APPENDIX C

Noise Modeling Assumptions

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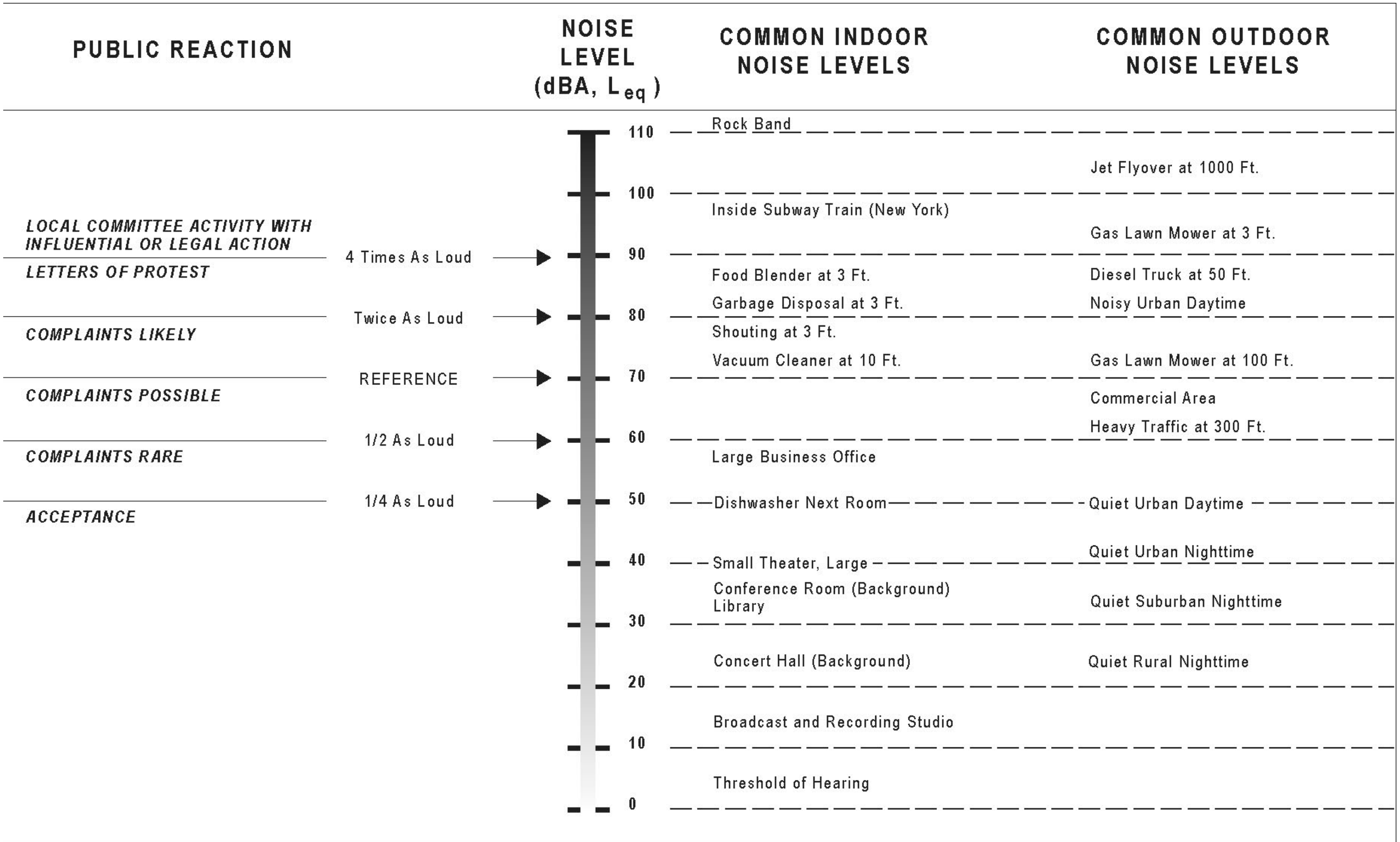
This Appendix describes the assumptions used in the noise modeling analysis conducted in support of the ALUCP update for Rio Vista Municipal Airport.

C.1 Environmental Noise Fundamentals

Noise is defined as unwanted sound. Sound, traveling in the form of waves from a source, exerts a sound pressure level (referred to as sound level) which is measured in decibels (dB), with zero dB corresponding roughly to the threshold of human hearing, and 120 to 140 dB corresponding to the threshold of pain. Pressure waves traveling through air exert a force registered by the human ear as sound.

Sound pressure fluctuations can be measured in units of hertz (Hz), which correspond to the frequency of a particular sound. Typically, sound does not consist of a single frequency, but rather a broad band of frequencies varying in levels of magnitude (sound power). When all the audible frequencies of a sound are measured, a sound spectrum is plotted consisting of a range of frequencies spanning 20 to 20,000 Hz. The sound pressure level, therefore, constitutes the additive force exerted by a sound corresponding to the sound frequency/sound power level spectrum.

The typical human ear is not equally sensitive to all frequencies of the audible sound spectrum. As a consequence, when assessing potential noise impacts, sound is measured using an electronic filter that de-emphasizes the frequencies below 1,000 Hz and above 5,000 Hz in a manner corresponding to the human ear's decreased sensitivity to extremely low and extremely high frequencies. This method of frequency weighting is referred to as A-weighting and is expressed in units of A-weighted decibels (dBA). A-weighting follows an international standard methodology of frequency weighting and is typically applied to community noise measurements. Some representative noise sources and their corresponding A-weighted noise levels are shown on **Figure C-1**.



SOURCE: OSHA, 2013. Adapted by ESA, 2016.

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Figure C-1
Effect of Noise on People

C.2 Noise Exposure and Community Noise

An individual's noise exposure is a measure of noise over a period of time. A noise level is a measure of noise at a given instant in time. The noise levels presented on Figure C-1 are representative of measured noise at a given instant in time, however, they rarely persist consistently over a long period of time. Rather, community noise varies continuously over a period of time with respect to the contributing sound sources of the community noise environment. Community noise is primarily the product of many distant noise sources, which constitute a relatively stable background noise exposure, with the individual contributors unidentifiable.

The background noise level changes throughout a typical day, but does so gradually, corresponding with the addition and subtraction of distant noise sources such as traffic and atmospheric conditions. What makes community noise constantly variable throughout a day, besides the slowly changing background noise, is the addition of short duration single event noise sources (e.g., aircraft flyovers, motor vehicles, sirens), which are readily identifiable to the individual.

These successive additions of sound to the community noise environment varies the community noise level from instant to instant requiring the measurement of noise exposure over a period of time to legitimately characterize a community noise environment and evaluate cumulative noise impacts. This time-varying characteristic of environmental noise is described using statistical noise descriptors. The most frequently used noise descriptors are summarized below.

C.3 Noise Descriptors

Noise levels are measured using a variety of scientific metrics. As a result of extensive research into the characteristics of transportation-related noise and human response to that noise, standard noise descriptors have been developed for use in noise exposure analyses.

The noise descriptor most commonly used to describe aircraft and surface transportation noise is referred to as a "cumulative" noise descriptor. Such descriptors present the amount of noise occurring at a given location over a defined period of time in numerical terms. Depending upon the descriptor used, this period can be as brief as one hour, but is usually calculated for an annualized 24-hour period. Cumulative noise descriptors can be used to present noise exposure from a specific source, such as a roadway or an airport, to describe total noise exposure from all noise sources affecting a specific location.

The noise descriptors used in this analysis are described as follows:

A-Weighted Sound Pressure Level (dBA): The decibel (dB) is a unit used to describe sound pressure level. When expressed in dBA, the sound has been filtered to reduce the effect of very low and very high frequency sounds, much as the human ear filters sound frequencies. Without this filtering, calculated and measured sound levels would include events that the human ear cannot hear (e.g., dog whistles and low frequency sounds, such as the groaning sounds emanating from large buildings with changes in temperature and wind). With A-weighting, calculations and sound monitoring equipment approximate the sensitivity of the human ear to sounds of different frequencies.

Some common sounds on the dBA scale are listed in **Table C-1**. The relative perceived loudness of a sound doubles for each increase of 10 dBA, although a 10-dBA change in the sound level corresponds to a factor of 10 change in relative sound energy. Generally, individual sounds with differences of 2 dBA or less are not perceived to be noticeably different by most listeners.

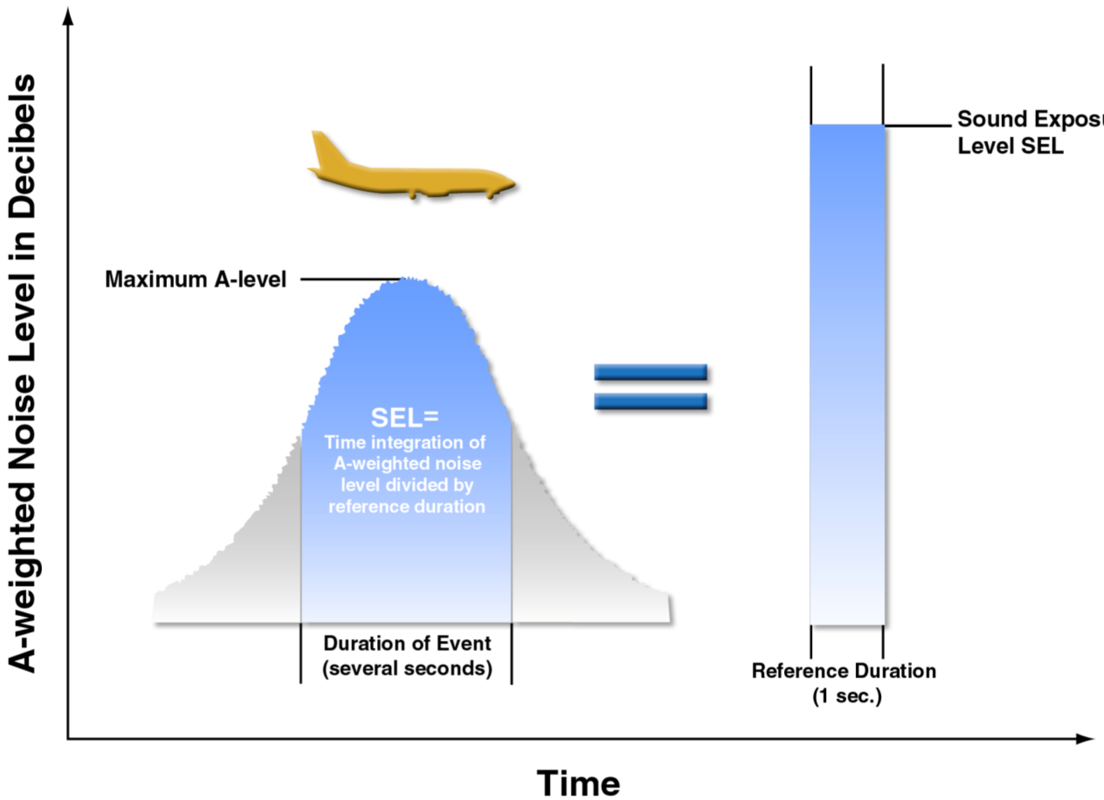
TABLE C-1
COMMON SOUNDS ON THE A-WEIGHTED DECIBEL SCALE

Sound	Sound level (dBA)	Relative loudness (approximate)	Relative sound energy
Rock music, with amplifier	120	64	1,000,000
Thunder, snowmobile (operator)	110	32	100,000
Boiler shop, power mower	100	16	10,000
Orchestral crescendo at 25 feet, noisy kitchen	90	8	1,000
Busy street	80	4	100
Interior of department store	70	2	10
Ordinary conversation, 3 feet away	60	1	1
Quiet automobiles at low speed	50	1/2	.1
Average office	40	1/4	.01
City residence	30	1/8	.001
Quiet country residence	20	1/16	.0001
Rustle of leaves	10	1/32	.00001
Threshold of hearing	0	1/64	.000001

SOURCE: U.S. Department of Housing and Urban Development, Aircraft Noise Impact—Planning Guidelines for Local Agencies, 1972.

Maximum Noise Level (Lmax): Lmax is the maximum or peak sound level during a noise event. The metric only accounts for the instantaneous peak intensity of the sound, and not for the duration of the event. As an aircraft passes by an observer, the sound level increases to a maximum level and then decreases. Some sound level meters measure and record the maximum level or Lmax.

Sound Exposure Level (SEL): SEL, expressed in dBA, is a time integrated measure, expressed in decibels, of the sound energy of a single noise event at a reference duration of one second. The sound level is integrated over the period that the level exceeds a threshold. Therefore, SEL accounts for both the maximum sound level and the duration of the sound. The standardization of discrete noise events into a one-second duration allows calculation of the cumulative noise exposure of a series of noise events that occur over a period of time. Because of this compression of sound energy, the SEL of an aircraft noise event is typically 7 to 12 dBA greater than the Lmax of the event. SELs for aircraft noise events depend on the location of the aircraft relative to the noise receptor, the type of operation (landing, takeoff, or overflight), and the type of aircraft. The SEL concept is depicted on **Figure C-2**.



SOURCE: Brown-Buntin Associates, Inc., November 2004.

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Figure C-2
Sound Exposure Level Concept

Community Noise Equivalent Level (CNEL): The cumulative noise descriptor required for aircraft noise analyses in the State of California is the CNEL. CNEL is used to describe cumulative noise exposure for an annual-average day of aircraft operations. The CNEL is calculated by mathematically combining the number of single events that occur during a 24-hour day with how loud the events were and what time of day they occurred.

CNEL includes penalties applied to noise events occurring after 7:00 p.m. and before 7:00 a.m., when noise is considered more intrusive. The penalized time period is further subdivided into evening (7:00 p.m. through 9:59 p.m.) and nighttime (10:00 p.m. to 6:59 a.m.). CNEL treats every evening operation as though it were three and every night as though it were ten. This “weighting” adds a 4.77 dB penalty during the evening hours and a 10 dB penalty during the nighttime hours.

Because of the interrelationship between the weighted number of daily noise events and the noise levels 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.

The CNEL metric used for this aircraft noise analysis is based on an average annual day of aircraft operations, generally derived from data for a calendar year. An annual-average day (AAD) activity profile is computed by adding all aircraft operations occurring during the course of a year and dividing the result by 365. As such, AAD does not reflect activities on any one specific day, but represents average conditions as they occur during the course of the year. The evening weighting is the only difference between CNEL and DNL. For purposes of aircraft noise analysis in the State of California, the FAA recognizes the use of CNEL, and the metric is used to assess potential significant impacts.

C.4 Aviation Environmental Design Tool

The Aviation Environmental Design Tool (AEDT) is the FAA’s standard model for evaluating aircraft noise at airports. The AEDT Version 2b SP3 (which was the latest version of this model when the project was started) was used to model aircraft noise exposure at the Airport for the 2015 existing condition and 2035 future condition. The noise analysis used AEDT standard settings.

The AEDT uses runway and flight track information, operation levels distributed by time of day, aircraft fleet mix, and aircraft profiles as inputs. The AEDT calculates noise exposure levels at a series of “noise grids”, and produces noise exposure contours based on the grid results, for a variety of noise metrics including CNEL, DNL, Lmax, Leq, and SEL. As described below, for this ALUCP the AEDT was used to calculate CNEL contours for existing conditions (2015) and 20-year future conditions (2035).

C.5 Existing and Future Conditions Noise Exposure

Noise exposure contours were developed for the Airport using the latest version of the FAA’s AEDT. The following sections summarize the data/inputs used to develop the existing (2015) and future (2035) conditions CNEL contours. The 2035 CNEL contours are presented in Chapter 4 of this ALUCP.

C.5.1 Aircraft Operations and Fleet Mix

For CNEL aircraft noise exposure calculations, aircraft operations associated with the annual-average day (AAD) are used in the AEDT. The number of annual operations by each AEDT aircraft type is divided by 365 to arrive at the AAD level. This representation of airport activity does not reflect any particular day, but gives an accurate picture of the character of operations throughout the year. Use of AAD is required by the FAA for aircraft noise modeling.

2015 and 2035 AAD operations by aircraft type, operation type (i.e., arrival, departure, touch-and-go), and time of day are summarized in **Table C-4** of this Appendix. Touch-and-go operations in the AEDT consist of an arrival and a departure. The number of touch-and-go operations at the Airport in 2015 and 2035 was assumed to be 90% of local operations divided by two.

C.5.2 Time of Day

As noted previously, the CNEL metric applies different weighting penalties to aircraft operations during the evening or nighttime hours. Therefore, the average daily numbers of operations by aircraft type during the evening and nighttime periods are required inputs to the AEDT. Due to the CNEL weighting scheme, evening and nighttime operations have a greater potential effect on the shape and size of the noise exposure area than their number might suggest. In the calculation of CNEL, one operation during the evening hours is equivalent to three daytime operations and one operation during the nighttime hours is equivalent to 10 daytime operations.

Based on information contained in the 1988 ALUCP for Rio Vista Municipal Airport, it was assumed that approximately 90% of the operations at the Airport in 2015 were performed during daytime hours, 9% of the operations were performed during evening hours, and 1% of the operations were performed during nighttime hours. Note that it was also assumed that (1) jet engine aircraft operations were only performed during daytime and evening hours and (2) approximately 20% of agricultural related operations occurred during nighttime hours.

C.5.3 Runway Use

Runway use for departures or arrivals is typically a function of prevailing wind and weather; lengths and widths of the runways; runway instrumentation; and effects of other airports or air traffic facilities in the area. Runway use may also be influenced by the direction of flight of an arriving or departing aircraft; the aircraft parking position; and/or periodic closures of runways and taxiways. Finally, noise abatement procedures may also influence runway use at an airport.

Runway use information for the existing (2015) and future (2035) conditions was derived from the 1988 ALUCP and is presented in **Table C-2**.

TABLE C-2
EXISTING (2015) AND FUTURE (2035) CONDITIONS RUNWAY USE BY OPERATION TYPE

	Operational Category		
Runway	**SEP/MEP**	**JET**	**AG Departure / Arrival**
07	7%	10%	1% / 17%
25	70%	90%	96% / 80%
15	3%	0%	0.5% / 0.5%
33	20%	0%	2.5% / 2.5%

NOTES:
SEP = Single Engine Propeller Aircraft
MEP = Multi Engine Propeller Aircraft
JET = Jet Engine Aircraft
AG = Agricultural Aircraft

SOURCE: Solano County Airport Land Use Commission. Airport/Land Use Compatibility Plan, Rio Vista Municipal Airport and New Rio Vista Airport. May 1988.

C.5.4 Flight Tracks and Flight Track Use

Once aircraft leave a runway on departure or while approaching a runway on arrival, their location and altitude over surrounding communities becomes a determining factor in how much noise is experienced on the ground. For this reason, flight track information is an important input to the AEDT.

Flight tracks are defined to represent the typical paths of the large majority of aircraft located throughout the study area. When using AEDT, these flight tracks are specified to capture the complexity of the actual flight patterns by representing the center of a specific flow of traffic.

Arrival, departure, and touch and go flight tracks used to model existing conditions (2015) and future conditions (2035) noise contours for the Airport are presented at the end of this appendix on **Figures C-3 through C-6.** Due to the extension of the Runway 7-25 in the future (2035), touch and go flight tracks are larger than ones used in the existing conditions (2015). Arrival and departure flight tracks would remain unchanged in the future. **Table C-3** presents flight track use data for existing conditions (2015) and future conditions (2035).

C.6 Future Conditions Noise Exposure

Noise exposure contours were developed for the Airport using the latest version of the FAA's AEDT. The following sections summarize the data/inputs used to develop the future conditions (2035) CNEL contours presented in Section 4 of this ALUCP.

It should be noted that FAA's Terminal Area Forecast (TAF) predicts that the number of aircraft operations at the airport in 2035 will be unchanged from the number of aircraft operations that occurred in 2015. For the purposes of developing aircraft noise contours for 2035, it was assumed that time of day, runway use, and flight track use in 2035 will also be unchanged from 2015. The primary difference between the existing conditions (2015) and future conditions (2035) scenarios involves the length of Runway 07-25. According to the Rio Vista Municipal Airport Layout Plan, May 2016, Runway 07-25 will be extended by approximately 1,700 feet to the east in the future.

TABLE C-3
FLIGHT TRACK USE BY RUNWAY AND OPERATION TYPE

Flight Track Name[1]	Runway	Operation Type	Track Use %
07D1	07	Departure	100%
		Subtotal	**100%**
25D1	25	Departure	95%[1]
25D2	25	Departure	95%[1]
25D3	25	Departure	5%[2]
		Subtotal	**100%**
15D1	15	Departure	100%
		Subtotal	**100%**
33D1	33	Departure	100%
		Subtotal	**100%**
07A1	07	Arrival	100%
		Subtotal	**100%**
25A1	25	Arrival	95%
25A2	25	Arrival	5%[2]
		Subtotal	**100%**
15A1	15	Arrival	100%
		Subtotal	**100%**
33A1	33	Arrival	100%
		Subtotal	**100%**
07T1	07	Touch and Go	100%
		Subtotal	**100%**
25T1	25	Touch and Go	100%
		Subtotal	**100%**
15T1	15	Touch and Go	100%
		Subtotal	**100%**
33T1	33	Touch and Go	100%
		Subtotal	**100%**
H1D1	Helipad	Departure	70%
H1D2	Helipad	Departure	7%
H1D3	Helipad	Departure	20%
H1D4	Helipad	Departure	3%
		Subtotal	**100%**
H1A1	Helipad	Arrival	70%
H1A2	Helipad	Arrival	7%
H1A3	Helipad	Arrival	20%
H1A4	Helipad	Arrival	3%
		Subtotal	**100%**

[1] 25D1 is used by aircraft, which will be greater than 700 feet above ground elevation before making a right turn over the residential area. 25D2 is used by aircraft, which will be less than 700 feet above ground elevation over the residential area.
[2] 25A2 and 25D3 comprise the arrival and departure portions of the published missed approach flight procedure.

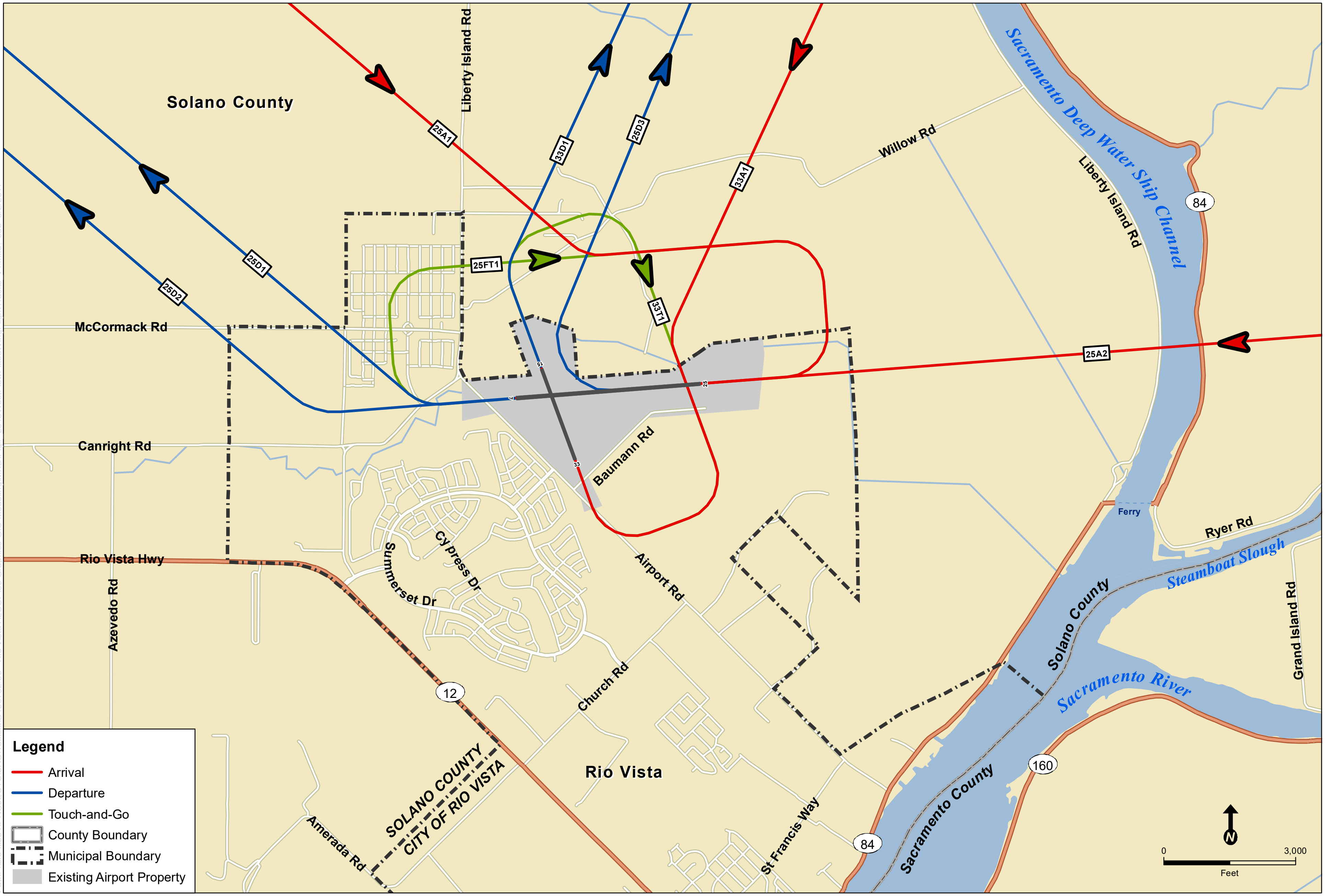
SOURCE: ESA 2016

TABLE C-4
ANNUAL AVERAGE DAY OPERATIONS – EXISTING (2015) AND FUTURE (2035) CONDITIONS

		Arrivals			Departures			Touch-and-Go Operations		
Aircraft Type	**INM Type**	**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**
Helicopter	B206L	1.18	0.12	0.02	1.18	0.12	0.02	0.00	0.00	0.00
Single-engine propeller	GASEPV	7.99	0.80	0.13	7.99	0.80	0.13	20.49	1.08	0.00
Single-engine propeller	GASEPF	4.44	0.45	0.07	4.44	0.45	0.07	0.00	0.00	0.00
Single-engine propeller	CNA172	1.77	0.18	0.03	1.77	0.18	0.03	0.00	0.00	0.00
Single-engine propeller	CNA206	1.77	0.18	0.03	1.77	0.18	0.03	0.00	0.00	0.00
Single-engine propeller	PA28	1.77	0.18	0.03	1.77	0.18	0.03	0.00	0.00	0.00
Multi-engine propeller	BEC58P	2.49	0.25	0.04	2.49	0.25	0.04	0.00	0.00	0.00
Multi-engine propeller	PA30	1.07	0.11	0.02	1.07	0.11	0.02	0.00	0.00	0.00
Jet	LEAR35	0.07	0.01	0.00	0.07	0.01	0.00	0.00	0.00	0.00
Jet	CNA500	0.05	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
	Total	**22.60**	**2.28**	**0.37**	**22.60**	**2.28**	**0.37**	**20.49**	**1.08**	**0.00**

NOTE: In the AEDT, a touch-and-go operation consists of an arrival and a departure. Touch and go operations were divided by two to calculate the number of touch-and-go operations at Rio Vista Airport.

SOURCES: ESA, 2016, based on aircraft operation information included in the 1988 ALUCP. FAA TAF, 2016.



SOURCE: ESA, 2016; ESRI Mapping Services

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Figure C-3

2015 West Flow Fixed-Wing Flight Tracks

Rio Vista Municipal Airport

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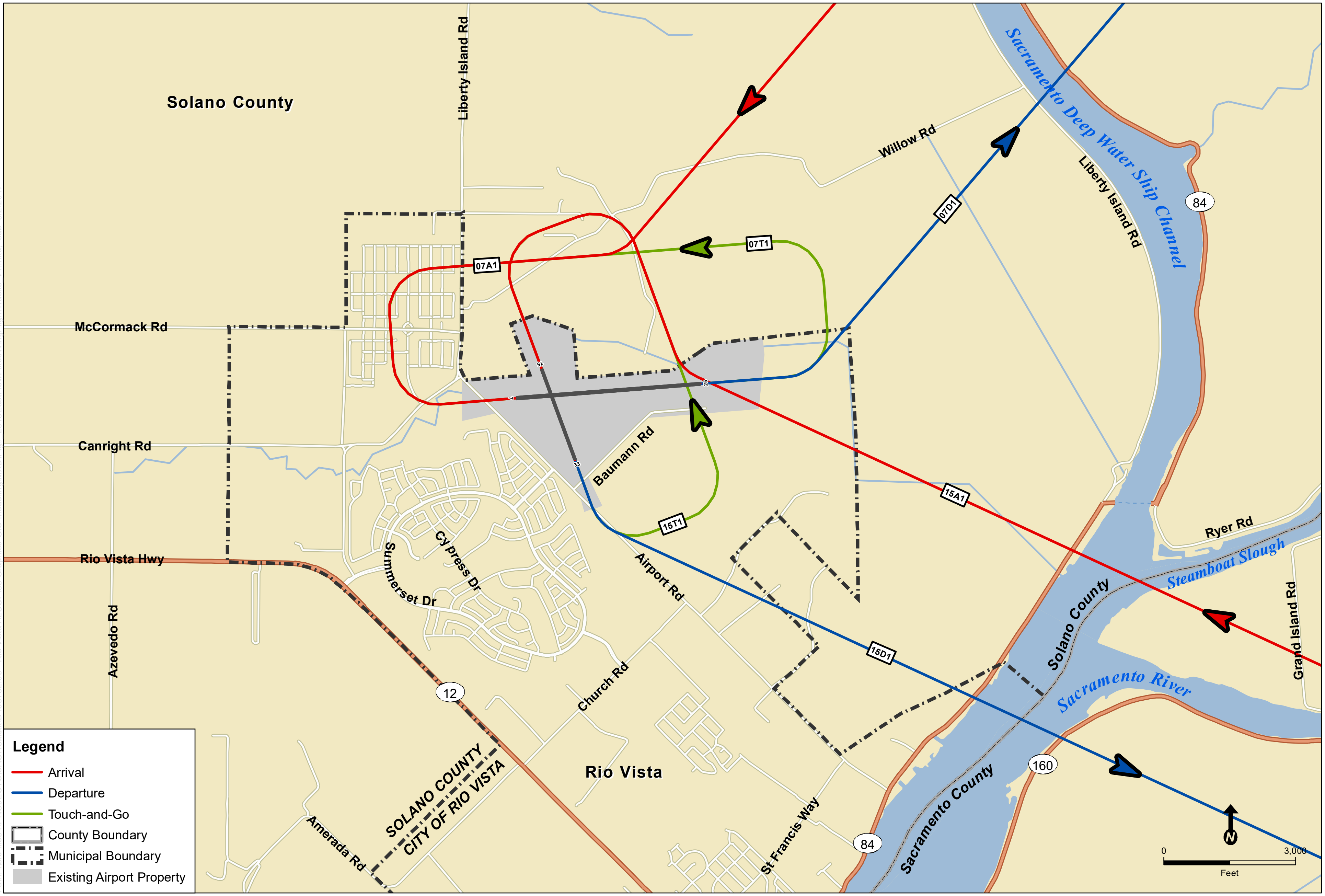

SOURCE: ESA, 2016; ESRI Mapping Services

Rio Vista Municipal Airport ALUCP.150732

Figure C-4
2015 East Flow Fixed-Wing Flight Tracks
Rio Vista Municipal Airport

ESA

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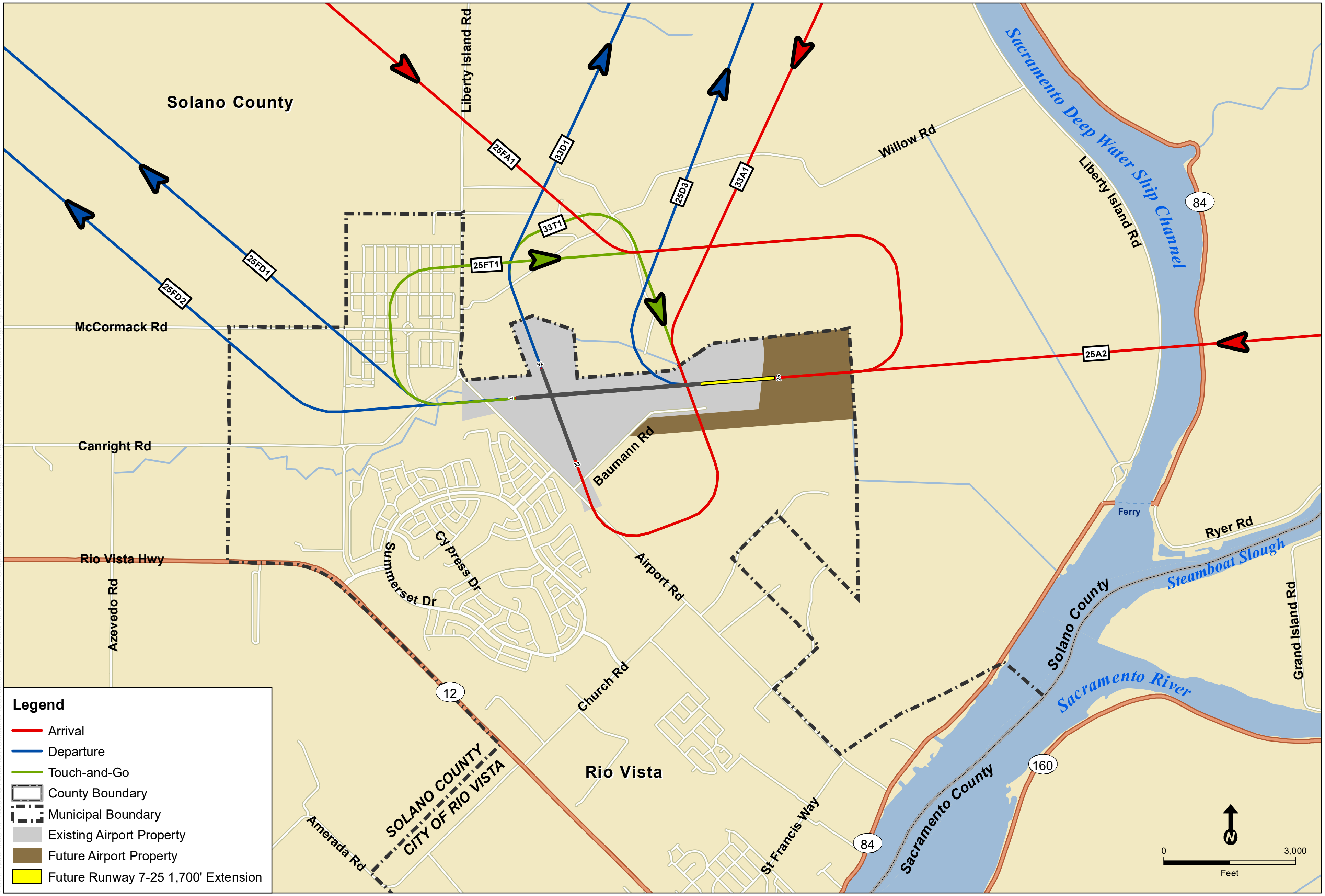

SOURCE: ESA, 2016; ESRI Mapping Services

Rio Vista Municipal Airport ALUCP.150732

Figure C-5

2035 West Flow Fixed-Wing Flight Tracks

Rio Vista Municipal Airport

ESA

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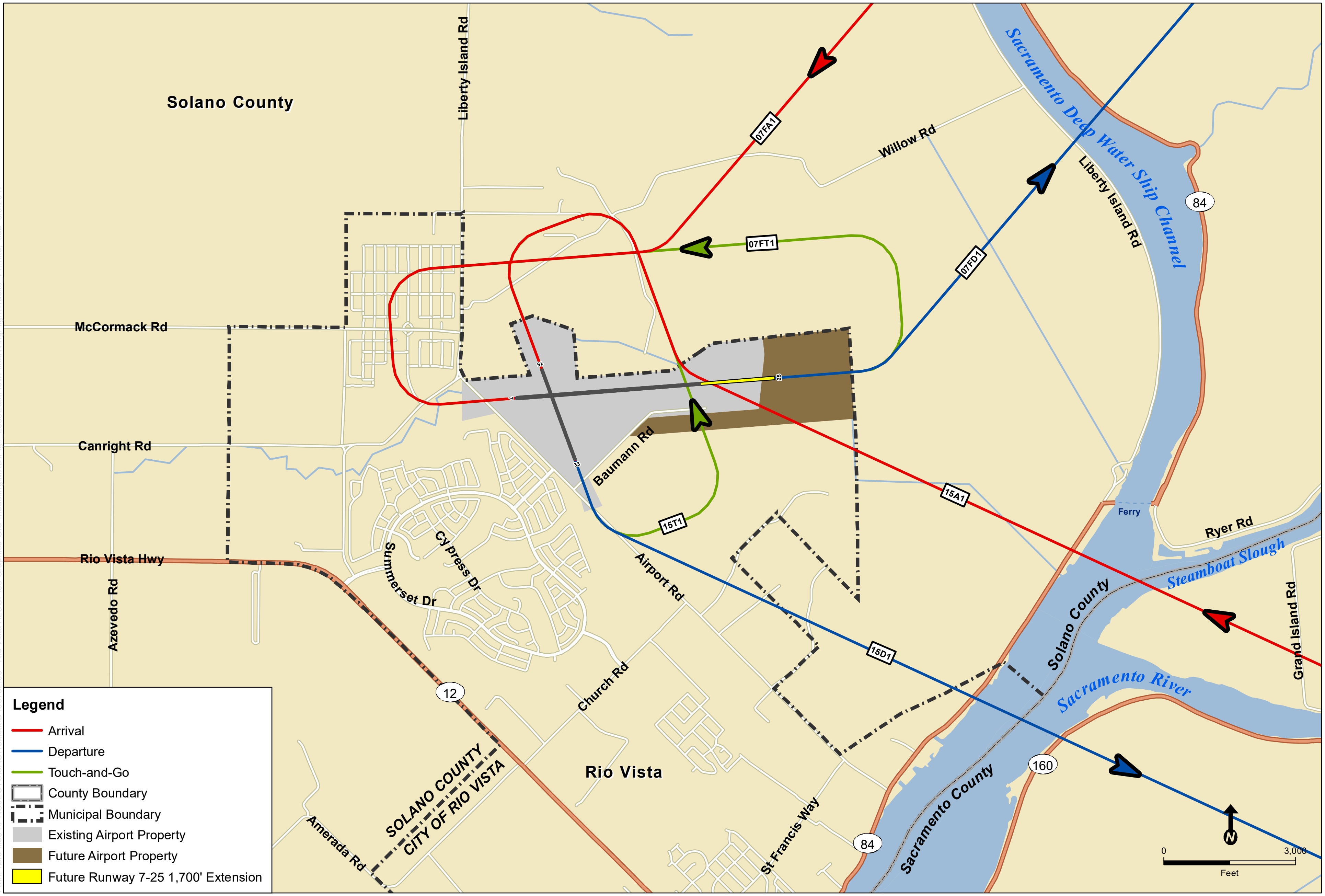

SOURCE: ESA, 2016; ESRI Mapping Services

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Figure C-6

2035 East Flow Fixed-Wing Flight Tracks

Rio Vista Municipal Airport

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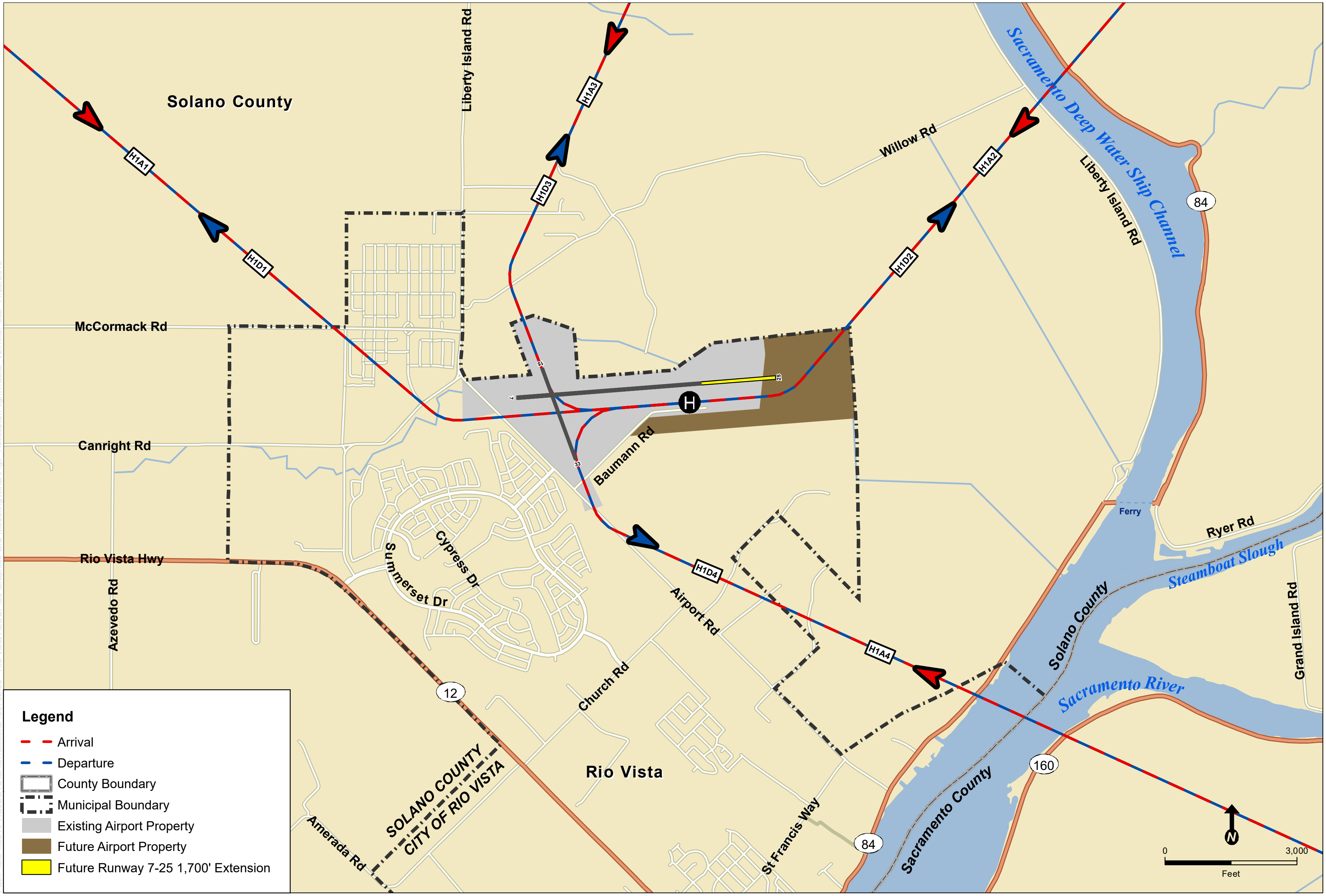

SOURCE: ESA, 2016; ESRI Mapping Services

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Figure C-7
Helicopter Flight Tracks
Rio Vista Municipal Airport

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