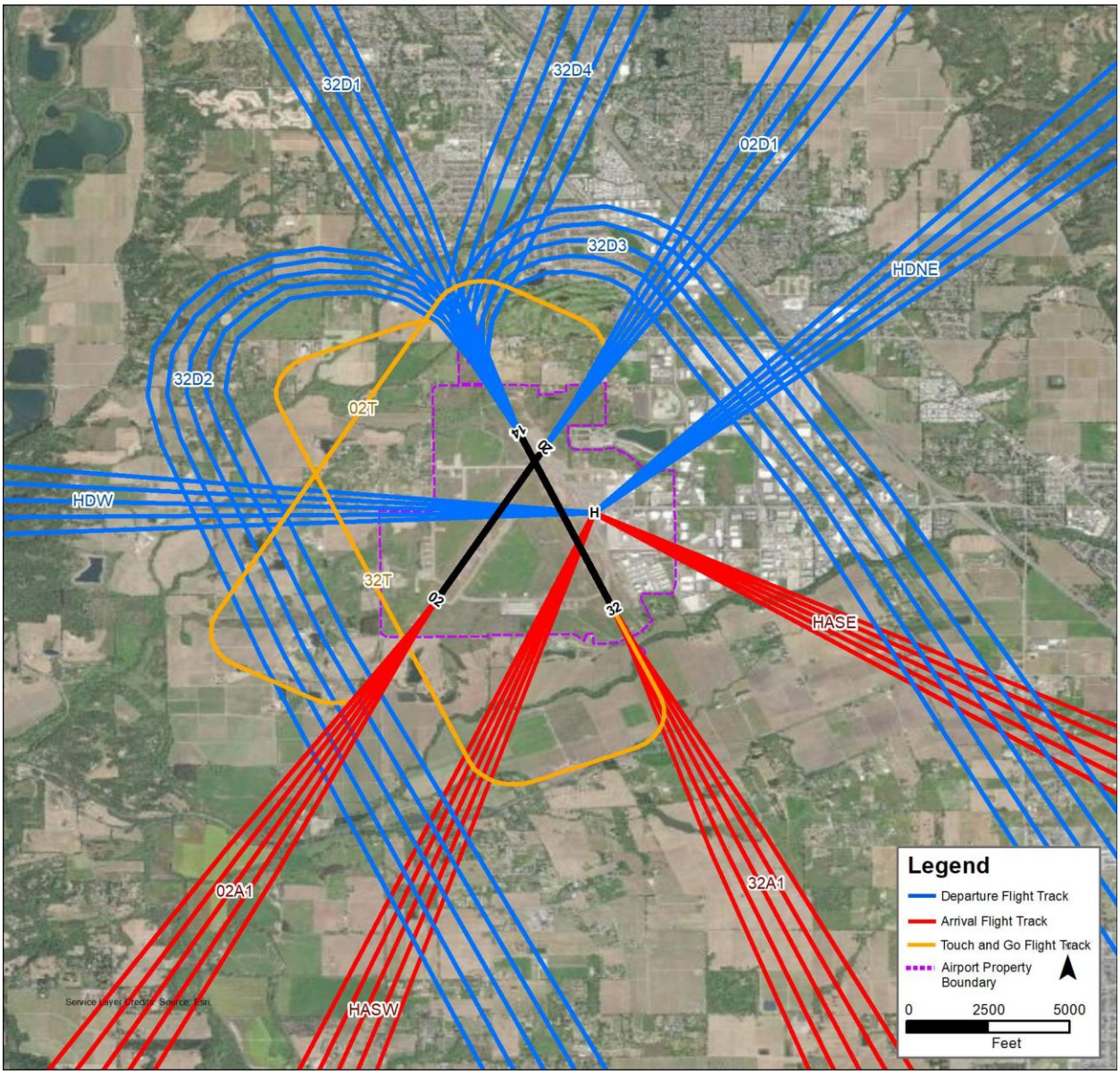
The location of flight tracks is an important factor in determining the geographic distribution of noise on the ground. The AEDT uses airport-specific ground tracks and vertical flight profiles to compute three-dimensional flight paths for each modeled aircraft operation. The "default" AEDT vertical profiles, which consist of altitude, speed, and thrust settings, are compiled from data provided by aircraft manufacturers. The flight tracks and track use estimates were developed from input by STS air traffic control tower personnel. The modeled Base scenario AEDT flight tracks for north flow and south flow are depicted on **Figures C1** and **C2** respectively. The modeled flight track use percentages are shown in **Table C8**. For modeling purposes, Cal Fire and military operations were modeled consistent with the commercial aircraft. The flight tracks for the Ultimate scenario were only slightly modified to have aircraft departures match the new Runway 20 end. Arrival flight tracks to Runway 20 remained consistent with the Base scenario with aircraft arriving to the displaced threshold. Helicopters were modeled operating from a helipad on the east side of the airfield.

***TABLE C8 - MODELED FLIGHT TRACK USE***

| | Track ID | | | | | |
|---|---|---|---|---|---|---|
| | | | North Flow Departures | | | |
| Runway 2 | 02D1 | | | | | Sum |
| Commercial | 100% | | | | | 100% |
| GA Jet / Turboprop | 100% | | | | | 100% |
| GA Piston | 100% | | | | | 100% |
| | | | | | | |
| Runway 32 | 32D1 | 32D2 | 32D3 | 32D4 | | |
| Commercial | 40% | 60% | | | | 100% |
| GA Jet / Turboprop | 40% | 50% | 5% | 5% | | 100% |
| GA Piston | 30% | 20% | 30% | 20% | | 100% |
| | | | North Flow Arrivals | | | |
| Runway 2 | 02A1 | | | | | |
| Commercial | 100% | | | | | 100% |
| GA Jet / Turboprop | 100% | | | | | 100% |
| GA Piston | 100% | | | | | 100% |
| | | | | | | |
| Runway 32 | 32A1 | | | | | |
| Commercial | 100% | | | | | 100% |
| GA Jet / Turboprop | 100% | | | | | 100% |
| GA Piston | 100% | | | | | 100% |
| | | | South Flow Departures | | | |
| Runway 20 | 20D1 | 20D2 | 20D3 | | | |
| Commercial | 50% | 25% | 25% | | | 100% |
| GA Jet / Turboprop | 50% | 25% | 25% | | | 100% |
| GA Piston | 40% | 20% | 40% | | | 100% |
| | | | | | | |
| Runway 14 | 14D1 | 14D2 | 14D3 | 14D4 | 14D5 | |
| Commercial | 35% | 10% | 25% | - | 30% | 100% |
| GA Jet / Turboprop | 30% | 15% | 25% | 5% | 25% | 100% |
| GA Piston | 20% | 20% | 20% | 20% | 20% | 100% |
| | | | South Flow Arrivals | | | |
| Runway 20 | 20A1 | | | | | |
| Commercial | 100% | | | | | 100% |
| GA Jet / Turboprop | 100% | | | | | 100% |
| GA Piston | 100% | | | | | 100% |
| | | | | | | |
| Runway 14 | 14A1 | 14A2 | 14A3 | 14A4 | 14A5 | |
| Commercial | 40% | | 50% | 10% | | 100% |
| GA Jet / Turboprop | 40% | | 50% | 10% | | 100% |
| GA Piston | 20% | 30% | 5% | 5% | 40% | 100% |

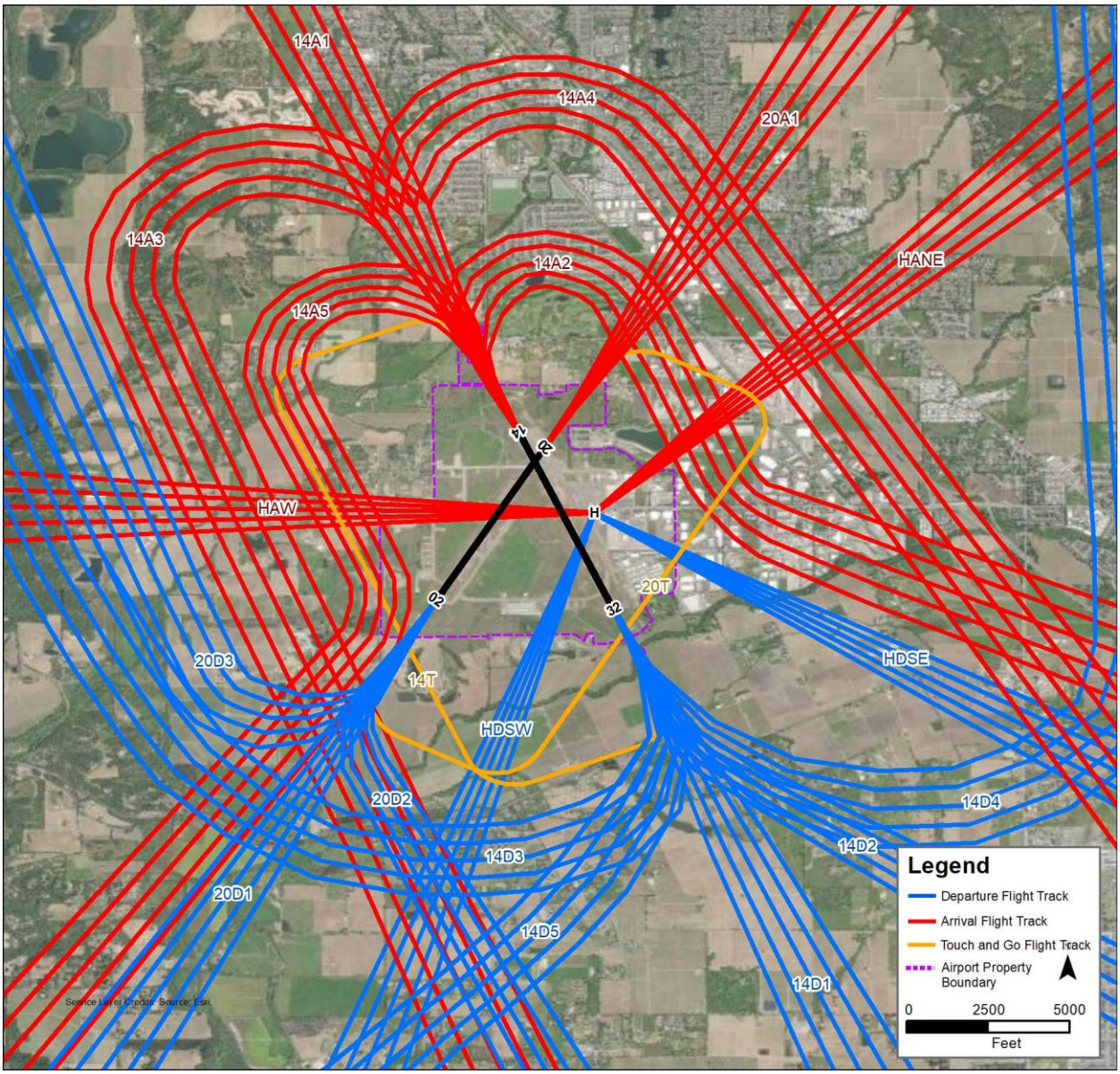
Source: STS ATCT Personnel; RS&H, 2021

***FIGURE C1 - MODELED AIRCRAFT FLIGHT TRACKS – NORTH FLOW***




Source: STS ATCT Personnel; RS&H, 2021

***FIGURE C2 - MODELED AIRCRAFT FLIGHT TRACKS – SOUTH FLOW***




Source: STS ATCT Personnel; RS&H, 2021

## 1.3 BASE SCENARIO CNEL CONTOURS

The Base scenario 60-75 CNEL contours are provided on **Figure C3**. **Table C9** identifies the areas within the CNEL contour ranges. As shown in the table, the total area within the 60 and greater CNEL contour is approximately 1,394 acres. The size of the contours are largest off the ends of Runway 14-32, which is the highest used runway at STS.

***TABLE C9 - CNEL CONTOUR AREAS - BASE***

| CNEL Range | Area (acres) |
|---|---|
| 60 - 65 | 887 |
| 65 - 70 | 304 |
| 70 - 75 | 114 |
| 75+ | 89 |
| Total | 1,394 |

Source: RS&H, 2021

## 1.4 ULTIMATE SCENARIO CNEL CONTOURS

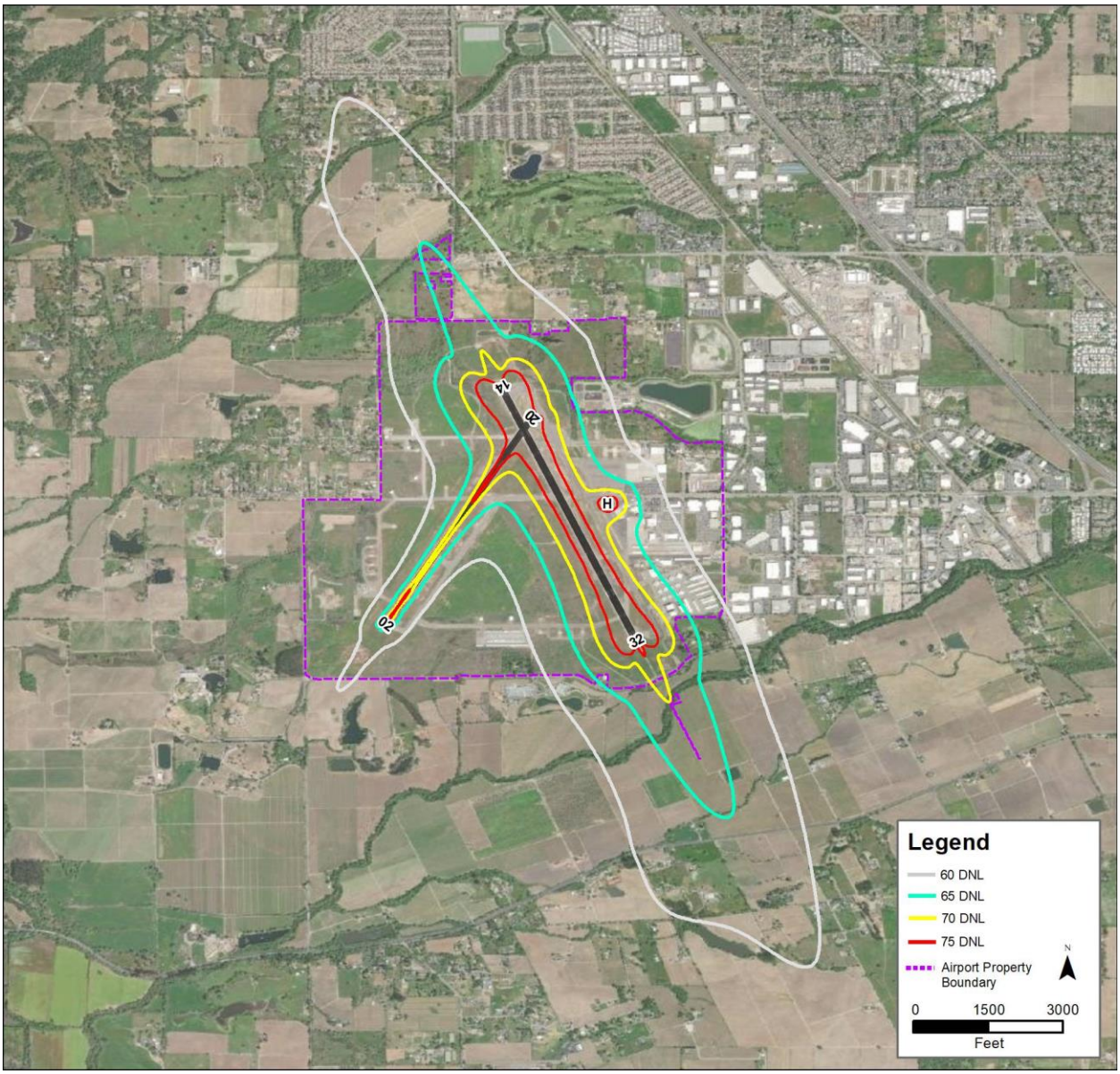
The Ultimate scenario 60-75 CNEL contours are provided on **Figure C4**. **Table C10** identifies the areas within the CNEL contour ranges. As shown in the table, the total area within the 60 and greater CNEL contour is approximately 1,852 acres. The contours are slightly larger than the Base scenario due to the greater number of operations forecast at the airport with the Ultimate scenario.

***TABLE C10 - CNEL CONTOUR AREAS – ULTIMATE***

| CNEL Range | Area (acres) |
|---|---|
| 60 - 65 | 1,185 |
| 65 - 70 | 415 |
| 70 - 75 | 140 |
| 75+ | 112 |
| Total | 1,852 |

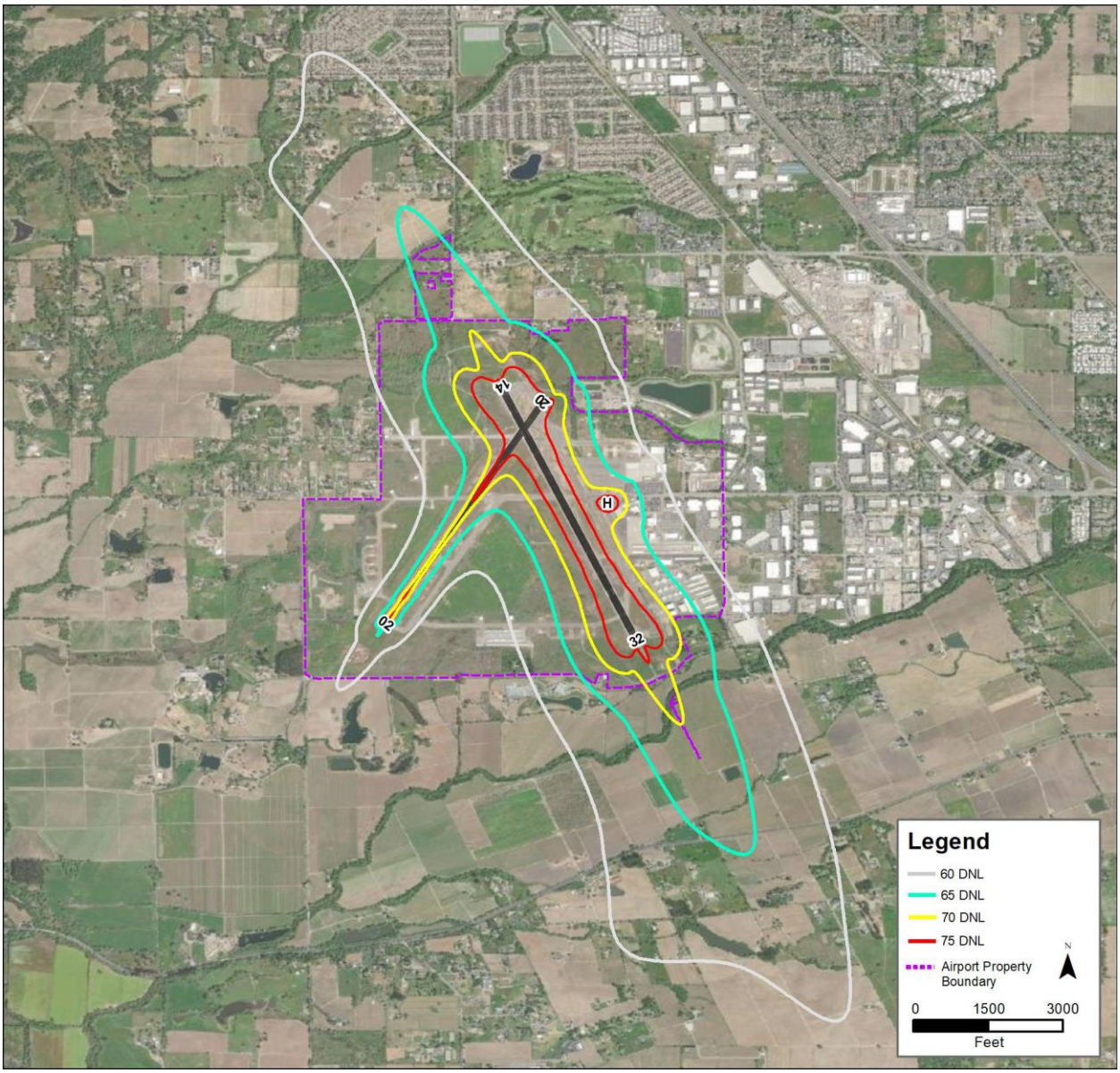
Source: RS&H, 2021

***FIGURE C3 - BASE SCENARIO 60-75 CNEL CONTOURS***




Source: RS&H, 2021

***FIGURE C4 - ULTIMATE SCENARIO 60-75 CNEL CONTOURS***




Source: RS&H, 2021

## 1.5 AIRCRAFT EMISSIONS

The operational emissions inventory was prepared for the aircraft operations, which are by far the largest contributor to emissions at an airport, for the Base and Ultimate Scenarios. Other sources that contribute to emissions at an airport include aircraft auxiliary power units, ground support equipment, motor vehicles and stationary sources. The aircraft emissions were computed using the AEDT version 3d. The inventories were prepared for emissions of CO, $NO_x$, $SO_x$, $PM_{10}$/$PM_{2.5}$ and VOC. The aircraft annual operations and fleet are shown in **Table C11**. The runway use, flight tracks and stage lengths used to model the emissions were the same as the data used in the noise modeling effort. **Table C12** presents the aircraft operational emission inventories for the Base and Ultimate scenarios.

***TABLE C11 - BASE AND ULTIMATE SCENARIOS ANNUAL AIRCRAFT OPERATIONS***

| Representative Aircraft Type (s) | AEDT Equip ID | AEDT ANP | Base Operations | Ultimate Operations |
|---|---|---|---|---|
| Embraer 175 | 3815 | EMB175 | 5,840 | 9,490 |
| Boeing 737-800 | 203 | 737800 | 5,110 | 8,030 |
| Canadair RJ 700/900 | 2426 | CRJ9-ER | 4,380 | 2,920 |
| Airbus A320 | 2587 | A320-232 | - | 730 |
| Bombardier Challenger 300/350/600 | 1239 | CL600 | 1,894 | 2,185 |
| Cessna Citation CJ1/CJ2/CJ3 | 1288 | CNA500 | 1,415 | 1,632 |
| Cessna 525 Citation Jet | 6060 | CNA525C | 1,109 | 1,278 |
| Learjet 35/45/60, Hawker 800 | 2028 | LEAR35 | 1,094 | 1,262 |
| Cessna 560 Citation XLS | 6065 | CNA560XL | 1,033 | 1,192 |
| Cessna 750 Citation X, Falcon 2000 | 1307 | CNA750 | 975 | 1,124 |
| Gulfstream G400, Falcon 7X | 1920 | GIV | 970 | 1,119 |
| Citation II/Bravo | 1292 | CNA55B | 903 | 1,042 |
| Cessna Citation Sovereign/ Latitude | 3047 | CNA680 | 749 | 864 |
| Cessna Citation Mustang, Phenom 100 | 6062 | CNA510 | 680 | 784 |
| Raytheon Premier I, Beechjet400 | 6159 | MU3001 | 639 | 737 |
| Dassault Falcon 50/900 | 1320 | FAL900EX | 634 | 732 |
| Cessna 560 Citation V/Ultra | 1298 | CNA560U | 473 | 546 |
| Gulfstream GV / 500 | 1923 | GV | 422 | 487 |
| Bombardier Global Express | 1773 | BD-700-1A10 | 383 | 442 |
| Israel IAI-1125 Astra/1126 Galaxy | 1977 | IA1125 | 302 | 349 |
| Cessna Citation III | 1234 | CIT3 | 199 | 230 |
| Gulfstream G280 | 4198 | CL601 | 195 | 224 |
| Bombardier Global 5000 | 2573 | BD-700-1A11 | 123 | 142 |
| Eclipse 500 | 3159 | ECLIPSE500 | 112 | 130 |
| King Air 90, Super King Air 300/350 | 1503 | DHC6 | 5,259 | 5,873 |
| Pilatus PC12, Cessna 208, Socata TBM7 | 1489 | CNA208 | 5,192 | 5,798 |
| Cessna 441, Piper Cheyenne, TBM-850 | 2580 | CNA441 | 2,342 | 2,616 |
| Cessna 172/177/206 | 1261 | CNA172 | 12,926 | 13,627 |
| Beech 35/36, Cessna 210, DA-40 | 1276 | GASEPV | 12,325 | 12,994 |
| Cirrus SR20/22 | 1325 | COMSEP | 8,578 | 9,045 |
| Cessna 206 | 3172 | CNA206 | 785 | 827 |
| Baron 55/58, Cessna 340/414/421P | 1196 | BEC58P | 11,989 | 12,706 |

| | | | | |
|---|---|---|---|---|
| King Air 90, Super King Air 300/350 | 1546 | DHC6 | 989 | 994 |
| Rockwell OV-10 Bronco | 1457 | OV10A | 264 | 265 |
| Lockheed C-130 Hercules | 3170 | C130E | 66 | 66 |
| Airbus Helicopters H135 | 4097 | EC130 | 3,140 | 3,283 |
| Robinson R-44 | 3161 | R44 | 449 | 469 |
| Agusta A-109 | 28 | A109 | 449 | 469 |
| Bell 429 | 4125 | B429 | 449 | 469 |
| Eurocopter MH-65 Dolphin | 4120 | SA365N | 344 | 344 |
| UH-60 Black Hawk | 21 | S70 | 114 | 115 |
| Lockheed C-130 Hercules | 3170 | C130E | 229 | 229 |
| | | | 95,523 | 107,860 |

Source: Mead & Hunt; RS&H, 2021

***TABLE C12 - AIRCRAFT EMISSIONS (TONS PER YEAR)***

| Scenario | CO | $NO_x$ | $SO_x$ | $PM_{10}$ | $PM_{2.5}$ | VOC |
|---|---|---|---|---|---|---|
| BASE | 463.4 | 65.2 | 8.7 | 1.0 | 1.0 | 47.6 |
| ULTIMATE | 522.9 | 92.4 | 11.6 | 1.3 | 1.3 | 55.4 |

Source: RS&H, 2021