3 AFFECTED ENVIRONMENT, ENVIRONMENTAL CONSEQUENCES, AND MITIGATION MEASURES

3.5 Electromagnetic Fields and Electromagnetic Interference

3.5.1 Introduction

PURPOSE

Electromagnetic Fields and Electromagnetic Interference

Electromagnetic interference is the disruption of operation of an electronic device when it is in the vicinity of an electromagnetic field in the radio frequency spectrum of another device. This analysis is performed to protect sensitive equipment and inform the public of any potential impacts.

Section 3.5, Electromagnetic Fields and Electromagnetic Interference, of the Los Angeles to Anaheim Project Section (project section) Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) describes the regulatory setting, affected environment, effects of, and mitigation measures for electromagnetic interference (EMI) and electromagnetic fields (EMF) associated with the No Project Alternative and the High-Speed Rail (HSR) Project Alternatives, otherwise called Shared Passenger Track Alternative A and Shared Passenger Track Alternative B, within the resource study area (RSA). The analysis examines the potential impacts on EMI- and EMF-sensitive receptors from local sources of EMI and EMFs and the impact of HSR-generated EMI/EMFs. The analysis also describes impact avoidance and minimization features (IAMF) incorporated into the project that avoid, minimize, or reduce these impacts and, where applicable, mitigation measures proposed to further reduce, compensate for, or offset impacts of the Shared Passenger Track Alternatives.

Additional details on EMF and EMI are provided in the following appendices in Volume 2 of this Draft EIR/EIS.

- Appendix 2-A, Impact Avoidance and Minimization Features
- Appendix 2-B, Applicable Design Standards
- Appendix 3.1-A, Regional and Local Policy Inventory and Consistency Analysis
- Appendix 3.5-A, Preconstruction Electromagnetic Measurement Survey

This section includes detailed analysis of environmental resources, affected environment, environmental consequences, and mitigation measures based on the guidance provided in *Project Environmental Impact Report/Environmental Impact Statement Environmental Methodology Guidelines*, Versions 5.9 and 5.11 as amended (Authority 2017, 2022). Seven other resource sections in this Draft EIR/EIS provide additional information about issues related to EMF/EMI:

- **Section 3.2, Transportation:** Construction and operational impacts from the Shared Passenger Track Alternatives related to other freight and passenger railroad transportation existing where the Shared Passenger Track Alternatives would be located.
- **Section 3.6, Public Utilities and Energy:** Construction and operational impacts from the Shared Passenger Track Alternatives related to utilities and electric transmission facilities.
- **Section 3.11, Safety and Security:** Construction and operational impacts from the Shared Passenger Track Alternatives related to safety and security in communities adjacent to the project corridor.
- **Section 3.12, Socioeconomics and Communities:** Construction and operational impacts from the Shared Passenger Track Alternatives on economics, including jobs.
- **Section 3.13, Station Planning, Land Use, and Development:** Construction and operational impacts from the Shared Passenger Track Alternatives on zoning and future development's effects related to locations and types of sensitive receptors and land uses along the project corridor, including proximity to sensitive equipment.

- **Section 3.18, Regional Growth:** Construction and operational impacts from the Shared Passenger Track Alternatives on future development's effects related to regional growth along the project corridor.
- **Section 3.19, Cumulative Impacts:** Construction and operational impacts from the Shared Passenger Track Alternatives related to EMF/EMI in combination with other past, present, and reasonably foreseeable projects.

Definitions: Electromagnetic Spectrum and Electromagnetic Waves

The electromagnetic spectrum is the range of waves of electromagnetic energy. It includes static fields such as the Earth's magnetic field, radio waves, microwaves, X-rays, and light.

The frequency and wavelength of an electromagnetic wave are directly related to each other—the higher the frequency, the shorter the wavelength.

3.5.1.1 Definition of Resources

The following are definitions for EMF and EMI analyzed in this Draft EIR/EIS.

- **EMF:** EMFs are electric and magnetic fields. EMF occurs throughout the electromagnetic spectrum, is found in nature, and is generated both naturally and by human activity. Naturally occurring EMF includes the Earth's magnetic field, static electricity, and lightning. EMFs are also created by the generation, transmission, and distribution of electricity; the use of everyday household electric appliances and communication systems; industrial processes; and scientific research.
- **EMI:** EMI is the interference that occurs when the EMF produced by a source adversely affects the operation of an electrical, magnetic, or electromagnetic device. EMI may be caused by a source that intentionally radiates EMF (such as a television broadcast station), or one that does so incidentally (such as an electric motor).

EMFs are described in terms of their frequency, which is the number of times the electromagnetic field increases and decreases its intensity each second. In the U.S., the commercial electric power system operates at a frequency of 60 hertz (Hz), or cycles per second, meaning that the field increases and decreases its intensity 60 times per second. Electric power system components are typical sources of electric and magnetic fields. These components include generating stations and power plants, substations, high-voltage transmission lines, and electric distribution lines. Even in areas not adjacent to transmission lines, 60-Hz EMFs are present from electric power systems and common building wiring, electrical equipment, and appliances.

Natural and human-generated EMFs cover a broad frequency spectrum. EMFs that are nearly constant in time are called DC (direct current) EMFs. EMFs that vary in time are called AC (alternating current) EMFs. AC EMFs are further characterized by their frequency range. Extremely low-frequency magnetic fields typically are defined as having a lower limit of 3 to 30 Hz and an upper limit of 30 to 3,000 Hz. The HSR overhead contact system (OCS) and power distribution system primarily would generate extremely low-frequency fields at 60 Hz and at harmonics (multiples) of 60 Hz.

Radio and other communications operate at much higher frequencies, often in the range of 500,000 Hz (500 kilohertz [kHz]) to 3 billion Hz (3 gigahertz [GHz]). Typical radio frequency (RF) sources of EMF include antennas associated with cellular telephone towers; broadcast towers for radio and television; airport radar, navigation, and communication systems; high-frequency and very high-frequency communication systems used by police, fire, emergency medical technicians, utilities, and governments; and local wireless systems, such as wireless fidelity (WiFi) or cordless telephone.

The strength of magnetic fields often is measured in milligauss (mG), gauss (G), tesla, or microtesla (μT). For comparison, Earth's ambient magnetic field ranges from 500 to 700 mG DC (0.5 to 0.7 G) (50 to 70 μT) at its surface. Average AC magnetic field levels within homes are approximately 1 mG (0.001 G) (0.1 μT), and measured AC values range from 9 to 20 mG (0.009 to 0.020 G) (0.9 to 2 μT) near appliances (Severson et al. 1988). The strength of an EMF rapidly decreases with distance away from its source; therefore, EMFs higher than background levels are usually found close to EMF sources.

The information presented in this section primarily concerns EMF at the 60-Hz power frequency and at radio frequencies produced intentionally by communications or unintentionally by electric discharges. EMF from HSR operations would consist of the following:

- **Power-frequency electric and magnetic fields from the traction power system, traction power substations (TPSS), emergency generators that provide backup power to the stations in case of a power outage, and utility feeder lines:** 60-Hz electric fields would be produced by the 25-kilovolt (kV) operating voltage of the HSR traction system TPSS, and 60-Hz magnetic fields would be produced by the flow of currents providing power to the HSR vehicles. Along the tracks, magnetic fields would be produced by the flow of propulsion currents to the trains in the OCS and rails.
- **Harmonic magnetic fields from vehicles:** Depending on the design of power equipment in the HSR trains, power electronics would produce currents with frequencies in the kHz range. Potential sources include power conversion units, switching power supplies, motor drives, and auxiliary power systems. Unlike the traction power system, these sources are highly localized in the trains and move along the track as the trains move.
- **RF fields:** The HSR system would use a variety of communications, data transmission, and monitoring systems—both on and off vehicles—that operate at radio frequencies. These wireless systems would meet the Federal Communications Commission (FCC) regulatory requirements for intentional emitters (47 Code of Federal Regulations [CFR] Part 15 and FCC Office of Engineering Technology Bulletin No. 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields)*.

Unit Definitions and Conversions

- Hertz (Hz): Unit of frequency equal to one cycle per second
- 1 kilohertz (kHz) = 1,000 Hz
- 1 gigahertz (GHz) = 1 billion Hz
- Gauss (G): Unit of magnetic flux density (intensity) (English units)
- 1 G = 1,000 milligauss (mG)
- Tesla (T): Unit of magnetic flux density (intensity) (International units)
- 1 T = 1 million microtesla (µT)
- 1 G = 100 µT
- 1 mG = 0.1 µT

Of these EMFs, the dominant effect is expected to be the 60-Hz AC magnetic fields from the propulsion currents flowing in the traction power system—that is, the OCS and rails.

3.5.1.2 Characteristics of Electromagnetic Radiation

The electromagnetic (EM) spectrum spans an enormous range of wavelengths or frequencies. The most energetic radiation consists of short-wavelength or high-frequency radiation, including ultraviolet, x-ray, and gamma ray radiation. At longer wavelengths, EM radiation includes radio waves, microwaves, and infrared radiation. Visible light is the portion of the EM spectrum that lies between the infrared and ultraviolet portions of the EM spectrum. Less energetic, longer-wavelength radiation, including visible light, infrared, microwaves, and radio waves, is sometimes referred to as *nonionizing radiation*. This section addresses the potential impacts of nonionizing, long-wave EM radiation—at wavelengths below those of visible light—on human health and on sensitive electric and electronic equipment and facilities along the project section.

Nonionizing EM radiation consists of waves characterized by variations in electric fields (measured in volts per meter, or V/m) and magnetic fields (measured in tesla or G). These periodic waves move through a medium, such as air, transferring energy from place to place as they go. The waves move at the speed of light, and have dimensions of intensity or amplitude; wavelength, or the distance between two adjacent peaks of the wave; and number of cycles per second (Hz), or frequency. Table 3.5-1 presents wavelengths for a range of different frequencies. Table 3.5-2 presents the magnetic field strengths of electrical devices and facilities commonly found in urban areas.

Table 3.5-1 Relationship between Typical Frequencies and Their Wavelengths

Frequency	Wavelength	Common Commercial Uses
60 Hz	3,105 miles	Electric power grid
10 kHz	18.6 miles	Radio navigation
10 MHz	98.4 feet	Shortwave radio
100 MHz	9.8 feet	FM radio
2,000 MHz	6 inches	Cellular Communications

Source: Authority 2017
Hz = hertz; kHz = kilohertz; MHz = megahertz

Table 3.5-2 Typical Magnetic Field Strengths

Electrical Source	Magnetic Field Strength (mG)
Dishwasher	30[1]
Hair dryer	70[1]
Electric shaver	10[1]
Vacuum cleaner	200[1]
High-voltage power/transmission line (115 kV–500 kV)	30–87[2]
Medium-voltage power distribution line (4 kV–24 kV)	10–70[2]

Source: NIEHS 2002
[1] Measured 1 foot from appliance
[2] At ground level, directly beneath the lines
kV = kilovolt; mG = milligauss

Naturally occurring EMFs consist of both electric fields and magnetic fields that are generated by the sun, lightning, biological processes, and currents within the Earth's molten metallic core. Artificial EMFs are intentionally generated by electrical devices, such as television and radio broadcasting towers, hand-held radios, X-ray machines, microwave links, and cellular phones. EMFs of human origin are also unintentionally generated by devices such as electric power transmission and distribution lines, televisions, computers, appliances, ignition systems, and electrical wiring and switches.

Although both DC and AC electrical devices generate EMFs, the magnetic flux density is much higher for DC than for AC current. The strength of an electric field is proportional to the strength of its electric charge (voltage), and the strength of a magnetic field is proportional to the motion of the charge (current); when no current is flowing in an electrical circuit, only the electrical field is present. The power of an EMF (i.e., the rate at which energy is transferred) is measured in watts, and the power density (power distributed over a given cross-sectional area perpendicular to the direction of its flow) of the field is measured in watts per square meter.

Electrical devices generate both near-field and far-field EMFs. Nonradiative near-field behaviors of EMFs dominate close to the device (e.g., within 1 to 2 wavelengths of their sources), and far-field behaviors dominate at greater distances. Near-field EM strength decreases in proportion to increasing distance from the source, and far-field EM strength decreases in proportion to the square of increasing distance from the source (the so-called inverse-square law).

EMF Frequencies

EMFs are described in terms of their frequency, which is the number of times the EMF increases and decreases in intensity each second. The U.S. commercial electric power system operates at a frequency of 60 Hz, or 60 cycles per second, meaning that the field increases and decreases in intensity 60 times per second. Electric power system components are typical sources of electric and magnetic fields. These components include generating stations and power plants, substations, high-voltage transmission lines, and electric distribution lines. Even in areas not adjacent to transmission lines, 60-Hz EMFs are generated by electric power systems and building wiring, electrical equipment, and appliances.

Natural and human-generated EMFs cover a broad frequency spectrum. EMFs that are nearly constant in time are called DC EMFs. EMFs that vary in time are called AC EMFs. AC EMFs are further characterized by their frequency range. Extremely low-frequency magnetic fields typically are defined as having a lower limit of 3 to 30 Hz and an upper limit of 30 to 3,000 Hz. The HSR OCS and electrical transmission, power, and distribution system primarily would generate extremely low-frequency fields at 60 Hz and at harmonics (multiples) of 60 Hz.

Radio and other communications operate at much higher frequencies, often in the range of 500,000 Hz (500 kHz) to 3 GHz. Typical RF sources of EMFs include antennas on cellular telephone towers; radio and television broadcast towers; airport radar, navigation, and communication systems; high-frequency and very high-frequency communication systems used by police, fire, emergency medical technicians, utilities, and governments; and local wireless systems, such as wireless fidelity or cordless telephone. The project would employ active RF EMF sources.

The strength of magnetic fields is measured either in mG, G, tesla, or μT. For comparison, Earth's ambient magnetic field ranges from 300 to 600 mG DC (0.3 to 0.6 G) (30 to 60 μT) at its surface. Average AC magnetic field levels within homes are approximately 1 mG (0.001 G) (0.1 μT), and measured AC values range from 9 to 20 mG (0.009 to 0.020 G) (0.9 to 2 μT) near appliances (Severson et al. 1988). The strength of an EMF rapidly decreases with distance away from its source; thus, EMFs higher than background levels are usually found close to EMF sources. For overhead transmission and power lines, the strength of an EMF is typically the highest directly under the overhead line and decreases rapidly with increasing distance from the line. Table 3.5-3 presents the typical EMF levels from overhead electrical lines at varying distances. EMF levels at a distance of 200 feet from a 230-kV transmission line and a 115-kV power line are reduced by approximately 97 and 99 percent, respectively.

Table 3.5-3 Typical EMF Levels for Transmission/Power Lines

Voltage of Source	Field Strength at Specified Distances from Source				
	Directly Under Lines	50 feet (edge of project ROW)	100 feet	200 feet	300 feet
230-kV transmission line electric field strength (kV/m)	2.0	1.5	0.3	0.05	0.01
230-kV transmission line mean magnetic field (mG)	57.5	19.5	7.1	1.8	0.8
115-kV power line electric field strength (kV/m)	1.0	0.5	0.07	0.01	0.003
115-kV power line mean magnetic field (mG)	29.7	6.5	1.7	0.4	0.2

Source: NIEHS 2002
EMF = electromagnetic field; kV = kilovolt; kV/m = kilovolt per meter; mG = milligauss; ROW = right-of-way

EMF Exposure and Health Effects

EMFs can cause EMI and disrupt sensitive equipment (e.g., implanted medical devices), possibly triggering a malfunction; at sufficiently high exposure levels, EMFs also directly affect human health. Extensive research on EMFs has led most scientists and health officials to conclude, however, that low-frequency EMFs have no adverse health effects at typical exposure levels. Objective scientific reviews of animal studies, from which some human health risks have been extrapolated, have also concluded that existing data are inadequate to indicate a potential risk of cancer, which is the primary human health concern associated with EMF exposure (WHO 2007; IARC 2002). However, EMFs remain a human health concern and are the subject on continuing research (WHO 2007).

3.5.1.3 EMI

General Considerations

EMI is an electromagnetic disturbance from an external source that interrupts or degrades the performance of an electrical device, circuit, or signal. Ambient EMI occurs when EM radiation intentionally or unintentionally jams, or blocks, another EM signal in free space. Hardware EMI occurs when EM radiation induces an unintended current in an electrical circuit. To interfere with a radio or microwave signal, the EMI must be at or near the signal frequency. Radio and other communications systems typically operate in the range of 500 kHz to 3 GHz.

Commercial standards developed for EM compatibility (EMC) both limit EMI generated by electrical devices and reduce susceptibility of electrical devices to external EMI. For example, the Federal Aviation Administration’s interim EMC commercial standards require aircraft systems to withstand EMFs of up to 200 V/m (FAA 2014).

EMI and Radio Communications

Intentional radio signals exist in a sea of unwanted RF noise, so radio communications systems and devices are designed to operate in this environment. General frequency ranges are assigned for various types of radio signals, and specific RFs and power output levels are assigned to individual users to minimize the potential for disruptions. Radio equipment is designed to separate the frequency of interest from background noise and to reject transient or unfocused signals.

EMI and Sensitive Equipment

Research equipment is generally designed to operate within the Earth’s natural magnetic field, and to compensate for fluctuations in that field of up to 10 mG (Field Management Services 2009). Industries associated with the use, assembly, calibration, or testing of sensitive or unshielded RF equipment, however, are still sensitive to EMI. In particular, fluctuations in the magnetic field can interfere with nuclear magnetic resonance (NMR), nuclear magnetic imaging, and other imaging equipment, such as electron microscopes. Computed tomography and computed axial tomography scanning devices are also sensitive to EMI, because are some semiconductor, nano-technology, and bio-technology operations. NMR spectrometers are sensitive to time-varying DC magnetic fields of under 2 mG (Field Management Services 2009). For unshielded equipment that is sensitive to magnetic fields in the range of 1 to 3 mG, such as magnetic resonance imaging (MRI) systems, EMI is possible at distances of up to 200 feet. An installation guide for NMR equipment recommends a separation distance of 328 feet (100 meters) from electric trains (Field Management Services 2009).

3.5.2 Laws, Regulations, and Orders

This section describes the federal and state laws, regulations, and orders that are relevant to EMF and EMI. General National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) requirements for assessment and disclosure of environmental impacts are described in Section 3.1, Introduction, and are therefore not restated in this resource section. NEPA and CEQA requirements specific to the evaluation of EMF/EMI are, however, described in this section.

Additionally, several organizations have developed guidelines for EMF exposure, including individual states, FCC, Occupational Safety and Health Administration (OSHA), Institute of Electrical and Electronics Engineers (IEEE), American National Standards Institute (ANSI), and

American Conference of Governmental Industrial Hygienists (ACGIH). Neither the California government nor the U.S. government has regulations limiting EMF exposure to residences.

EMF exposure guidelines and standards have also been adopted by the International Commission on Non-Ionizing Radiation Protection in the extremely low-frequency and RF bands applicable to HSR emissions. The International Commission on Non-Ionizing Radiation Protection and IEEE standards both address EMF exposure by the general public for the United States and abroad (and have been formally adopted by the European Union); the IEEE standards have been identified in the *Final Program EIR/EIS for the Proposed California High-Speed Train System* (Authority and FRA 2005) to assess the potential for health and compatibility effects from anticipated HSR emissions. For occupational exposure, the International Commission on Non-Ionizing Radiation Protection–recommended exposure limits are 417 μT for magnetic fields and 8.333 kilovolts per meter (kV/m) for 60-Hz electric fields (ICNIRP 1998).

The IEEE Standard C95.6, *IEEE Standard for Safety Levels With Respect to Human Exposure to Electromagnetic Fields, 0–3 kHz*, which is often referenced in the United States and has been formally adopted by ANSI, specifies maximum permissible exposure (MPE) levels for the general public and for occupational exposure to extremely low-frequency EMFs, which have frequencies of 0 to 3 kHz. The HSR electrification and traction power systems would generate extremely low-frequency EMFs with frequencies of 60 Hz, which are in the range covered by this standard. The IEEE Standard C95.6 exposure levels are presented in Table 3.5-4 and Table 3.5-5. Note that the IEEE exposure levels are recommendations only, not regulations.

Table 3.5-4 Institute of Electrical and Electronics C95.6 Magnetic Field Maximum Permissible Exposure Levels for the General Public

Body Part	Frequency Range (Hz)	B-Field (mG)
Head and torso	20–759	9.04×10^3
	759–3,000	$6.87 \times 10^6/f$
	60	9.04×10^3
Arms and legs	<10.7	3.53×10^6
	10.7–3,000	$3.79 \times 10^7/f$
	60	632,000

Source: Authority 2022
< = less than; /f = divide by the frequency; Hz = hertz; mG = milligauss

Table 3.5-5 Institute of Electrical and Electronics Engineers C95.6 Electric Field Maximum Permissible Exposure Levels for the General Public

Body Part	Frequency Range (Hz)	E-Field (V/m)
Whole Body	1–368	5,000
	386–3,000	$1.84 \times 10^6/f$
	60	5,000

Source: IEEE 2002
/f = divide by the frequency; Hz = hertz; V/m = volts per meter

In 2006, ANSI adopted IEEE Standard C95.1 as its standard for safe human exposure to nonionizing electromagnetic radiation (IEEE 2006). The HSR train control and communications systems would use radio signals within the range covered by this standard. The C95.1 Standard specifies MPE levels for whole- and partial-body exposure to electromagnetic energy. MPE exposure levels are lower at 100 to 300 megahertz (MHz) because the human body absorbs the greatest percentage of incident energy at these frequencies. The MPE standards become progressively higher at frequencies above 400 MHz because the human body absorbs less energy at these higher frequencies. The IEEE C95.1 Standard MPEs are based on RF levels averaged over a 30-minute exposure time for the general public. For occupational exposure, the averaging time varies with frequency from 6 minutes at 450 MHz to 3.46 minutes at 5,000 MHz.

Both the IEEE C95.6 and C95.1 standards specify safety levels for occupational and general-public exposure. For each, the exposure levels are frequency dependent. The general-public exposure safety levels are stricter because workers are assumed to have knowledge of occupational risks and are better equipped to protect themselves (e.g., through use of personal safety equipment). The general-public safety levels are intended to protect all members of the public (including pregnant women, the unborn, infants, and the infirm) from short- and long-term exposure to EMFs. The safety levels are also set at 10 to 50 times below the levels at which scientific research has indicated harmful effects may occur, thus incorporating a large safety factor (EEE 2006).

OSHA safety standards for occupational exposure to RF emissions are found at 29 CFR Part 1910.97. The OSHA safety levels do not vary with frequency and are less stringent than the equivalent ANSI/IEEE and FCC MPEs, except for occupational exposure to fields with frequencies above 5,000 MHz, where the OSHA MPE is equal to the C95.1 MPE and is twice that of the FCC MPE. The OSHA MPEs are based on a 6-minute averaging time.

ACGIH (2015) provides that occupational exposures should not exceed 10 G (10,000 mG or 1 μT). ACGIH additionally recommends that workers with pacemakers should not exceed 1 G (1,000 mG or 0.1 μT). The ACGIH 10-G guideline level is intended to prevent effects such as induced currents in cells or nerve stimulation. However, the ACGIH guidelines are for occupational exposure, not general public exposure.

3.5.2.1 Federal

U.S. Department of Transportation, Federal Railroad Administration, Procedures for Considering Environmental Impacts (64 *Federal Register* 28545)

On May 26, 1999, the Federal Railroad Administration (FRA) released Procedures for Considering Environmental Impacts (FRA 1999). These FRA procedures describe the FRA's process for assessing the environmental impacts of actions and legislation proposed by the agency and for the preparation of associated documents (42 U.S. Code 4321 et seq.). The FRA Procedures for Considering Environmental Impacts states that "the EIS should identify any significant changes likely to occur in the natural environment and in the developed environment. The EIS should also discuss the consideration given to design quality, art, and architecture in project planning and development as required by U.S. Department of Transportation Order 5610.4." These FRA procedures state that an EIS should consider possible impacts from EMF/EMI.

U.S. Department of Transportation, Federal Railroad Administration, 49 CFR Part 236.8, 238.225, 229 Appendix F, and 236 Appendix C

These regulations provide rules, standards, and instructions regarding operating characteristics of EM, electronic, or electrical apparatus and safety standards for passenger equipment (FRA 2011, 2012a, 2012b).

U.S. Department of Commerce, Federal Communications Commission, 47 CFR Part 15

Part 15 provides rules and regulations regarding licensed and unlicensed RF transmissions. Most telecommunications devices sold in the United States, whether they radiate intentionally or unintentionally, must comply with Part 15. However, Part 15 does not govern any device used exclusively in a vehicle, including in HSR trains (FCC 2010a).

U.S. Department of Commerce, Federal Communications Commission, Office of Engineering and Technology Bulletin 65, Evaluating Compliance with Federal Communications Commission Guidelines for Human Exposure to Radiofrequency EMF

Office of Engineering and Technology Bulletin 65 (FCC 1997), including revisions and supplements, provides assistance in evaluating whether proposed or existing transmitting facilities, operations, or devices comply with limits for human exposure to RF fields adopted by FCC (FCC 1997).

U.S. Department of Commerce, Federal Communications Commission, 47 CFR Part 1.1310, *Radiofrequency Radiation Exposure Limits*

FCC regulations at 47 CFR Part 1.1310, in the frequency range from 100 MHz to 1,500 MHz, are generally based on the 1992 version of ANSI/IEEE C95.1 safety standard. Table 3.5-6 presents MPE contained in the ANSI/IEEE C95.1 and FCC standards at frequencies of 450, 900, and 5,000 MHz, which covers the range of frequencies that may be used by HSR radio systems. FCC MPEs are based on an averaging time of less than 30 minutes for exposure of the general public and less than 6 minutes for occupational exposure (FCC 2020). As presented in Table 3.5-6, the differences between the ANSI/IEEE C95.1 and FCC MPEs are minor.

Specific absorption rate, per 47 CFR Part 1.1310, shall be used to evaluate the environmental impact of human exposure to RF radiation within the frequency range of 100 kHz to 6 GHz (inclusive). The special absorption rate limits for occupational/controlled exposure are 0.4 watt per kilogram (W/kg) whole-body average and 8 W/kg peak spatial average (except 20 W/kg for body extremities). The special absorption rate limits for general population/uncontrolled exposure are 0.08 W/kg whole-body average and 1.6 W/kg peak spatial average (except 4 W/kg for body extremities) (FCC 2020).

U.S. Environmental Protection Agency, Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997)

Executive Order 13045 directs federal agencies to make it a priority to identify and assess environmental health and safety risks that may disproportionally affect children and to ensure that policies, programs, activities, and standards address disproportionate risks to children, including risks from EMF exposure (USEPA 1997).

U.S. Department of Labor, Occupational Health and Safety Administration, 29 CFR Part 1910.97, *Nonionizing Radiation*

Title 29 CFR Part 1910.97 provides safety standards for occupational exposure to RF emissions in the 10-MHz to 100-GHz range. Table 3.5-6 presents MPEs contained in the OSHA standards. The OSHA safety levels do not vary with frequency and are less stringent than the equivalent ANSI/IEEE and FCC MPEs, except for occupational exposure to fields with frequencies above 5,000 MHz where the OSHA MPE is equal to the C95.1 MPE and is two times higher than the FCC MPE. The OSHA MPEs are based on averaging over any 6-minute time interval.

Table 3.5-6 Radio Frequency Emissions Safety Levels Expressed as Maximum Permissible Exposure

Frequency	ANSI/IEEE C95.1 MPE (mW/cm^2)		FCC MPE (mW/cm^2)		OSHA MPE (mW/cm^2)
	Occupational	General Public	Occupational	General Public	Occupational
450 MHz	1.5	0.225	1.5	0.3	10
900 MHz	3.0	0.45	3.0	0.6	10
5,000 MHz	10	1.0	5.0	1.0	10

Source: 47 CFR Part 1.1310, Table 1 (FCC); 29 CFR Part 1910.97 (OSHA)
ANSI/IEEE = American National Standards Institute/Institute of Electrical and Electronics Engineers; CFR = Code of Federal Regulations; FCC = Federal Communications Commission; MHz = megahertz; MPE = maximum permissible exposure; mW/cm^2 = milliwatts per square centimeter; OSHA = Occupational Safety and Health Administration

3.5.2.2 State

California High-Speed Rail Authority (Authority)—Electromagnetic Compatibility Program Plan

The Electromagnetic Compatibility Program Plan (EMCPP) defines the project's High-Speed Transport Protocol EMC objective, which will provide for EM compatibility of HSR equipment and facilities with themselves, with equipment and facilities of the HSR's neighbors, and with passengers, workers, and neighbors of the HSR. The EMCPP will also guide and coordinate the EMC design, analysis, testing, documentation, and certification activities among HSR project management, systems, and sections through the project phases; conform to the EMC-related HSR system requirements; and comply with applicable regulatory requirements, including EMC requirements in 49 CFR Parts 200 to 299 for the HSR systems and sections (Authority 2010).

California Department of Education, California Code of Regulations, Title 5, Section 14010(c)

This section sets minimum distances for siting school facilities from the edge of power line easements: 100 feet for 50- to 133-kV line, 150 feet for 220- to 230-kV line, and 350 feet for 500- to 550-kV line.

California Public Utilities Commission Decision D.93-11-013

The California Public Utilities Commission (CPUC) decision adopted a policy regarding EMFs from regulated utilities.

California Public Utilities Commission Decision D.06-01-042

The August 2004 CPUC decision updates the EMF policy originally defined in D.93-11-013. D.06-01-042 re-affirmed D.93-11-013 in that health hazards from exposures to EMFs have not been established and that state and federal public health regulatory agencies have determined that setting numeric exposure limits is not appropriate. The CPUC also re-affirmed the existing no-cost and low-cost precautionary-based EMF policy to be continued. D.06-01-042 ordered the utilities to convene a utility workshop to develop standard approaches for design guidelines, including the development of a standard table presenting EMF mitigation measures and costs.

California Public Utilities Commission EMF Guidelines for Electrical Facilities

These CPUC guidelines, based on D.93-11-013 and D.06-01-042, establish priorities between land use classes for EMF mitigation. Although the CPUC decisions, general orders, and guidelines do not directly apply to the HSR, they are listed because:

- The Shared Passenger Track Alternatives could cause environmental impacts associated with the HSR project TPSS and associated electric power substations, station switches, and high-voltage transmission lines consistent with CPUC D.93-11-013, D.06-01-042.
- Decision D.06-01-042 reaffirms the key elements of the updated EMF policy.

3.5.2.3 Regional and Local

This section discusses relevant regional and local programs, policies, regulations, and permitting requirements. The project section would primarily be within Los Angeles and Orange Counties, and the cities of Los Angeles, Vernon, Commerce, Bell, Montebello, Pico Rivera, Santa Fe Springs, Norwalk, La Mirada, Buena Park, Fullerton, and Anaheim. Table 3.5-7 lists local plans and policies that were identified and considered for analysis. No plans or policies related to EMF/EMI were identified for the cities of Vernon, Bell, or Santa Fe Springs.

Table 3.5-7 Regional and Local Plans and Policies

Policy Title	Summary
City of Los Angeles	
Los Angeles Municipal Code (2025)	The Los Angeles Municipal Code includes the following relevant electromagnetic policies: ▪ Section 12.21.20.a.1: The antenna on any monopole or support structure must meet the minimum siting distances to habitable structures required for compliance with Federal Communications Commission (FCC) regulations and standards governing the environmental effects of radio frequency emissions. ▪ Section 12.21.20.b.4: (Application requirements) Statements regarding the regulations of the Federal Aviation Administration (FAA) and the Federal Communications Commission (FCC), respectively, that: (ii) the application complies with the regulations of the Federal Communications Commission, or a statement from the applicant that compliance is not necessary, and the reasons therefor.
City of Commerce	
Commerce Municipal Code (2024)	The Commerce Municipal Code includes the following relevant electromagnetic policy: ▪ Section 19.19.150: No activity shall be permitted if it causes electrical disturbance that affects the operation of equipment located beyond the property line. Radio, television, and microwave transmitters shall be suitably wired, shielded, and controlled so that they do not emit electrical waves or impulses that may affect other electronic devices or equipment.
City of Norwalk	
Norwalk Municipal Code (2024)	The Norwalk Municipal Code, updated in December 2024, includes the following relevant electromagnetic policies: ▪ Section 17.02.295.B.2.b: (Application requirements) An engineering certification demonstrating planned compliance with all existing federal radio frequency emissions standards, and providing technical data sufficient to justify the proposed height of the proposed wireless telecommunication facility. ▪ Section 17.02.295.D.1.a: (Peer Review) Compliance with applicable radio frequency emission standards.
City of Montebello	
Montebello Municipal Code (2024)	The Montebello Municipal Code current through Ordinance 2463, updated March 27, 2024, includes the following relevant electromagnetic policy: ▪ Section 17.32.180.B: Radio and television transmitters shall be operated at the regularly assigned wave lengths (or within the authorized tolerances therefor) as assigned thereto by the appropriate governmental agency. All electrical and electronic devices and equipment shall be suitably wired, shielded, and controlled so that in operation they shall not, beyond the lot lines, emit any electrical impulse or wave which will adversely affect the operation and control of any other electrical or electronic devices and equipment.

Policy Title	Summary
City of Pico Rivera	
Pico Rivera Municipal Code (2025)	The Pico Rivera Municipal Code includes the following relevant electromagnetic policies: ▪ Section 18.49.010: To provide a comprehensive set of standards for the development of wireless telecommunication facilities in the city. The regulations contained herein are designed to protect and promote the safety, welfare, image and aesthetic values of the community as set forth in the goals, objectives and policies of the Pico Rivera general plan; while allowing the orderly development of wireless telecommunication facilities. ▪ Section 18.49.030.C: Provider to provide proof of compliance with existing federal or ANSI standards relative to RF or EMF transmissions. Letter from certified RF engineer fulfills this requirement. Additional compliance verification may be required should federal standards be modified.
City of La Mirada	
La Mirada Code of Ordinances (2024)	The La Mirada Code of Ordinances is current through Ordinance 732, updated February 13, 2024, and includes the following relevant electromagnetic policies: ▪ Section 21.46.010.a: The purpose of the regulatory provisions set forth in this chapter is to establish development standards for the installation and maintenance of antennas and wireless antenna facilities within specified areas of the city. These standards are intended to ensure that the design and location of those antennas and facilities are consistent with previously adopted policies of the city, to promote the public health, safety, comfort, convenience, and general welfare of the city's residents, and to enhance the aesthetic quality and appearance of the city by maintaining architectural and structural integrity and by protecting views and vistas from obtrusive and unsightly accessory uses and facilities. ▪ Section 21.46.010.c: With regard to the regulatory requirements set forth herein, the city council expressly finds and determines that they are necessary, desirable, and in the best interests of the community to protect public safety. The city council further finds and determines that these regulatory requirements are applicable to the proposed installation of satellite earth station antennas or fixed wireless antenna facilities that are not permitted accessory uses and that, because of legitimate safety-related concerns, do not meet the criteria for exemption from local regulation established by the Federal Communications Commission (FCC) under the Telecommunications Act of 1996. ▪ Section 21.46.120.b.4: (Review requirement) Documentation that the electromagnetic fields (EMFs) from the proposed wireless facility, both individually and cumulatively, will be within the limits approved by the FCC. As a condition of approval of any permit or other entitlement, the approving authority may require the annual submission of a report prepared by a qualified person evidencing the fact that EMFs continue to be within approved FCC limits. ▪ Section 21.46.120.b.5: (Review requirement) A statement concerning the minimum distance from the proposed wireless antenna facility that is required to ensure that no person will be exposed to any harmful effects attributable to EMFs.

Policy Title	Summary
City of Buena Park	
Buena Park Municipal Code (2025)	The Buena Park Municipal Code, updated in 2025, includes the following relevant electromagnetic policies: ▪ Section 19.1220.010.C: (Applicability) These regulations prohibit: (3) Wireless telecommunications facilities not in compliance with the regulations of this chapter that do not have legal non-conforming status. ▪ Section 19.1220.040: Wireless telecommunications facilities are subject to approvals at federal, state, county and city levels. Applicants are responsible to obtain approvals at each level. ▪ Section 19.1220.060.B.6: The City shall be provided wireless telecommunications facility monitoring reports with conclusions and recommendations, prepared at the applicant's expense by a qualified engineer, that assess ongoing compliance with federal and state radiofrequency electromagnetic field emission requirements: (a) No sooner than the first 30 nor later than the first 60 days of operation; and (b) Thereafter, annually.
City of Anaheim	
Anaheim Municipal Code (2025)	The Anaheim Municipal Code, current through 2025, includes the following relevant electromagnetic policies: ▪ Section 18.38.060.010: The purpose of this section is to provide placement, design and screening criteria for wireless communication facilities, in order to protect the public health, safety, general welfare, and quality of life in the City of Anaheim, consistent with the policy direction in the Anaheim General Plan, while preserving the rights of wireless communication providers. ▪ Section 18.38.060.0202: The following facilities are exempt from the provisions of this section: (.03) Unobtrusive, ground-plane-designed, ham- or citizens'-band-radio antennas, subject to proper Federal Communication Commission (FCC) licensed operation for such radio service stations and installation pursuant to FCC standards. ▪ Section 18.38.060.060.0601: All wireless communication facilities shall be erected, located, operated, and maintained at all times in compliance with this section and all applicable City, State or Federal laws and regulations. ▪ Section 18.38.060.060.0602: Radio Frequency Emissions Compliance. All wireless communication facilities shall comply with the federal requirements relating to radio frequency emissions and maximum exposure limits provided in Title 47 of the Code of Federal Regulations, Sections 1.1307, 1.1310 and 2.1093, as those sections may be amended from time to time. ▪ Section 18.38.060.090.0906: That the telecommunications equipment operator shall ensure that its installation and choice of frequencies will not interfere with the 800-MHz radio frequencies required by the City of Anaheim to provide adequate spectrum capacity for Public Safety and related purposes.

Sources: City of Anaheim 2025; City of Buena Park 2025; City of Commerce 2024; City of La Mirada 2024; City of Los Angeles 2025; City of Montebello 2024; City of Norwalk 2024; City of Pico Rivera 2025
EMF = electromagnetic field; ANSI = American National Standards Institute; RF = radio frequency

3.5.3 Consistency with Plans and Laws

As indicated in Section 3.1.5.3, Consistency with Plans and Laws, CEQA and NEPA require a discussion of inconsistencies or conflicts between a proposed undertaking and federal, state, regional, or local plans and laws. CEQA, and FRA NEPA implementing procedures require the discussion of any inconsistency or conflict between a proposed action and federal, state, regional, or local plans and laws. Where inconsistencies or conflicts exist, the Authority must provide a description of the extent of reconciliation and the reason for proceeding if full reconciliation is not feasible under NEPA (64 *Federal Register* 28545, 14(n)(15)) and must discuss the inconsistencies between the proposed project and applicable general plans, specific plans, and regional plans under CEQA (State CEQA Guidelines Section 15125(d)).

Several federal and state laws, listed in Section 3.5.2.1, Federal, and Section 3.5.2.2, State, pertain to EMF and EMI. The Authority, as the lead agency proposing to build and operate the HSR system, is required to comply with federal and state laws and regulations and to secure applicable federal and state permits prior to initiating construction of the project. Pursuant to U.S. Code Title 23 Section 327, under the NEPA Assignment Memorandum of Understanding between the FRA and the State of California, effective July 22, 2024, the Authority is the federal lead agency for environmental reviews and approvals for Phase 1 and Phase 2 California HSR System projects.

The Authority is a state agency and is therefore not required to comply with local land use and zoning regulations; however, it has endeavored to design and build the HSR project so that it is consistent with land use and zoning regulations. The Shared Passenger Track Alternatives would be consistent with all regional and local plans and policies related to EMI and EMF.

Refer to Appendix 3.1-A for a complete analysis of consistency with local plans and policies.

3.5.4 Methods for Evaluating Impacts

The following sections define the RSA and summarize the methods used to analyze impacts from EMF and EMI generated by the Shared Passenger Track Alternatives. As summarized in Section 3.5.1, Introduction, several other resource sections in this Draft EIR/EIS also provide additional information related to EMF and EMI.

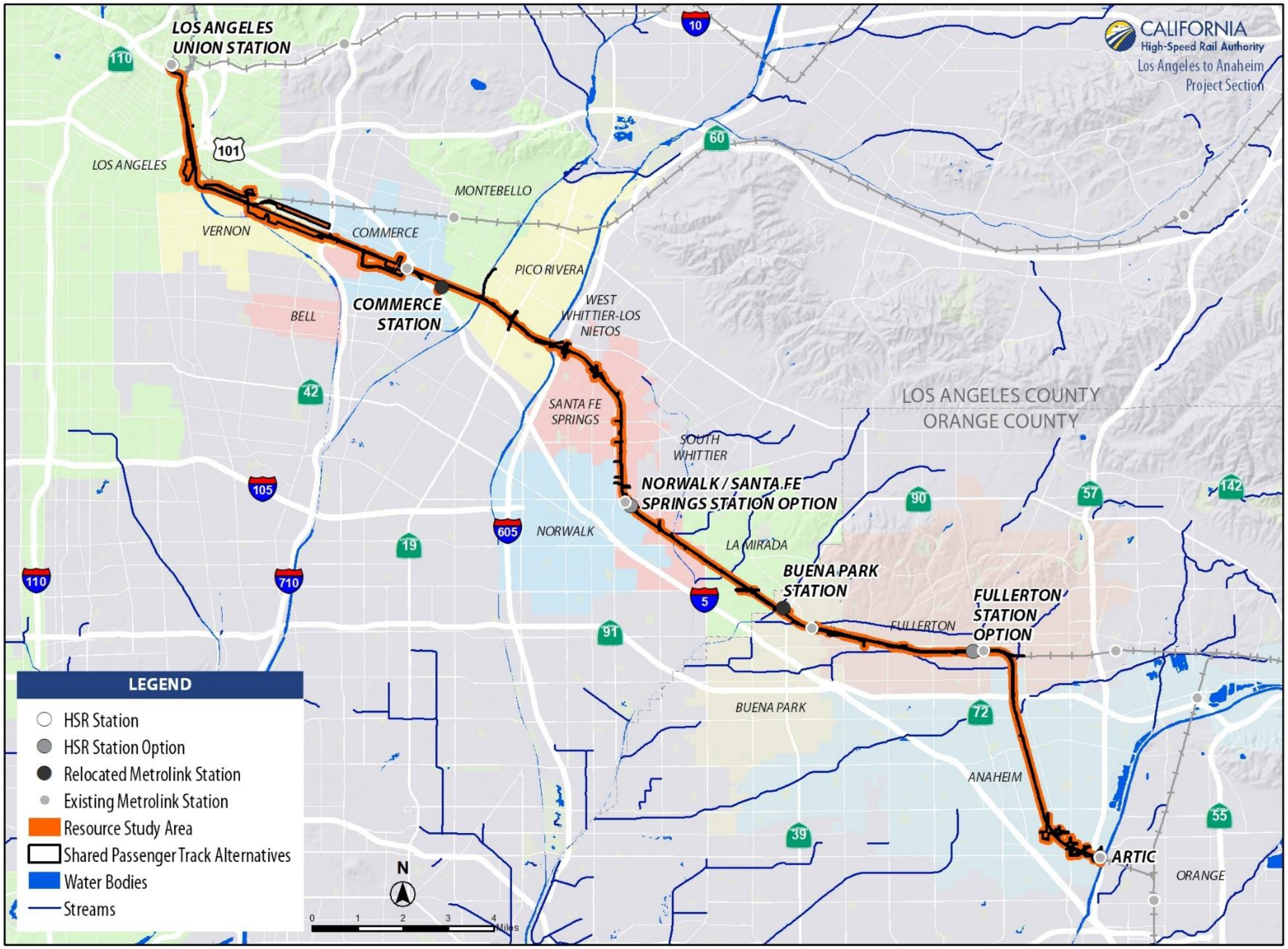
3.5.4.1 Definition of Resource Study Area

As defined in Section 3.1.5.4, Methods for Evaluating Impacts, RSAs are the geographic boundaries in which the Authority has conducted environmental investigations specific to each resource topic. The RSA for impacts on EMF and EMI includes the project footprints for the project section plus 500 feet from the track centerline (i.e., a 1,000-foot-wide corridor), 500 feet from the perimeter of the light maintenance facility (LMF) site, and 500 feet from TPSS facilities, switching stations, paralleling stations, and existing electric utility facilities to be modified. This distance is based on worst-case modeling (Authority 2012) and the distance from the source where EMI has fallen to a level of no concern for humans or sensitive equipment. The EMF and EMI impact analysis focuses on the effects of source EMFs and EMI on sensitive receptors. Sensitive EMF and EMI receptors are adjacent railroads and rail transit systems, airports, residential dwellings, schools, preschools and daycare facilities, public parks, hospitals, and commercial and industrial facilities. Table 3.5-8 provides a general definition and boundary description for the RSA in the project section as depicted on Figure 3.5-1.

Table 3.5-8 Definition of EMF/EMI Resource Study Area

General Definition	Resource Study Area Boundary
EMF/EMI	
Direct resource study area	The project footprint, plus 500 feet from the track centerline, and 500 feet from the perimeter of the light maintenance facility and traction power facilities (traction power substations, switching stations, and paralleling stations).[1]

EMF/EMI = electromagnetic fields/electromagnetic interference
[1] The project footprint includes all areas required to build, operate, and maintain all permanent high-speed rail facilities, including permanent right-of-way, permanent utility and access easements, and temporary construction easements.



Source: Google 2024

Figure 3.5-1 EMF/EMI Resource Study Area

The 500-foot screening distance of the RSA was determined based on typical screening distances identified in the Authority Technical Memorandum 300.07, *EIR/EIS Assessment of California High-Speed Train Alignment EMF Footprint* (Footprint Report) (Authority 2012) and project-specific factors. Screening distances in the Footprint Report were used to identify EMF- and EMI-sensitive receptors that might be near enough to the proposed alignment for EMF or EMI impacts to be possible under typical conditions, and the Footprint Report determined that EMF and EMI impacts would be unlikely where sensitive receptors are beyond these screening distances.

3.5.4.2 Impact Avoidance and Minimization Features

The Shared Passenger Track Alternatives incorporate standardized HSR features to avoid and minimize impacts. These features are referred to as IAMFs and are considered to be part of the project. The Authority will incorporate IAMFs during project design and construction; therefore, the analysis of impacts of the Shared Passenger Track Alternatives in this section factors in applicable IAMFs. Appendix 2-A provides a detailed description of IAMFs that are included as part of the project design. The IAMFs differ from mitigation measures in that they are part of the project regardless of whether an impact is identified in this document. In contrast, mitigation measures may be available to further reduce, compensate for, or offset project impacts that the analysis identifies under NEPA or concludes are significant under CEQA. IAMFs applicable to EMF and EMI for the Shared Passenger Track Alternatives include:

- **EMF/EMI-IAMF#1: Preventing Interference with Adjacent Railroads**. Prior to construction, the Authority will reduce potential exceedances of EMF/EMI standards by requiring the Authority-designated contractor to work with railroad engineering departments and apply standard design practices to prevent interference with the electronic equipment operated on parallel railroad facilities.
- **EMF/EMI-IAMF#2: Controlling Electromagnetic Fields/Electromagnetic Interference**. Prior to construction, the Authority will reduce potential exceedances of EMF/EMI standards by requiring the Authority-designated contractor to design the HSR to international guidelines and comply with federal and state laws and regulations related to EMF/EMI. Prior to construction, the Authority-designated contractor will also prepare an EMF/EMI technical memorandum for review and approval by the Authority. Project design will follow the Authority's Implementation Stage Electromagnetic Compatibility Program Plan (ISEP) to avoid EMI and provide for HSR operational safety.

In Section 3.5.6, Environmental Consequences, each impact narrative describes how these IAMFs are applicable and effective at avoiding or minimizing potential impacts to less-than-significant levels under CEQA.

3.5.4.3 Methods for Impact Analysis

This section describes the sources and methods the Authority used to analyze the impacts from implementing the Shared Passenger Track Alternatives on EMF/EMI-sensitive receptors in the RSA. These methods apply to both NEPA and CEQA analyses unless otherwise indicated. Refer to Section 3.1.5.4 for a description of the general framework for evaluating impacts under NEPA and CEQA. Laws, regulations, and local planning documents (refer to Section 3.5.2, Laws, Regulations, and Orders) that regulate EMF and EMI were also considered in the evaluation of impacts from EMF/EMI.

For the analysis of EMF/EMI effects, the context includes the existing levels of EMFs within the RSA; the locations and types of sensitive receptors and land uses along the project corridor, including proximity to sensitive equipment, adjacent railroads, electrical transmission facilities, or railroad towers; the number or sensitivity of persons working or residing adjacent to the railroad tracks or OCS system; and the regulatory setting pertaining to EMFs/EMI, including guidelines developed for EMF exposure. Intensity refers to the severity of the effect, considering the type (direct/indirect), extent (local, regional), and duration of the effect (short term or long term), and other considerations such as the unique characteristics of the geographic area and proximity to sensitive resources or the degree to which the project effects are likely to be controversial.

For the analysis of EMF/EMI effects, the Authority assessed:

- The magnitude of the change between the existing and modeled EMF levels
- The potential the proposed project could exceed applicable standards, including impacts on public health through exposure of people to EMF health risks in exceedance of applicable standards, exposing people to electric shock, or interfering with implanted biomedical devices
- The potential the proposed project could affect public safety by interfering with the operation of nearby railroads, rail transit systems, airports, or other businesses

The Authority relied on aerial imagery, land use surveys, photographs, and FCC databases to identify regional and local sources of EMFs and EMI. The Authority also used observations of existing conditions obtained during a preconstruction EM survey of the EMF/EMI RSA.

Local Conditions

As part of this evaluation, a preconstruction EM survey was performed at seven locations—selected in part from the land use survey described above—along the proposed alignment between Los Angeles Union Station and Anaheim Regional Transportation Intermodal Center. The purpose of the survey was to: (1) provide a baseline characterization of the existing EM environment, (2) permit comparisons with the expected EM footprint from the planned HSR system, and (3) provide guidance for EMC requirements by defining the typical EM environment that the HSR system must operate in without interference.

Existing facilities and uses along the entire project alignment were reviewed with respect to the EM environment, and seven measurement sites were selected to obtain a representative sample of typical EMF sources such as power lines and antenna towers, sensitive facilities such as medical or research facilities for comparison.

Two types of measurements were performed at each of the seven locations. The first type of measurement was of radiated electric field strengths (i.e., measured RF levels) from 10 kHz to 6 GHz, meant to characterize the existing RF environment. These RF levels were measured using an RF spectrum analyzer and calibrated antennas. Typical sources of RF signals include:

- Cell towers (cellular telephone)
- Broadcast towers (radio and television broadcasts)
- Airport radar and communications equipment
- General high-frequency and very high-frequency communications systems (police, fire, utility, and government)
- Local wireless (wireless fidelity and Worldwide Interoperability for Microwave Access)

The second type of measurement involved background DC and power frequency magnetic fields along the alignment. These magnetic fields were recorded using three-axis fluxgate sensors with a waveform recording data acquisition system. Typical sources of DC and low-frequency magnetic fields include:

- The geomagnetic field[1]
- Utility high-voltage transmission/power lines
- Utility electric distribution lines
- Utility substations
- Utility switching stations

[1] The geomagnetic field is produced naturally by electric currents flowing in the Earth's metallic core. At the Earth's surface, this field varies in strength from approximately 0.3 to 0.6 mG.

- Utility electrical generation facilities
- Geomagnetic perturbations caused by passing vehicles and trains on nonelectrified lines

The facilities most sensitive to shifts in the static (DC) or AC magnetic fields are:

- High-tech semiconductor (e.g., electron microscopes, electron-beam lithography)
- Medical imaging systems (e.g., MRI scanners, positron emission tomography scanners)
- Bio-tech research (e.g., NMR spectrometers)

Appendix 3.5-A documents the process for conducting field survey measurements, describes measurement sites, and discusses the existing EMF levels in the project section.

Sensitive Receptors

The impact analysis focused on impacts on sensitive receptors, which consist of land uses and facilities susceptible to EMFs and EMI produced by the HSR. These receptors include adjacent railroads and rail transit systems, airports, residential dwellings, schools, preschools and daycare facilities, public parks, hospitals, and commercial and industrial facilities. These land uses have communications systems, sensitive equipment, or other electronic devices that could be disrupted by EMF. Residences are considered to be EMF-sensitive for their exposure of people to EMF. The Authority identified sensitive receptors through a review of aerial imagery, county parcel data, and local planning documents.

EMF and EMI Levels

The following steps were performed to characterize the existing EMF environment in the RSA and to predict EMF levels from HSR operations:

- EMF-sensitive land uses were identified through a review of aerial imagery, county parcel data, and local planning documents.
- Baseline EMF levels were measured as described above and in Appendix 3.5-A.
- The Magnetic Field Calculation Model, a mathematical model of the HSR traction electrical system, was then used to calculate the anticipated maximum 60-Hz magnetic fields that a single HSR train would produce.

The model incorporates conservative assumptions for the possible EMF impacts of the HSR. For example, the projected maximum magnetic fields would exist only for a short period and only in certain locations as the train moves along the track or changes its speed and acceleration. The magnetic field levels would decline rapidly as the lateral distance from the tracks increases. For most locations and most times, exposure to EMFs would not be as high as predicted by the model, which predicts peak EMF levels.

The model also identifies how the projected maximum EMF levels would vary with the lateral distance from the centerline of the tracks. For the sensitive land uses identified, the maximum EMF levels that would be emitted by the HSR system were predicted and compared to the measured, existing ambient conditions. Because magnetic fields are expected to be the dominant EMF impact from the HSR operations for many sensitive receptors, these results are a key element in the EMF impact analysis.

For sensitive receptors, predicted EMF levels associated with the new/modified electrical infrastructure are based on the distance between the receptor and the nearest source. EMFs are also produced by electric substations, but because of the spacing of electrical equipment, measured field strengths are generally low outside the fence line of the substation. Fields close by a substation are mainly produced by the entering and exiting power lines (Western Area Power Administration n.d.).

EMF impacts on sensitive land uses were identified based on the differences between predicted EMF levels and existing conditions. The data from the seven site measurement locations were generalized to represent the entire RSA. Where the predicted magnetic fields would be comparable to or lower than the typical existing levels, no adverse effect would occur, and these locations were screened out. Where the predicted magnetic fields would be higher than typical existing levels for exposure, then the potential for EMI was used to evaluate whether adverse effects could be expected.

3.5.4.4 Method for Evaluating Impacts Under NEPA

NEPA implementing procedures, regulations, and guidance provide the basis for evaluating project effects (as described in Section 3.1.1). The criteria of context and intensity are considered together when determining the severity of changes introduced by the project:

- **Context:** For the analysis of EMF and EMI effects, the *context* would include the existing levels of EMF within the RSA; the location and type of sensitive receptors and land uses along the project corridor, including proximity to sensitive equipment, adjacent railroads, electrical transmission facilities, or railroad towers; and the regulatory setting pertaining to EMF and EMI, including guidelines developed for EMF exposure.
- **Intensity:** For the analysis of EMF and EMI effects, the *intensity* or severity of an effect would assess the magnitude of the change between the existing and modeled EMF levels; the degree to which the project could affect public health by exposing people to EMF health risks in exceedance of applicable standards, exposing people to electric shock, or interfering with implanted biomedical devices; and the degree to which the project could affect public safety by interfering with the operation of nearby railroads, rail transit systems, airports, or other businesses.

To inform the severity of an effect, projected levels of EMFs and EMI were compared to No Project levels. The Authority determined whether the increase would be of sufficient magnitude, frequency, or duration to present a documented health risk to persons living or residing in the project area and whether the increase could interfere with existing operations of an electrical device.

3.5.4.5 Method for Determining Significance Under CEQA

CEQA requires that an EIR identify the significant environmental effects of a project (State CEQA Guidelines Section 15126). One of the primary differences between NEPA and CEQA is that CEQA requires a threshold-based impact analysis. Significant impacts under CEQA are determined by evaluating whether project impacts would exceed the significance threshold for the resource. The Authority is using the following thresholds to determine if a significant impact from EMF or EMI would occur as a result of the Shared Passenger Track Alternatives. A significant impact is one that would:

- Expose a person to a documented EMF health risk, including a field intensity over the limit of an applicable standard, an electric shock, or interference with an implanted biomedical device
- Interfere with nearby sensitive equipment, including at hospitals, industrial and commercial facilities, railroads, rail transit systems, and airports

Human exposure and interference may be defined as follows:

- Human Exposure—The MPE limit (IEEE 2002, Table 2) for 60-Hz magnetic fields for the instantaneous exposure of the general public is 9.04 G (904 μT); the MPE for controlled environments where only employees are present is 27.12 G (2,712 μT). The MPE limit (IEEE Standard C95.6, Table 4) for 60-Hz electric fields for the general public is 5,000 V/m, or 5 kV/m. The MPE is 20 kV/m for controlled environments in which only HSR employees would work. MPE limits for RF exposure from HSR radio systems will be taken from Table 3.5-4 at the 450 MHz frequency. The IEEE Standard C95.6 was formally adopted by ANSI and is used regularly throughout the United States to analyze impacts related to EMF. The safety levels established by this standard are well below the levels at which scientific research has indicated harmful effects may occur, thus incorporating a large safety factor (IEEE 2006). The HSR electrification and traction systems would mainly generate 60 Hz EMFs, which this standard addresses (https://www.ices-emfsafety.org, IEEE 2002)

- Interference—The Footprint Report (Authority 2012) provides typical interference levels for common types of sensitive equipment. These reported levels are used as the significance criteria for this impact analysis. From the Footprint Report, 2 mG is a screening level for disturbance to unshielded sensitive equipment. In addition, 2 mG is a typical EMF level from early epidemiological studies, which indicated that it is the lowest level of chronic, long-term magnetic field exposure with no statistical association with a disease outcome (Savitz et al. 1988, Severson et al. 1988). The value of 2 mG also is a typical EMF level emitted from household appliances (NIEHS 2002).

The human exposure and equipment interference levels are summarized in Table 3.5-9, drawn from Table 3.5-1 through Table 3.5-6.

Table 3.5-9 Summary of CEQA Impact Thresholds

Exposure	Summary of Threshold
Human Exposure	
60 Hz, public	9.04 G for magnetic fields; 5 kV/m for electric fields
60 Hz, controlled	27.12 G for magnetic fields; 20 kV/m for electric fields
RF exposure (all)	Refer to Table 3.5-6 for limits
Implanted medical devices	1.0 G for magnetic fields; 1 kV/m for electric fields
Equipment Interference	
Research equipment	2.0 mG for magnetic fields; electric field unspecified
Rail signaling systems	No interference permitted (functional definition, no specific threshold)
Airport communications	No interference permitted (functional definition, no specific threshold)

Source: IEEE 2002
CEQA = California Environmental Quality Act; G = gauss; Hz = hertz; kV/m = kilovolt per meter; mG = milligauss; RF = radio frequency

3.5.5 Affected Environment

This section describes the affected environment related to EMF and EMI in the RSA, including sources of EMF and EMI; local conditions; receptors susceptible to EMI or EMF impacts; and railroad and transportation equipment susceptible to EMF and EMI impacts along the project footprint between Los Angeles and Anaheim. This information provides the context for the environmental analysis and evaluation of impacts.

A summary of stakeholder issues and concerns from public outreach efforts can be found in Chapter 9, Public and Agency Involvement.

3.5.5.1 Local Conditions

Table 3.5-10 identifies the location where EMI measurements were performed and Figure 3.5-2 depicts the location in the project section. The project section is heavily developed and includes industrial and commercial areas, retail, residential housing, high-voltage overhead power lines, and associated urban infrastructure. These areas may include laboratories and other facilities that operate EMI-sensitive research or medical devices. The nearest existing power source is Los Angeles Department of Water and Power Receiving Station No. 5, on the corner of De La Torre Way and E 15th Street, approximately 1.2 miles from the TPSS. Anaheim Public Utilities owns and operates a power substation on an approximately 16-acre site on the southwest corner of Lewis Street and Cerritos Avenue in Anaheim.

Populations Near High-Voltage Transmission Lines

There are many occupied structures, including some residential uses, near the proposed locations for the TPSS facility, switching station, paralleling station facilities, and associated utility feeds. However, none of the facility locations would be within 100 feet of the nearest building, or within 300 feet of the nearest residential site. The analysis did not identify receptors with potentially sensitive equipment within 500 feet of the locations.

Absent such sensitive equipment close to these facilities, impacts are not to be expected. Although the EMF levels developed at or just outside of the fence line would in most cases exceed the prevailing ambient levels, they would not exceed the electric or magnetic MPE limits for occupational or general public exposure.

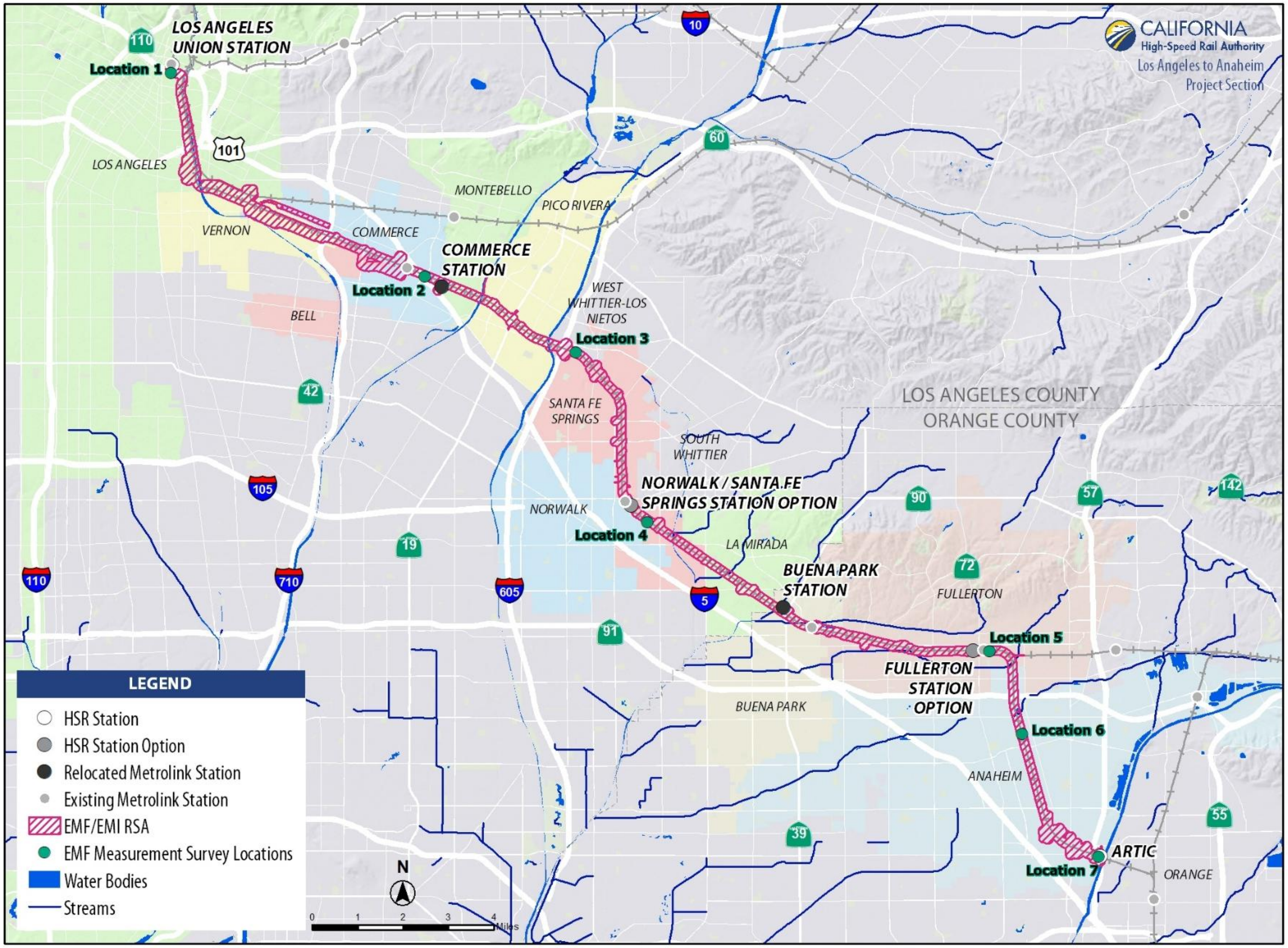
High-Speed Rail Equipment Susceptible to EMI Effects from Other Transmitters Along the Right-of-Way

No emitters were identified that would pose a threat to the RF portions of the HSR communications or control systems. Higher-powered broadcast sources in the region operate at spectrally remote frequencies and are too distant to degrade HSR control or communications equipment. Of the 210 AM, FM, and TV broadcast stations identified in the region, all are 1 mile or more from the HSR corridor. Military and airport transmitters in the region are similarly too distant to present a plausible risk anywhere along the project section.

Table 3.5-10 Field Measurement Survey Location

Site No.	Location	Nearest Cross Streets	Location	Notable EMF Sources, Sensitive Receptors
1	Los Angeles	Garey St/Commerce St	34.052983° -118.234269°	Just south of LAUS where the HSR tracks turn east. Mixed industrial/commercial area. Nearby communications and other RF sources.
2	Commerce	Garfield Ave/Telegraph Rd	33.988000° -118.136874°	Industrial/commercial area adjacent to existing rail lines. Nearby power distribution, cell towers, and railway communications.
3	Santa Fe Springs	Vicki Rd/Rivera Rd	33.963785° -118.078751°	Mostly residential, on north side of existing railroad tracks.
4	Norwalk	Foster Rd/Studebaker Ave	33.909585° -118.051213°	Residential area. Nearby power distribution, cell towers. Potentially sensitive receptors nearby.
5	Fullerton	Walnut Ave/Lemon St	33.868297° -117.920212°	Industrial/commercial area, across from the Fullerton Metrolink Station and near SCE Fullerton substation.
6	Anaheim	Sycamore St/Vine St	33.841725° -117.907607°	Primarily residential area. Some power distribution lines. Local RF sources include two cell towers and railroad communications.
7	Anaheim	Katella Ave/Douglass Rd	33.802430° -117.878446°	On south side of ARTIC. Cell towers, railway communications, and power distribution lines nearby.

Source: Google 2024
ARTIC = Anaheim Regional Transportation Intermodal Center; EMF = electromagnetic field; HSR = high-speed rail; LAUS = Los Angeles Union Station; RF = radio frequency; SCE = Southern California Edison



Source: Google 2024

Figure 3.5-2 EMF Measurement Site Locations

Summary of Measured EMF Levels

The field survey included measurements of existing RF levels from 10 kHz to 6 GHz. This frequency range encompasses many different applications, including broadcast radio and digital television signals, fixed and mobile communications, cellular telephones, and radar and navigation systems. In general, the measured RF levels were consistently high and uniform across sites and are consistent with levels observed in other highly urbanized areas.

The survey also quantified typical power-frequency magnetic field levels along the project section to characterize typical DC and extremely low-frequency (up to 1,000 Hz) sources such as high-voltage transmission lines, electrical distribution lines, and electrical substations or generating equipment. The maximum or peak 60 Hz magnetic fields recorded in this survey varied from 0.02 mG to approximately 6.09 mG, with levels depending primarily on the measurement locations' proximity to local distribution and transmission power lines. Appendix 3.5-A provides additional analysis and the full measurement results from the field survey.

Table 3.5-11 summarizes the distance between each measurement site and the nearest HSR track, the average measured DC and AC (60 Hz) magnetic field strengths, and the predicted maximum HSR field strengths at each of the test sites.

Table 3.5-11 Comparison of Measured and Modeled Magnetic Fields

Site/Community	Distance to nearest HSR track (feet)	Measured average DC field (mG)	Measured average 60 Hz field (mG)	Modeled 60 Hz field – single train (mG)
1. Los Angeles	35	458	0.15	109
2. Commerce	95	417	0.13	14.3
3. Santa Fe Springs	125	453	1.00	8.2
4. Norwalk	160	448	0.02	5.0
5. Fullerton	65	446	4.88	30.9
6. Anaheim	40	416	2.45	82.8
7. Anaheim	60	460	0.10	36.7

DC = direct current; HSR = high-speed rail; Hz = hertz; mG = milligauss

Sensitive Receptors and Facilities

Table 3.5-12 identifies 20 facilities within the RSA that were identified as potentially sensitive, along with the proximity of the receptors to the project alignment and the predicted maximum HSR field strengths for a single train. These receptors were included based on their proximity to the project section or associated infrastructure such as substations or maintenance areas, proximity to HSR construction activities, or both. In addition to these facilities, existing rail systems, buried pipelines, ungrounded metallic fencing, and other linear receptors of concern are known to occur in the RSA and have the potential for EMI concerns.

Table 3.5-12 List of Potentially Sensitive Receptors

Receptor Site ID and Name	Location	Distance to nearest track (feet)	Distance to construction easement (feet)	Modeled 60 Hz field (mG)[1]	Site notes
1. Metropolitan Water District (Heliport)	700 Alameda St, Los Angeles	295	295	1.4	Heliport location
2. Los Angeles Fire Department, Station 17	1601 S Santa Fe Ave, Los Angeles	1,300	250 (from 15th St LMF)	0.07	Fire department in Los Angeles; included only for Shared Passenger Track Alternative A
3. Childtime of Commerce	4820 S Eastern Ave #F, Commerce	1,870	218	0.03	Infant care, preschool, prekindergarten, and other early education programs
4. Maizeland Elementary	7601 Cord Ave, Pico Rivera	309	292	1.3	School district–run daycare and Kindergarten–6
5. Pioneer High School	10800 Benavon St, Whittier	854	50	0.17	Grades 9–12
6. Los Nietos Middle School	11425 E Rivera Rd, Whittier	260	248	1.9	Grades 7, 8
7. Zimmerman Park	13031 Shoemaker Ave, Norwalk	155	40	5.3	Community park, 8.4 acres
8. John Glenn High School	13520 Shoemaker Ave, Norwalk	161	141	4.9	RSA intersects with sports field only
9. MedCoast Ambulance Service	14325 Iseli Rd, Santa Fe Springs	400	390	0.78	Ambulance service
10. Neff Park	14300 San Cristobal Dr, La Mirada	440	430	0.64	Community park, 7.5 acres
11. Froebel Daycare	15932 Dalmatian Ave, La Miranda	241	154	2.2	Daycare
12. Jesus' Hands Montessori Preschool	5621 Beach Blvd, Buena Park	498	453	0.5	Preschool, kindergarten, and afterschool care
13. Nutrilite Health Institute	5600 Beach Blvd, Buena Park	110	75	10.7	Possible NMR spectrometer operator
14. Fullerton Airport	4011 W Commonwealth Ave, Fullerton	100	0	12.9	Municipal airport; CHP, police, and fire based at heliport here
15. Pacific Drive Elementary School	1501 Valencia Dr, Fullerton	339	288	1.1	Kindergarten–6 school, district administration offices

Receptor Site ID and Name	Location	Distance to nearest track (feet)	Distance to construction easement (feet)	Modeled 60 Hz field (mG)[1]	Site notes
16. Independence Park	801 Valencia Dr, Fullerton	45	0	65.2	Community recreational facility and pools, 8.7 acres
17. Amerige Park	300 W Commonwealth Ave, Fullerton	195	75	3.3	Community park and athletic center, 4.2 acres
18. Fullerton Fire Department	312 E Commonwealth Ave, Fullerton	490	380	0.51	North of Metrolink station
19. QPE Technical Institute	1557 N Gemini Pl, Anaheim	57	0	40.3	Technical school
20. Citrus Park	104 Atchison St, Anaheim	30	0	177	Community park, 1.3 acres

Source: Google 2024

[1] Calculated magnetic field for a single high-speed rail train passing the measurement location. Estimated from Figure E-1b of Footprint Report (Authority 2012)

CHP = California Highway Patrol; Hz = hertz; ID = identification; LMF = light maintenance facility; mG = milligauss; MRI = magnetic resonance imaging; NMR = nuclear magnetic resonance; RSA = resource study area

3.5.6 Environmental Consequences

3.5.6.1 Overview

This section discusses the potential impacts associated with EMF/EMI generated from construction and operation of the project alternatives and station options. Each resource category addresses potential impacts from the No Project Alternative and the Shared Passenger Track Alternatives. For this resource topic, any differences in the impacts for the HSR station options are described in the analysis. This section evaluates how the No Project Alternative and the Shared Passenger Track Alternatives could be affected by EMF/EMI. This section evaluates impacts of EMF/EMI from the project on sensitive receptors and facilities including humans, sensitive equipment, schools, underground pipelines and cables, adjoining rail systems, and airport communication systems. For this resource topic, any differences in the impacts for the alternatives and station options are described in the analysis.

Project construction would generate RF fields from occasional radio transmissions and DC magnetic field disturbances from movement of large construction vehicles and equipment. These impacts would be intermittent, occurring only during construction, and would be primarily restricted to the construction areas. Operational and maintenance activities would affect local EMF and EMI levels, potentially increasing EMF exposure of sensitive receptors or causing nuisance shocks. These impacts could be either temporary, occurring intermittently during operations of the project, or permanent, occurring continuously during operations.

The project design includes several features (IAMFs) to allow continued use of the facilities with minimal disruption from HSR construction and operation (refer to Volume 2, Appendix 2-A). **EMF/EMI-IAMF#1** requires coordination with adjacent railroads before commencing project operation to prevent EMI/EMF interference. The Authority will also coordinate with third-party owners of sensitive facilities and equipment in the vicinity of the HSR system and, if necessary, take specific steps to avoid or reduce potential interference (**EMF/EMI-IAMF#2**). These features ensure compliance with EMI/EMF standards by specifying standard design practices for electronic equipment, requiring coordination with adjacent railroad engineering departments, designing the HSR system in accordance with international guidelines, and complying with federal and state laws and regulations pertaining to EMF and EMI. Before the activation of any potentially interfering HSR systems, the Authority will contract with a qualified engineering professional to validate the efficacy of design provisions preventing interference (**EMF/EMI-IAMF#1** and **EMF/EMI-IAMF#2**).

The IAMFs differ from mitigation measures in that they are part of the project and are a binding commitment by the Authority. In contrast, mitigation measures may be available to further reduce, compensate for, or offset project impacts that the analysis identifies under NEPA or concludes are significant under CEQA.

The impacts of the Shared Passenger Track Alternatives are described and organized as follows.

Construction Impacts

- Impact EMF/EMI-1: Temporary Impacts from Use of Heavy Construction Equipment
- Impact EMF/EMI-2: Temporary Impacts from Communications Equipment
- Impact EMF/EMI-3: Temporary Impacts from Operation of Electrical Equipment

Operational Impacts

- Impact EMF/EMI-4: Permanent Human Exposure to Electromagnetic Fields
- Impact EMF/EMI-5: People with Implanted Medical Devices and Exposure to Electromagnetic Fields
- Impact EMF/EMI-6: Potential for Corrosion of Underground Pipelines, Cables, and Adjoining Rail
- Impact EMF/EMI-7: Potential for Nuisance Shocks
- Impact EMF/EMI-8: Effects on Adjacent Existing Rail Lines
- Impact EMF/EMI-9: Permanent Interference with Sensitive Equipment
- Impact EMF/EMI-10: Electromagnetic Interference Effects on Schools
- Impact EMF/EMI-11: Effects Related to Adjacent Airports

3.5.6.2 No Project Alternative

Under the No Project Alternative, recent development trends in the project section are anticipated to continue. In general, the region is highly urbanized. The areas surrounding the project section are largely built out and can add population and businesses only through limited infill and more intensive development. However, it is reasonable to assume that the use of electricity and RF communication equipment, including high-voltage transmission/power lines and directional and nondirectional (cellular and broadcast) antennas that result in EMFs and EMI, would continue and would likely increase along the length of the project section given the anticipated population growth in the counties. The development of new schools, hospitals, police stations, and other facilities with sensitive equipment would increase the prevalence of receptors potentially sensitive to EMI.

By 2040, the use of electricity and RF communications would increase along with increased development, greater use of electrical devices, and technological advances in wireless transmission (such as wireless data communication). As a result, increased generation of EMFs and EMI that could affect people and sensitive receptors is expected. Planned development and transportation projects that would occur under the No Project Alternative would likely include building and equipment design features intended to address increased levels of EMF and EMI.

If the Shared Passenger Track Alternatives are not built, then temporary construction impacts and permanent changes from operations associated with the project would be avoided. Under the No Project Alternative, construction and operational impacts from EMF associated with the project would not occur at the potentially sensitive receptors identified in Table 3.5-12.

However, similar impacts, including further elevation of EMF levels from increased utility demands, could persist through recent development trends. These trends are anticipated to continue and could affect sensitive receptors and facilities in the RSA. Planned development and transportation projects that would occur as a result of the No Project Alternative should include mitigation to address impacts on these resources. These development activities include demolition and new construction including movement of large vehicles and operation of electrical and radio equipment that could lead to impacts on nearby sensitive receptors and facilities.

The reasonably foreseeable development under the No Project Alternative would be evaluated to determine the significance of impacts and mitigation measures, as needed, to avoid or reduce significant impacts. It would be the affected jurisdictions' responsibility to ensure compliance with adopted regulations. The other transportation and development projects and planned projects under the No Project Alternative would undergo environmental review, and potential effects on sensitive receptors and facilities would be analyzed and mitigated.

3.5.6.3 Project Impacts

Construction and operation of the Shared Passenger Track Alternatives could result in temporary and permanent impacts on sensitive receptors and facilities, including humans, sensitive equipment, and underground pipelines and cables, as well as adjoining rail systems.

Construction would involve demolition of existing structures, clearing and grubbing; reduction of permeable surface area; handling, storing, hauling, excavating, and placing fill; possible pile driving; and construction of aerial structures, bridges, road modifications, rail yard improvements, utility upgrades and relocations, power pole installation, HSR electrical systems, and railbeds. Operation would include the operation of trains, and inspection and maintenance along the track and at LMFs and railroad right-of-way, as well as on the structures, fencing, power system, train control, electric interconnection facilities, rail yards, and communications. Construction and operations and maintenance are more fully described in Chapter 2, Alternatives.

The following sections separately describe each construction and operational impact for the Shared Passenger Track Alternatives.

Construction Impacts

Impact EMF/EMI-1: Temporary Impacts from Use of Heavy Construction Equipment

Shared Passenger Track Alternative A

Construction of Shared Passenger Track Alternative A would require the temporary use of heavy equipment, trucks, and light vehicles, which, like all motor vehicles, generate EMFs. Additionally, many types of construction equipment contain electric motors that generate EMFs. Movement of large construction vehicles could result in transient changes to the static (DC) magnetic field. Although such changes can interfere with some sensitive equipment, construction vehicles must be both very large and operate very closely to the equipment in question to cause interference. As an example, articulated buses (approximately 50,000 pounds) produce magnetic field shifts of approximately 0.5 mG at a distance of 70 feet (ERM 2007). For a construction vehicle with twice this mass, the magnetic field shift would be 1 mG at 70 feet, or at the threshold level of 2 mG at 50 feet. A vehicle with half this mass would need to be within 25 feet to generate the same field shift. Although it is not known at this time exactly what heavy construction equipment would be used and where, weights for most construction equipment would fall well below 100,000 pounds. Because the magnitude of this disturbance decreases with both mass and distance, all but the largest construction vehicles would pose no reasonable risk to magnetically sensitive equipment beyond the construction footprint, nor would they pose a health risk to workers or the nearby public.

In conformance with the EMCPP and ISEP (Technical Memorandum 300.10), when heavy construction equipment encroaches within 50 feet, the Authority and its designated contractor will coordinate with third-party owners of sensitive facilities and, if found necessary, take specific steps (e.g., controlling EMI/EMF through preparation of a technical memorandum, performing

EMC/EMI safety analyses, implementing HSR standard corrosion protection measures) to avoid or reduce potential interference (**EMF/EMI-IAMF#2**). As part of the ISEP, the Authority will monitor field conditions to determine if such EMC issues arise and provide the necessary coordination with affected third parties and the Authority-designated construction contractor to resolve the problem. Steps to resolve such problems could include equipment shielding, equipment relocation, or coordination of construction activities to avoid interference.

It is unlikely that the conditions described above would occur during construction. However, if they were to occur, **EMF/EMI-IAMF#2**, through the ISEP, requires coordination with third-party owners of sensitive facilities to avoid or minimize any construction-related impacts from EMI. This is particularly true given the temporary nature of the disruption.

Medical and high-tech facilities commonly contain equipment that could be affected by EMI, including equipment sensitive to small variations in the surrounding magnetic field (e.g., medical MRI scanners, NMR spectrometers) and focused-beam devices (e.g., electron microscopes, ion-writing systems). The potential for interference with sensitive equipment in use at high-tech facilities will be addressed through the Authority's EMCPP and the design criteria of the project (**EMF/EMI-IAMF#2**). HSR-related EMI may still affect highly susceptible, unshielded sensitive RF equipment such as older MRI systems and other measuring devices common to medical and research laboratories. Most of the devices manufactured today have adequate shielding from potential EMI sources; however, the potential exists for older devices to be affected and require shielding. One facility was identified in the project section that is believed to be currently operating magnetically sensitive equipment, as presented in Table 3.5-12: Site 13 (NMR spectrometers). There is uncertainty regarding the type and age of sensitive equipment used at these sensitive receptor sites, making it difficult to specifically identify equipment-specific impacts or feasible mitigation. Accordingly, any sensitive equipment-specific impacts will be reduced by implementing **EMF/EMI-MM#1, Protect Sensitive Equipment** (described in more detail in Section 3.5.7, Mitigation Measures). Under this mitigation measure, the Authority will contact the affected third parties and determine how best to protect sensitive equipment, either through relocation or shielding in place.

The types, numbers, and sizes of construction equipment in use would vary along the project section, depending on the type of construction involved, (e.g., aerial structures versus cut-and-cover construction). Unintended EMF from use of construction vehicles, heavy equipment, and electric motors would be minor, and radio communications systems used on construction sites would comply with FCC regulations. Therefore, construction of Shared Passenger Track Alternative A would not:

- Be a substantial source of EMI that could expose a person to a documented health risk
- Cause electric shocks
- Interfere with implanted medical devices
- Affect the operation of nearby railroads, airports, or other businesses

EMF/EMI-IAMF#2 will minimize potential interference through coordination with third-party owners of sensitive facilities to avoid or minimize any construction-related impacts. Substantial EMF fluctuations caused by construction vehicle movements would be limited to within 50 feet of the construction footprint, and radio communications systems would comply with FCC regulations designed to prevent EMI. Any equipment-specific impacts for those identified sensitive receptors included in Table 3.5-12 will be addressed with implementation of **EMF/EMI-MM#1**. The potential for impacts applies at receptor Site 13 (Nutrilite Health Institute) in Buena Park.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A, because it would require the same types of heavy equipment during construction, and the sensitive receptors within the RSA would be the same. **EMF/EMI-IAMF#2** will avoid or minimize temporary impacts on sensitive receptors from use of heavy construction equipment. **EMF/EMI-MM#1** would be implemented to ensure that temporary equipment-specific impacts associated with the use of heavy construction equipment are minimized.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, temporary impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because it would require the same types of heavy equipment during construction, and the sensitive receptors within the RSA would be the same. Although the duration of construction could be longer with inclusion of the Norwalk/Santa Fe Springs HSR Station Option (refer to Chapter 2 for construction details), the overall impact on sensitive receptors would be the same. None of the sensitive receptors in Table 3.5-12 are within 500 feet of this HSR station option. **EMF/EMI-IAMF#2** will minimize potential interference through coordination with third-party owners of sensitive facilities to avoid or minimize any construction-related impacts. Therefore, construction of this HSR station option would not result in additional or different impacts at the station site.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because it would require the same types of heavy equipment during construction, and the sensitive receptors within the RSA would be the same. None of the sensitive receptors in Table 3.5-12 are within 500 feet of this HSR station option. Therefore, construction of this HSR station option would not result in additional or different impacts at the station site. **EMF/EMI-IAMF#2** will minimize potential interference through coordination with third-party owners of sensitive facilities to avoid or minimize any construction-related impacts.

CEQA Conclusion

The potential for interference with high-tech equipment because of use of heavy construction equipment during construction of the Shared Passenger Track Alternatives will be addressed through conformance with the Authority’s ISEP and applicable design criteria (**EMF/EMI-IAMF#2**), which are intended to prevent EMI with identified neighboring uses. Even with **EMF/EMI-IAMF#2**, the impact under CEQA related to interference with sensitive equipment during project construction would be potentially significant at one facility identified in the RSA—Site 13, Nutrilite Health Institute (Buena Park)—because of the uncertainty regarding both the type and age of sensitive equipment used at this receptor site. The Authority will coordinate with the owners of the nearby sensitive equipment at Nutrilite Health Institute to identify appropriate shielding mitigation to avoid these effects, including performing tests to confirm equipment is free from impacts (**EMF/EMI-MM#1**). With implementation of **EMF/EMI-MM#1**, which requires relocating or shielding affected equipment, impacts related to interference with sensitive equipment would be reduced to less-than-significant levels.

Movement of heavy construction and electrical equipment would exceed thresholds of EMF identified in Table 3.5-9 and would cause EMI with nearby sensitive land uses. However, potential interference would be minimal and would not expose people to a documented EMF health risk. Accordingly, impacts associated with exposure of people to a documented EMF health risk would be less than significant and CEQA does not require mitigation.

Impact EMF/EMI-2: Temporary Impacts from Communications Equipment

Shared Passenger Track Alternative A

Construction activities would involve licensed radio transmissions between construction vehicles, which would occur occasionally. As indicated in Section 3.5.2, Shared Passenger Track Alternative A would adhere to 47 CFR Part 15 and its general provision that devices may not cause interference, must accept interference from other sources, and must prohibit the operation of devices if the operator is notified by the FCC that the device is causing interference. As such, there would be no exposure of people to a substantial EMF risk generated by radio transmissions between construction personnel. Compliance with the above provisions means that interference with other radio-based service would be avoided.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A, because it would require the same types of communications equipment during construction. There would be no exposure of people to a substantial EMF risk generated by radio transmissions between construction personnel. Compliance with the above provisions means that interference with other radio-based service would be avoided.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because it would require the same types of communications equipment during construction, and there would be no exposure of people to a substantial EMF risk generated by radio transmissions between construction personnel. Therefore, construction of this HSR station option would not result in additional or different impacts at the station site.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives with the station area, because it would require the same types of communications equipment during construction, and there would be no exposure of people to a substantial EMF risk generated by radio transmissions between construction personnel. Therefore, construction of this HSR station option would not result in additional or different impacts at the station site.

CEQA Conclusion

The impact under CEQA from communications equipment during project construction would be less than significant because through compliance with 47 CFR Part 15, EMFs generated by radio transmissions during construction activity would not exceed the thresholds identified in Table 3.5-9, and would not cause EMI with nearby radio services or expose people to an EMF health risk. Therefore, CEQA does not require mitigation.

Impact EMF/EMI-3: Temporary Impacts from Operation of Electrical Equipment

Shared Passenger Track Alternative A

Many types of construction equipment contain generators or electric motors that generate EMFs. However, these sources of EMFs would not generate substantial EMI beyond the construction footprint and do not present a health risk to workers or the general public (refer to Impact EMF/EMI-1 stating that substantial EMF fluctuations caused by heavy construction vehicle movements would be limited to within 50 feet of the construction footprint, and radio communications systems would comply with FCC regulations designed to prevent EMI). Most other construction equipment used would be smaller than the heavy construction vehicles and therefore are expected to be well below 1 mG at 50 feet (refer to discussion in Impact EMF/EMI-1 regarding the magnetic field shifts by large equipment and how it decreases with size and with greater distance) in most cases. However, electric welding equipment represents the one instance where substantial magnetic fields could be generated. Welders with implanted medical devices and using high welding currents (greater than 225 amperes) should work with caution (Fetter et al. 1996). EMF strengths from large electric welding machines could be in the range of 1 to 5 mG at 50 feet, so intermittent interference with magnetically sensitive equipment would be possible. However, other construction workers, including those with implanted medical devices, would not be at risk operating other types of construction equipment.

Magnetic field strengths from large electric welders could cause transient interference with magnetically sensitive equipment is possible. In such instances, **EMF/EMI-IAMF#2**, which requires implementation of design practices to avoid EMI, adherence to the Authority's ISEP, and compliance with applicable federal and state laws, will minimize impacts. As part of the ISEP, the Authority will monitor field conditions to determine if such EMC issues arise and provide the necessary coordination with affected third parties and the Authority-designated construction contractor to resolve the interference.

The potential impact applies to Site 13 (Nutrilite Health Institute) in Buena Park, because EMFs would exceed thresholds identified in Table 3.5-9. It is unlikely that the conditions described would occur during construction, and **EMF/EMI-IAMF#2** will minimize impacts. This is particularly true, given the temporary nature of the disruption. Given the uncertainty regarding the type and age of the sensitive equipment used at the receptor site, any remaining equipment-specific impacts will be addressed through **EMF/EMI-MM#1**, in which the Authority will contact the affected third parties and explore the possibility of either relocating or shielding the affected equipment.

In summary, operation of electric equipment during project construction would not:

- Be a substantial source of EMI that could expose a person to a documented health risk
- Interfere with implanted medical devices

With incorporation of **EMF/EMI-IAMF#2**, the project is not anticipated to interfere with sensitive equipment; however, when necessary for equipment-specific impacts, implementation of **EMF/EMI-MM#1** will reduce or minimize impacts on sensitive equipment.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A regarding temporary impacts from operation of electrical equipment, because it would require the same types of electrical equipment during construction, and the sensitive receptors within the RSA would be the same. **EMF/EMI-IAMF#2** will ensure that temporary impacts regarding operation of electrical equipment are minimized. Implementation of **EMF/EMI-MM#1** will reduce or minimize any equipment-specific impacts.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives, because it would require the same types of electrical equipment during construction, and the sensitive receptors within the RSA would be the same. None of the sensitive receptors in Table 3.5-12 are within 500 feet of this HSR station option. Therefore, construction of this HSR station option would not result in additional or different impacts at the station area. **EMF/EMI-IAMF#2** will ensure that temporary impacts regarding operation of electrical equipment are minimized.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because it would require the same types of electrical equipment during construction, and the sensitive receptors within the RSA would be the same. None of the sensitive receptors in Table 3.5-12 are within 500 feet of this HSR station option. Therefore, construction of this HSR station option would not result in additional or different impacts at the station area. **EMF/EMI-IAMF#2** will ensure that temporary impacts regarding operation of electrical equipment are minimized.

CEQA Conclusion

The impact under CEQA from operation of electrical equipment during construction of the Shared Passenger Track Alternatives would be potentially significant before mitigation at one receptor location Site 13 (Nutrilite Health Institute) because EMFs would exceed thresholds identified in Table 3.5-9. **EMF/EMI-IAMF#2** will generally reduce temporary impacts from the operation of electrical equipment during construction in accordance with the ISEP and design practices to avoid EMI, and through compliance with applicable federal and state laws; however, the impact would still be significant given the uncertainty regarding the type and age of sensitive equipment housed within the receptor site. Therefore, the Authority would implement **EMF/EMI-MM#1**, which requires contacting affected third parties to explore the possibility of either relocating or shielding the affected equipment to eliminate interference. EMF exposure of the general public, including those with implanted medical devices, will not exceed the threshold for human exposure listed in Section 3.5.2. With implementation of **EMF/EMI-MM#1**, temporary equipment-specific impacts from the operation of electrical equipment during construction would be reduced to less-than-significant levels because actions such as relocating or shielding affected equipment would eliminate the potential for interference.

Operational Impacts

Impact EMF/EMI-4: Permanent Human Exposure to Electromagnetic Fields

Shared Passenger Track Alternative A

Human exposure to EMFs during operations of Shared Passenger Track Alternative A would be permanent but intermittent. Operation of Shared Passenger Track Alternative A would generate 60-Hz EMFs on and adjacent to trains, including in passenger station areas. Table 3.5-13 presents predicted HSR exterior EMF levels that passengers and other members of the public could be exposed to at a station platform, at the fence line, and 500 feet from the project centerline. In all cases, the predicted EMF value would be less than the thresholds of MPE limits of 5 kV/m for electric fields and 9,040 mG for magnetic fields for public exposure identified for this project section.

Table 3.5-13 Summary of Predicted High-Speed Rail Exterior EMF Levels

EMF Analysis	Platform: 16 Feet from HSR Alignment Centerline	Fence Line: 30 Feet from HSR Alignment Centerline	RSA: 500 Feet from HSR Alignment Centerline
Magnetic field (mG) single-train HSR	720	177	Less than 1
Electric field (V/m), typical 2-track OCS geometry	810	110	Less than 1

Source: Authority 2011
EMF = electromagnetic field; HSR = high-speed rail; mG = milligauss; OCS = overhead contact system; RSA = resource study area; V/m = volts per meter

Electric power for the HSR traction power system would be supplied through connections to the existing electric power grid. Connections to utility substations would be performed by the electric utility, the Los Angeles Department of Water and Power, including required upgrades such as reconductoring existing feeders or installing new overhead lines.

In performing these upgrades, the utility is subject to the same CPUC and California Department of Education rules regarding EMF, and impacts from upgraded, relocated, or new overhead power lines would remain well within the MPE limits presented in Section 3.5.2.

Passengers on HSR trains would also be exposed to EMFs. Magnetic field measurements have been made in the passenger compartments onboard other HSR systems such as the Acela Express (119 mG) and the French *Train à Grande Vitesse* A (165 mG), as well as in the operator's cab of the Acela Express (58 mG) and French *Train à Grande Vitesse* A (367 mG) (FRA 2006). The IEEE has a standard 95.6 MPE limit of 9,040 mG for the public. Therefore, exposure to operational EMFs for people at nearby schools, hospitals, businesses, colleges, and residences would be substantially below the IEEE standard because measurements of existing systems indicate that, even within the right-of-way, these levels would not be reached.

The HSR design procedures and IAMFs will substantially limit and control EMFs. Human exposure to operational EMFs generated either by the trains, the OCS, or wayside equipment or HSR maintenance activities would fall well below the MPE limit. Passengers, HSR workers, and the public would not be exposed to an EMF health risk.

There would be no exposure of a person to documented EMF levels to which passengers or members of the public would be exposed in exceedance of thresholds of MPE limits of 5 kV/m and 9,040 mG for the public identified for this project section.

The locations of the traction power and paralleling stations in the project section are provided in Table 3.5-14.

Table 3.5-14 Traction Power, Paralleling, and Switching Station Locations within the Resource Study Area

Station Type	Location
Traction power substation	South of Washington Blvd and west of Soto St in Los Angeles, adjacent to the existing railroad viaduct in the city of Los Angeles
Paralleling station	Southwest corner of Maple Ave and Sycamore St, south of the HSR tracks, in the city of Montebello
Switching station	Northeast corner of Los Nietos Rd and Santa Fe Springs Rd, north of HSR tracks in the city of Santa Fe Springs
Paralleling station	Northwest corner of Dale St and Artesia Ave, south of the HSR tracks, in the city of Fullerton
Traction power substation	On the corner of Lewis St and Cerritos Ave, southwest of the HSR tracks, in the city of Anaheim

HSR = high-speed rail

The TPSS along Washington Boulevard in Los Angeles would be in a dense industrial area. Access to the site is provided via Washington Boulevard and power is supplied from an overhead grid layout with power poles on each side of Washington Boulevard. The poles also carry communication lines. The nearest existing power source is Los Angeles Department of Water and Power Receiving Station No. 5, on the corner of De La Torre Way and East 15th Street, approximately 1.2 miles from the TPSS. Power to the TPSS from the receiving substation would be supplied via two 115-kV circuits to be built on the south side of Washington Boulevard after crossing the existing Union Pacific Railroad (UPRR) tracks. The steel tubular poles would be approximately 75 to 80 feet in height (65 feet above grade) and spaced at a maximum interval of 200 feet along Washington Boulevard. Each pole would be placed within a 10- by 40-foot area to allow for flexibility. Approximately 35 poles would be required to connect the TPSS to the power source on De La Torre Way and 15th Street. Existing poles and utility lines may be left in place or transferred to the new pole lines.

The proposed TPSS site in Anaheim, near the intersection of Lewis Street and Cerritos Avenue, is in an area composed of office complexes and mixed commercial/light manufacturing facilities. Access to this TPSS would be provided via Cerritos Avenue. Anaheim Public Utilities owns and operates a power substation on an approximately 16-acre site on the southwest corner of Lewis Street and Cerritos Avenue. It is assumed that this substation would be the source of power for the HSR TPSS approximately 0.2 mile northeast of the substation, on the opposite corner of Lewis Street and Cerritos Avenue. Because the general area has underground power distribution along Cerritos Avenue, it is assumed that the two 115-kV circuits would be routed to the TPSS site underground. Additionally, because Cerritos Avenue would be grade separated as part of the HSR project, two 30-inch power conduits would be installed during construction of the grade separation. Beginning at the existing substation, the 30-inch conduits would be installed in Lewis Street and run north for approximately 750 feet to Cerritos Avenue. Junction/bending structures would be required to complete the installation of conduit and conductors.

In addition to traction power, switching, and paralleling stations, emergency standby generators produce EMFs and would be in the locations provided in Table 3.5-14, specifically in the cities of Los Angeles, Montebello, Santa Fe Springs, Fullerton, and Anaheim. The standby generators would be in secure work areas and inaccessible to the general public. Because the traction power distribution and interconnection facilities, including standby generators, are only accessible to authorized personnel, they would not present a health risk to HSR passengers or members of the public with implanted medical devices. Additionally, there would be no change in baseline conditions when reconductoring power lines because the voltage would remain the same.

There would be no exposure of a person to documented EMF levels in exceedance of thresholds of MPE limits of 5 kV/m and 9,040 mG during project operation.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A related to permanent human exposure to EMFs, because the HSR trains and TPSS facility sites would all be the same. EMF exposure would be below the IEEE standard limit of 9,040 mG and would not exceed thresholds identified in Table 3.5-9. There would be no exposure of a person to documented EMF levels in exceedance of identified thresholds.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives within the station area related to permanent human exposure to EMFs, because the HSR trains and TPSS facility sites would all be the same. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. There would be no exposure of a person to documented EMF levels in exceedance of identified thresholds.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area related to permanent human exposure to EMFs, because the HSR trains and TPSS facility sites would all be the same. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. There would be no exposure of a person to documented EMF levels in exceedance of identified thresholds.

CEQA Conclusion

There is no impact under CEQA from permanent exposure of passengers, HSR workers, and the public to EMFs during project operation because EMF exposure would be below the IEEE standard limit of 9,040 mG and would not exceed thresholds identified in Table 3.5-9. Accordingly, there would be no exposure of a person to a documented EMF health risk. Therefore, CEQA does not require mitigation.

Impact EMF/EMI-5: People with Implanted Medical Devices and Exposure to Electromagnetic Fields

Shared Passenger Track Alternative A

Passengers and members of the public with implanted medical devices are especially sensitive to EMFs. Magnetic fields of 1,000 to 12,000 mG (1 to 12 G) may interfere with implanted medical devices (EPRI 2004). ACGIH recommends magnetic and electric field exposure limits of 1,000 mG and 1 kV/m, respectively, for people with pacemakers (ACGIH 2015). These levels would occur only inside traction power, switching, or paralleling stations, which are unmanned and inaccessible to the general public. The locations of the TPSS facilities in the project section are provided in Table 3.5-14.

In addition to traction power, switching, and paralleling stations, emergency standby generators produce EMFs and would be at the TPSS facilities and the passenger station areas of the Commerce Metrolink Station, Buena Park Metrolink Station, and passenger station area of Anaheim Regional Transportation Intermodal Center. The standby generators would be in secure work areas and inaccessible to the general public. Because the traction power distribution and interconnection facilities, including standby generators, are only accessible to authorized personnel, they would not present a health risk to HSR passengers or members of the public with implanted medical devices. Additionally, there would be minimal change in baseline conditions when reconductoring power lines because the voltage would remain the same.

Impacts from exposure to EMF at interconnection facilities will be avoided through incorporation of **EMF/EMI-IAMF#2**. **EMF/EMI-IAMF#2**, through the ISEP, requires implementation of a safety program that will preclude workers with implanted medical devices from entering facilities with electrical equipment that could endanger them. Signs will be posted to alert employees to avoid the potentially hazardous conditions. A provision in the ISEP (**EMF/EMI-IAMF#2**) is to post signs at the TPSSs, switching stations, and on tie-line structures warning persons with an implanted medical device of the presence of high levels of EMFs, avoiding the potential for interference and related health risks. For passengers and members of the public, the EMI and EMF exposure levels will be below the MPE and will not interfere with an implanted medical device. Additionally, passengers and members of the public will not have access to traction power distribution facilities, interconnection facilities, and emergency standby generator facilities, which can produce EMF levels that could interfere with implanted medical devices.

Although EMF levels in traction power distribution facilities, interconnection facilities, and emergency standby generator facilities could interfere with implanted medical devices, these facilities will be inaccessible to the public, and the provisions of the Authority's EMCPP will restrict workers with implanted medical devices from accessing traction power facilities and emergency power generators (**EMF/EMI-IAMF#2**). These measures will avoid or reduce the health risk for the public and workers with implanted medical devices.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A, because the TPSS facility and emergency standby generator sites would all be the same. Impacts from exposure to EMF at interconnection facilities will be avoided or reduced through incorporation of **EMF/EMI-IAMF#2**.

High-Speed Rail Station Options

<u>High-Speed Rail Station Option: Norwalk/Santa Fe Springs</u>

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives within the station area. There would be an additional emergency standby generator as part of the HSR station facilities, but it would be in a secure work area inaccessible to the general public. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. Impacts from exposure to EMF at interconnection facilities will be avoided or reduced through incorporation of **EMF/EMI-IAMF#2**.

<u>High-Speed Rail Station Option: Fullerton</u>

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area. There would be an additional emergency standby generator as part of the HSR station facilities, but it would be in a secure work area inaccessible to the general public. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. Impacts from exposure to EMF at interconnection facilities will be avoided or reduced through incorporation of **EMF/EMI-IAMF#2**.

CEQA Conclusion

The impact under CEQA on people with implanted medical devices from exposure to EMF during project operation would be less than significant because EMF would not exceed thresholds identified in Table 3.5-9 and passengers and members of the public would not have access to traction power distribution facilities, interconnection facilities, and emergency standby generator facilities. Accordingly, the public and workers with implanted medical devices would not be exposed to an EMF health risk. Therefore, CEQA does not require mitigation.

Impact EMF/EMI-6: Potential for Corrosion of Underground Pipelines, Cables, and Adjoining Rail

Shared Passenger Track Alternative A

Ground currents have the potential to result in corrosion. TPSSs would be at approximately 30-mile intervals along the HSR system and would deliver AC current to the HSR trains through the OCS; return current would flow from the trains back to the TPSS through the steel rails and static wire in the immediate vicinity of the train. At paralleling stations, which would be positioned approximately every 5 miles along the right-of-way, most of the return current to the TPSSs would be transferred from the rails to the negative feeder wire by the autotransformer action. Most return current would be carried by the negative feeder and the static wires back to the TPSS, but some return current would flow in the rails and could find a path to the ground through leakage from the rails via the track ballast or the insulated rail clips in nonballasted sections.

Soils in the RSA tend to be sandy and dry (except where irrigated), and have higher electrical resistivity and lower ability to carry electrical current than soils with more clay and moisture content (refer to Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources, for additional information regarding soil and geologic conditions within the RSA). Nevertheless, other linear metallic objects such as buried pipelines or cables, or adjoining rails that parallel the HSR corridor, could carry some AC ground current. AC ground currents have a much lower propensity to cause corrosion in parallel conductors than the DC currents used by rail transit lines such as Bay Area Rapid Transit or the Los Angeles County Metropolitan Transportation Authority (Barlo and Zdunek 1995; Hosokawa 2006; Brenna et al. 2014). However, stray AC currents might cause corrosion by galvanic action.

Because Shared Passenger Track Alternative A must comply with federal regulations, the Authority-designated contractor will follow the ISEP (Authority 2014a) to avoid and address possible impacts on underground pipelines and cables, including the grounding of pipelines (**EMF/EMI-IAMF#2**). If adjacent pipelines and other linear metallic structures are not sufficiently grounded through the direct contact with earth, additional grounding of pipelines and other linear metallic objects will be included, in coordination with the affected owner or utility, as part of construction (**EMF/EMI-IAMF#2**). Alternatively, insulating joints or couplings may be installed in continuous metallic pipes to prevent current flow. Specific measures for avoiding stray current corrosion are discussed in Chapter 23 of the *Design Criteria Manual* (Authority 2014b), and in detail in “Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems,” National Association of Corrosion Engineers SP0177 (National Association of Corrosion Engineers 2014). These preventive measures, incorporated during design and construction, are standardized practices in industry and have a record of effectively preventing corrosion. As a result, the risk of corrosion from ground currents resulting from project operation will be avoided.

Ground currents generated by project operation could result in corrosion of underground pipelines and cables. However, project features (**EMF/EMI-IAMF#2**) discussed above include the grounding of nearby ungrounded linear metal structures or insulating metallic pipes to prevent flow of leakage current, such that corrosion will be minor.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A, because the TPSS facilities and adjoining rails would be the same. Project features (**EMF/EMI-IAMF#2**) include the grounding of nearby ungrounded linear metal structures or insulating metallic pipes to prevent flow of leakage current, such that corrosion will be minor.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because the adjoining rails would be the same. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. Project features (**EMF/EMI-IAMF#2**) include the grounding of nearby ungrounded linear metal structures or insulating metallic pipes to prevent flow of leakage current, such that corrosion will be minor.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives, because the adjoining rails would be the same. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. Project features (**EMF/EMI-IAMF#2**) include the grounding of nearby ungrounded linear metal structures or insulating metallic pipes to prevent flow of leakage current, such that corrosion will be minor.

CEQA Conclusion

The impact under CEQA from corrosion of underground pipelines and cables due to ground currents generated by project operation would be less than significant because interference with sensitive equipment in the form of corrosion of underground pipelines and cables would be minor. **EMF/EMI-IAMF#2** requires grounding of nearby ungrounded linear metal structures or insulating metallic pipes to prevent current flow in accordance with measures called for in Chapter 23 of the *Design Criteria Manual* (Authority 2014b). Therefore, project features will avoid or minimize the potential for corrosion from ground currents, and CEQA does not require mitigation.

Impact EMF/EMI-7: Potential for Nuisance Shocks

Shared Passenger Track Alternative A

Nuisance shocks can occur when induced electrical currents build voltage in ungrounded linear metal structures that are capable of conducting electric current. EMFs from the voltage on and from currents running through the OCS could induce voltage and current in nearby conductors, such as ungrounded metal fences alongside the HSR alignment. This effect would be more likely where long ungrounded fences (1 mile or more) run parallel to the HSR, and are electrically continuous throughout that distance. Such voltages could cause a nuisance shock to anyone who may touch such a fence. Other adjacent metal structures are much shorter in length compared to long fences (e.g., lighting poles and communications towers), and they should already be properly grounded using National Electrical Code guidelines (Article 250) for building and electrical system safety and lightning protection.

To avoid shock hazards, the project design includes grounding and bonding of HSR metallic fences and of non-HSR parallel metal fences (with the cooperation of the affected owner or utility) within 45 feet of the HSR alignment (**EMF/EMI-IAMF#2**). In addition, insulating sections could be installed in fences to prevent the possibility of current flow. Ungrounded fences with a potential for nuisance shocks would be identified as part of the EMC coordination effort (Authority 2014a). Furthermore, modifications to utility facilities would be incorporated pursuant to CPUC General Order 95 (Rules for Overhead Electric Line Construction) and General Order 174 (Rules for Electric Utility Substations). Such measures will minimize the potential for nuisance shocks. For cases where such fences are purposely electrified, specific insulation design measures would be incorporated to address the possibility for nuisance shocks.

Electrical currents generated by project operation could result in nuisance shocks from ungrounded metal structures. The Authority will identify and ground nearby ungrounded linear metal structures to prevent possible risks (**EMF/EMI-IAMF#2**).

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A, because the fencing along the HSR alignment would be the same. Project design includes grounding and bonding of HSR metallic fences and of non-HSR parallel metal fences (with the cooperation of the affected owner or utility) within 45 feet of the HSR alignment (**EMF/EMI-IAMF#2**).

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, operational impacts would be the same as those described for the Shared Passenger Track Alternatives, because the fencing along the HSR alignment would be the same. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. Incorporation of **EMF/EMI-IAMF#2** will avoid exposure to EMF-related nuisance shock.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, operational impacts would be the same as those described for the Shared Passenger Track Alternatives within the station area, because the fencing along the HSR alignment would be the same. Therefore, operation of this HSR station option would not result in additional or different impacts at the station site. Incorporation of **EMF/EMI-IAMF#2** will avoid exposure to EMF-related nuisance shock.

CEQA Conclusion

There would be no impact under CEQA from exposure to EMF-related nuisance shock from operation of the project because **EMF/EMI-IAMF#2** requires grounding nearby ungrounded linear metal structures or insulating purposely electrified fences to prevent current flow, thereby avoiding nuisance shocks. Consequently, people would not be exposed to a documented EMF health risk. Therefore, CEQA does not require mitigation.

Impact EMF/EMI-8: Effects on Adjacent Existing Rail Lines

Shared Passenger Track Alternative A

As a result of the high currents used and contact EMI generated by the project OCS, permanent interference with the signal systems of adjacent railroads is possible. Signal systems control the movement of trains on the existing nonelectrified railroad tracks that would parallel the project alignment. These signal systems serve three general purposes:

- To warn drivers of street vehicles that a train is approaching. The rail signal system turns on flashing lights and warning bells; some crossings lower barricades to stop traffic.
- To warn train engineers of other train activity on the same track a short distance ahead and advise the engineer that the train should either slow or stop.
- To indicate to railroad dispatchers in a central control center where trains are located on the railway so train movements can be controlled centrally for safety and efficiency.

Railroad signal systems operate in several ways but are generally based on the principle that the railcar metal wheels and axles electrically connect the two running rails. An AC or DC voltage applied between the rails by a signal system will be shorted out (i.e., reduced to a low voltage) by the rail-to-rail connection of the metal wheel-axle sets of a train. This low-voltage condition is detected and interpreted by the signal system to indicate the presence of a train on that portion of track.

The HSR OCS would carry 60-Hz AC electric currents of up to 930 amperes per train. Interference between the HSR 60-Hz currents and nearby railroad signal systems used by nonelectrified passenger and freight services could occur under the following conditions:

- The high electrical currents flowing in the OCS and the return currents in the overhead negative feeder wire, HSR rails, and ground could induce 60-Hz voltages and currents in existing parallel railroad tracks. If an adjoining freight railroad track parallels the HSR tracks for a long enough distance (i.e., several miles), the induced voltage and current in the adjoining freight railroad tracks could interfere with the normal operation of the signal system so that it indicates there is no freight train present when in fact one is present (or so that it indicates the presence of a freight train when in fact none is there). These conditions exist through most of the HSR alignment through the project section.

- Higher-frequency EMI from several HSR sources (electrical noise from the contact on the pantograph sliding along the contact conductor, electrical equipment onboard the train, or the cab radio communication system) could cause electrical interaction with the adjoining freight railroad signal or communication systems.

Interference from HSR currents could result in a nuisance or reduction in operational efficiency by interrupting road and rail traffic. To preclude this possibility, the Authority will work with the engineering departments of freight railroads that would parallel the project alignment to apply the standard design practices that a nonelectric railroad must use when an electric railroad or electric power lines are installed next to its tracks (**EMF/EMI-IAMF#1**). These standard design practices include assessment of the specific track signal and communication equipment in use on nearby sections of existing rail lines, evaluation of possible impacts of HSR EMFs and RF interference on adjoining railroad equipment, and application of suitable design provisions on the adjoining rail lines to prevent interference. These standard design and operational practices prevent the possible effects that HSR operation might otherwise cause: disruption of the safe and dependable operation of the adjacent railroad signal system, resulting in train delays or hazards, or disruption of the road crossing signals, stopping road traffic from crossing the tracks when no train is there (EPRI 2006).

The Authority will follow the American Railway Engineering and Maintenance-of-Way Association, IEEE, and standards used by operators of other 25-kV, 60-Hz electrification systems. The Authority will replace track circuits as required for compatibility with the new 25-kV, 60-Hz electrification system.

The signal equipment to be implemented for the HSR project is equipment that is currently operating in similar corridors, such as the Northeast Corridor, where there are both high-speed passenger trains and slower-speed freight trains operating over the same segment of tracks. There would also be several areas in the shared corridor where nonelectrified freight tracks merge onto electrified tracks. The Authority will employ engineering standards and equipment already in place and tested to FRA standards in the same environment as the Northeast Corridor.

Shared Passenger Track Alternative A will also employ bonding and grounding standards used on other existing 25-kV, 60-Hz systems, including in the Northeast Corridor. These methods have been proven for many years and have been inspected under the authority of the FRA. Proper grounding and cross-bonding of adjacent tracks will be designed and built so return currents are properly managed.

Design provisions often include replacement of specific track circuit types on the adjoining rail lines with other types developed for operation on or near electric railways or adjacent to parallel utility power lines, providing filters for sensitive communication equipment, and potentially relocating or reorienting radio antennas. These design provisions will be put in place and determined to be adequately effective prior to the activation of potentially interfering systems of the HSR system.

Operation of Shared Passenger Track Alternative A would generate electrical currents that could result in minor interference with adjacent existing rail lines. Effects would be avoided because **EMF/EMI-IAMF#1** requires working with the engineering departments of adjacent parallel railroads to modify or upgrade their signal systems as needed to avoid interference from HSR operations. **EMF/EMI-IAMF#1** will avoid EMI effects on the signal and communication system when an electric railroad or electric power lines are installed adjacent to their respective tracks. The IAMF will prevent disruptions to the adjacent railroad signal system, which otherwise could result in train delays or hazards, or disruption of the road crossing signals, stopping road traffic from crossing the tracks when no train is there (EPRI 2006). Therefore, with **EMF/EMI-IAMF#1**, Shared Passenger Track Alternative A would not interfere with sensitive equipment and the signal systems of adjacent railroads would not be substantially affected.

The engineering approach in **EMF/EMI-IAMF#1** takes advantage of decades of experience in successfully addressing these interference problems. In these decades of experience, the FRA and system operators have developed solutions for blended corridor situations similar to the project. For example, Amtrak's Northeast Corridor has successfully operated blended operations using an identical 2 x 25 kV HSR electrification system that has been operating since 2000 without affecting freight and diesel passenger operations sharing the corridor.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A, because it would be adjacent to the same existing rail lines and the location of the LMF would not result in different impacts. **EMF/EMI-IAMF#1** will avoid EMI effects on the signal and communication system when an electric railroad or electric power lines are installed adjacent to their respective tracks.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, operational impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because the station would be adjacent to the same existing rail lines. **EMF/EMI-IAMF#1** will avoid EMI effects on the signal and communication system when an electric railroad or electric power lines are installed adjacent to their respective tracks.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, operational impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because the station would be adjacent to the same existing rail lines. **EMF/EMI-IAMF#1** will avoid EMI effects on the signal and communication system when an electric railroad or electric power lines are installed adjacent to their respective tracks.

CEQA Conclusion

There would be no impact under CEQA from interference with adjacent railroad equipment from operation of the Shared Passenger Track Alternatives because interference would be avoided by application of standard design practices that a nonelectric railroad must use when an electric railroad or electric power lines are installed next to its tracks and **EMF/EMI-IAMF#1**, which requires coordination with adjacent railroads before commencing project operation to prevent EMI/EMF interference. Accordingly, EMF would not exceed thresholds identified in Table 3.5-9. Therefore, CEQA does not require mitigation.

Impact EMF/EMI-9: Permanent Interference with Sensitive Equipment

Shared Passenger Track Alternative A

Medical and high-tech facilities commonly contain equipment that could be affected by EMI, including equipment sensitive to small variations in the surrounding magnetic field (e.g., medical MRI scanners, NMR spectrometers) and focused-beam devices (e.g., electron microscopes, ion-writing systems). Other forms of equipment sensitive to EMI include fire and police radio services, which could be affected by RF interference.

One facility was identified in the project section that is believed to be currently operating magnetically sensitive equipment, as presented in Table 3.5-12: Site 13 (Nutrilite Health Institute) is identified as a possible operator of NMR spectrometers. There are also two fire stations and one airport that includes police and fire services within the RSA (Sites 2, 14, and 18 in Table 3.5-12), all of which operate police and fire radio services.

The potential for interference with sensitive equipment in use at high-tech facilities will be addressed through the Authority's EMCPP and the design criteria of the project. The EMCPP defines the HSR system's High-Speed Transport Protocol EMC objective (refer to Section 3.5.2.2), which provides for compatibility with equipment of neighboring facilities. In conformance with the EMCPP and ISEP (Technical Memorandum 300.10), the Authority will coordinate with third-party owners of sensitive facilities and equipment in the vicinity of the HSR system and, if necessary, take specific steps (e.g., controlling EMI/EMF through preparation of a technical memorandum, performing EMC/EMI safety analyses, implementing HSR standard corrosion protection measures) to avoid or reduce potential interference (**EMF/EMI-IAMF#2**).

Chapters 22 and 26 of the *California High-Speed Train Design Criteria* manual describe the EMI-related measures that could be used to address impacts on sensitive equipment, such as equipment siting and grounding of equipment (Authority 2014b). As part of the ISEP, the Authority will coordinate with third parties to identify nearby sensitive equipment (including the one high-tech facility identified in the RSA for the project section as noted in Table 3.5-12) with the potential to be affected by the HSR system. If equipment-specific impacts are identified, appropriate mitigation to avoid these effects would be implemented, including performing tests to confirm equipment is free from impacts (**EMF/EMI-MM#1**). The Authority will also conduct tests prior to operation of the HSR system to confirm equipment is not affected. These project features will address the potential for interference with sensitive equipment at high-tech facilities.

EMFs generated during project operation could also interfere with police and fire radio services. However, interference with police and fire radio services will be avoided because the project will use dedicated frequency blocks and procurement of communications equipment meeting FCC regulations. Table 3.5-12

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A, because the 15th Street LMF does not affect different sensitive receptors. The potential for interference with high-tech equipment will be addressed through **EMF/EMI-IAMF#2**, which is intended to prevent EMI with identified neighboring uses. As part of the ISEP, the Authority will coordinate with third parties to identify nearby sensitive equipment with the potential to be affected by the HSR system. If equipment-specific impacts are identified, appropriate mitigation to avoid these effects would be implemented, including performing tests to confirm equipment is free from impacts (**EMF/EMI-MM#1**).

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, operational impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area, because the station option does not affect different sensitive receptors. None of the sensitive receptors identified as potentially having sensitive equipment are within 500 feet of this HSR station option. Therefore, operation of this HSR station option would not result in additional or different impacts at the station area. The potential for interference with high-tech equipment will be addressed through **EMF/EMI-IAMF#2**.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, operational impacts would be the same as those described for the Shared Passenger Track Alternatives, because the station option does not affect different sensitive receptors. None of the sensitive receptors identified as potentially having sensitive equipment are within 500 feet of this HSR station option. Therefore, operation of this HSR station option would not result in additional or different impacts at the station area. The potential for interference with high-tech equipment will be addressed through **EMF/EMI-IAMF#2**.

CEQA Conclusion

The potential for interference with high-tech equipment will be generally addressed through **EMF/EMI-IAMF#2**, which is intended to prevent EMI with identified neighboring uses. Even with **EMF/EMI-IAMF#2**, the impact under CEQA related to interference with sensitive equipment used at high-tech facilities during project operation would be potentially significant at one facility identified in the RSA for the section: Site 13 Nutrilite Health Institute (Buena Park). Interference with police and fire radio services would be avoided, and less than significant, because the project will use dedicated frequency blocks and procurement of communications equipment meeting FCC regulations. The Authority will coordinate with the owners of the nearby sensitive equipment at Nutrilite Health Institute and identify appropriate shielding mitigation to avoid these effects, including performing tests to confirm equipment is free from impacts (**EMF/EMI-MM#1**). With implementation of **EMF/EMI-MM#1**, which requires relocating or shielding affected equipment, impacts related to interference with sensitive equipment would be reduced to less-than-significant levels.

Impact EMF/EMI-10: Electromagnetic Interference Effects on Schools

Shared Passenger Track Alternative A

Shared Passenger Track Alternative A would use radio systems for the enhanced automatic train control, data transfer, and communications systems, raising the concern that HSR operations would result in EMI with the radio systems at nearby schools, colleges, and daycares.

HSR radio systems would transmit radio signals from antennas at stations and along the track alignment, as well as on locomotives and train cars. As described in Impact EMF/EMI-4 above, the Authority plans to acquire two dedicated frequency blocks for the enhanced automatic train control systems, so EMI with other users would not be expected. Communications systems at stations may operate at wireless fidelity frequencies to connect to stationary trains; channels would be selected to avoid EMI with other users, including wireless fidelity systems in use at nearby schools (Authority 2011, 2014a). Therefore, radio systems used during project operation would not interfere with communication systems at nearby schools.

The Authority will implement an EMCPP during project planning and implementation to ensure EMC with radio systems operated by neighboring uses, including schools, colleges, and daycares. In conformance with the EMCPP and ISEP (Technical Memorandum 300.10), during the planning stage through system design, the Authority will perform EMC/EMI safety analyses, which will include identification of existing nearby radio systems, design of systems to prevent EMI with identified neighboring uses, and incorporation of these design requirements into bid specifications used to procure radio systems (**EMF/EMI-IAMF#2**). During operations, the Authority will conduct monitoring and evaluation of system performance. This will address the possibility of HSR-generated EMFs to affect school communication systems. Moreover, most radio systems procured for HSR use are expected to be commercial off-the-shelf systems conforming to FCC regulations in 47 CFR Part 15, which contain emissions requirements designed to ensure EMC among users and systems. The Authority will require noncommercial off-the-shelf systems procured for HSR use to be certified in conformity with FCC regulations for Part 15, Sub-Part B, Class A devices. HSR radio systems will also meet emissions and immunity requirements designed to ensure EMC with other radio users that are contained in the European Committee for Electrotechnical Standardization EN 50121-4 Standard for railway signaling and telecommunications operations (CENELEC 2006).

Radio systems used during project operation could interfere with communication systems at nearby schools. The Authority has acquired dedicated, exclusive-use frequency blocks for the HSR system and HSR equipment will meet FCC regulations (47 CFR Part 15), which will prevent the potential for interference. In addition, during the planning stage, the Authority will identify users of existing nearby radio systems and design the HSR systems to prevent EMI with identified neighboring uses (**EMF/EMI-IAMF#2**). These project features will address the potential effects of interference with school communication systems.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B related to EMI effects on schools would be the same as those described for Shared Passenger Track Alternative A. Although Shared Passenger Track Alternative B would have a larger footprint for the 15th Street LMF, there are no additional schools within 500 feet of the 15th Street LMF footprint. The potential for interference with communication systems will be addressed through **EMF/EMI-IAMF#2**, intended to prevent EMI with identified neighboring uses.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, operational impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area. Although the Norwalk/Santa Fe Springs HSR Station Option would include a slightly larger area during operations compared to the Shared Passenger Track Alternatives, there are no additional schools within 500 feet of the HSR station option footprint. **EMF/EMI-IAMF#2** avoids EMI effects on schools.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, operational impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area. Although the Fullerton HSR Station Option would include a slightly larger area during operations compared to the Shared Passenger Track Alternatives, there are no additional schools within 500 feet of the HSR station option footprint. **EMF/EMI-IAMF#2** avoids EMI effects on schools.

CEQA Conclusion

There would be no impact under CEQA related to interference with school communication systems during project operation. Interference with communication systems at nearby schools would be avoided because the project would use dedicated frequency blocks and procurement of communications equipment meeting FCC regulations. The potential for any interference with school communication systems will be addressed through **EMF/EMI-IAMF#2**, intended to prevent EMI with identified neighboring uses. Therefore, CEQA does not require mitigation.

Impact EMF/EMI-11: Effects Related to Adjacent Airports

Shared Passenger Track Alternative A

Airports operate radio and other electronic systems that are potentially susceptible to EMI from other radio systems. Shared Passenger Track Alternative A would pass Fullerton Municipal Airport, a regional airport in Orange County. The airport handles about 65,000 operations per year and is a base for local fire and police helicopter fleets. The airport is being included in this analysis as a sensitive receptor given the safety-critical nature of the airport's radio-based systems and uncertainties about the locations of much of the airport equipment. The Metropolitan Water District Heliport, a single-craft heliport, in Los Angeles, is north of the project footprint.

Airports and commercial aircraft are electronically complex. Avigation systems such as marker beacons, distance-measuring equipment, traffic-alert and collision-avoidance systems, microwave-landing systems, and global positioning systems, among many others, operate across a wide range of radio frequencies. As such, EMI is an ongoing concern for aircraft electronic systems. Historically, EMI from high-powered sources such as radars and broadcast transmitters resulted in numerous aviation incidents and accidents (NASA 1994) and, as a result, such sources are now carefully considered in all aspects of design and certification of modern avionics. Furthermore, the radio spectrum for aeronautical services has been coordinated with and protected by federal law (FCC 2010b) in order to minimize the potential of EMI from other radio services. With one minor exception, all communications, instrument landing systems, and navigation services for U.S. aircraft operate in frequency bands exclusively reserved for those purposes. In complying with existing FCC requirements, HSR-related radio services would by definition avoid these frequency bands. This mutually exclusive arrangement serves to protect HSR communications systems from EMI from airport and aircraft emissions, as well.

In addition to avoiding frequency bands used by airport communication systems (the Authority has acquired two frequency blocks dedicated to the HSR system that are well-removed from bands used by aeronautical services), the Authority requires communications equipment procured for HSR use, including commercial and noncommercial off-the-shelf products, to comply with FCC regulations designed to prevent EMI with other equipment. The Authority will comply with an EMCPP during project planning and implementation to ensure compatibility with radio systems operated by Fullerton Municipal Airport (**EMF/EMI-IAMF#2**). During the planning stage through system design, the Authority will perform EMC/EMI safety analyses, which will include:

- Coordination with the Federal Aviation Administration spectrum engineering office and airport staff, as necessary
- Identification of existing airport radio systems
- Selection of systems to prevent EMI with identified airport uses, and incorporation of these requirements into bid specifications used to procure radio systems

The ISEP will include monitoring and evaluation of system performance for compatibility with airport systems.

HSR radio system will use dedicated frequency blocks and will meet FCC regulations (47 CFR Part 15) for EMI, and HSR equipment will be selected in consultation with Federal Aviation Administration RF interference specialists. In addition, during the planning and implementation stage, the Authority will design the HSR systems to prevent EMI with identified neighboring uses and monitor system performance to ensure ongoing compatibility (**EMF/EMI-IAMF#2**). These project features will avoid the potential for the project to interfere with airport systems.

Shared Passenger Track Alternative B

Impacts for Shared Passenger Track Alternative B would be the same as those described for Shared Passenger Track Alternative A. Although Shared Passenger Track Alternative B would have a larger footprint for the 15th Street LMF, there are no additional airports near the 15th Street LMF. Regardless of the LMF location, both Shared Passenger Track Alternatives A and B would pass by the Fullerton Airport in the same location. Incorporation of **EMF/EMI-IAMF#2** avoids effects related to adjacent airports.

High-Speed Rail Station Options

High-Speed Rail Station Option: Norwalk/Santa Fe Springs

With inclusion of the Norwalk/Santa Fe Springs HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area. Although the Norwalk/Santa Fe Springs HSR Station Option would include a slightly larger area during operations compared to the Shared Passenger Track Alternatives, there are no additional airports near the HSR station option. Operation of the HSR station option would not affect the Fullerton Municipal Airport. Incorporation of **EMF/EMI-IAMF#2** avoids effects related to adjacent airports.

High-Speed Rail Station Option: Fullerton

With inclusion of the Fullerton HSR Station Option, impacts would be the same as those described for the Shared Passenger Track Alternatives in the station area. Although the Fullerton HSR Station Option would include a slightly larger area during operations compared to the Shared Passenger Track Alternatives, there are no additional airports near the HSR station option. Operation of the HSR station option would not affect the Fullerton Municipal Airport. Incorporation of **EMF/EMI-IAMF#2** avoids effects related to adjacent airports.

CEQA Conclusion

There would be no impact under CEQA on adjacent airport sensitive equipment or operations from EMI from project operation because radio systems used during operations will use dedicated frequency blocks and will meet FCC regulations. Therefore, CEQA does not require mitigation.

3.5.7 Mitigation Measures

The Authority has identified the following EMF and EMI mitigation measures for impacts under NEPA and significant impacts under CEQA that cannot adequately be avoided or minimized by IAMFs.

3.5.7.1 EMF/EMI-MM#1: Protect Sensitive Equipment

The Authority will contact relevant entities regarding the potential impacts of both HSR-related EMF, RF, and low-frequency EMI on sensitive equipment or instrumentation prior to completion of final design. Where necessary to avoid interference, the final design will include suitable design provisions to prevent interference, in accordance with relevant standards and equipment-specific criteria. These design provisions may include establishing magnetic field shielding walls around sensitive equipment or installing RF filters into sensitive equipment.

HSR-related EMI may affect highly susceptible, unshielded sensitive RF equipment such as older MRI systems and other measuring devices common to medical and research laboratories. Most of the devices manufactured today have adequate shielding from potential EMI sources; however, the potential exists for older devices to be affected and require shielding.

A shielded enclosure is very effective at preventing external EMI. Metallic materials are used for shielding (specifically high-conductivity metals for high-frequency interference, such as from HSR operation), and high-permeability metals are used for low-frequency interference. Often either the housing of the affected device is coated with a conductive layer or the housing itself is made conductive. In some situations, it may be necessary to substantially reduce EMI for a suite of devices by creating a shielded room or rooms.

Attenuation, or the effectiveness of EMI shielding, is the difference between an EM signal's intensity before and after shielding. Attenuation is the ratio between field strength with and without the presence of a protective medium measured in decibels. This decibel range changes on a logarithmic scale, so an attenuation rating of 50 decibels indicates a shielding strength 10 times that of 40 decibels.

In general, a shielding range between 60 and 90 decibels may be considered a high level of protection, and 90 to 120 decibels is exceptional.

3.5.7.2 Impact of Mitigation

There would be no secondary impacts from implementation of mitigation measure **EMF/EMI-MM#1**, because the shielding would not affect any natural resources, would not represent a substantial change to the visual environment, and would not change land use, population growth characteristics, or other features of the human environment.

3.5.7.3 Early Action Projects

None of the early action projects that are a part of the Shared Passenger Track Alternatives would result in significant impacts. The two sensitive receivers are far enough from the early action projects (one is over 700 feet and one is 1,000 feet away) that equipment-specific impacts would not occur.

3.5.8 NEPA Impacts Summary

This section summarizes the impacts of the Shared Passenger Track Alternatives and compares them to the anticipated impacts of the No Project Alternative.

3.5.8.1 No Project Alternative

In general, the region is highly urbanized. The areas surrounding the project section are largely built out and can add population and businesses only through limited infill and more intensive development. However, it is reasonable to assume that the use of electricity and RF communication equipment, including high-voltage transmission/power lines and directional and nondirectional (cellular and broadcast) antennas that result in EMFs and EMI, would continue under the No Project Alternative and would likely increase along the length of the project section. The development of new schools, hospitals, police stations, and other facilities with sensitive equipment would increase the prevalence of receptors potentially sensitive to EMI. These uses would not generate harmful levels of EMF/EMI, given their size, scale, and type of development.

3.5.8.2 Shared Passenger Track Alternatives

Construction of the Shared Passenger Track Alternatives would result in the following impacts:

- **Impact EMF/EMI-1:** Even with **EMF/EMI-IAMF#2**, impacts related to interference with sensitive equipment during project construction could occur at one facility identified in the RSA—Site 13, Nutrilite Health Institute (Buena Park)—because of uncertainty regarding both the type and age of sensitive equipment used at the receptor site. With implementation of **EMF/EMI-MM#1**, which requires relocating or shielding affected equipment, impacts related to interference with sensitive equipment would be reduced.

Operation of the Shared Passenger Track Alternatives could result in impacts, which include:

- **Impact EMF/EMI-4:** Human exposure to EMFs would be below the IEEE standard limit of 9,040 mG and would not exceed thresholds identified in Table 3.5-9.
- **Impact EMF/EMI-5:** Interference with implanted medical devices from EMF levels at TPSSs and standby generator rooms

- **Impact EMF/EMI-6:** Corrosion of underground metal structures from ground currents generated by HSR operation
- **Impact EMF/EMI-7:** Nuisance shocks from underground metal as a result of electrical currents generated by operation of the Shared Passenger Track Alternatives
- **Impact EMF/EMI-8:** Minor interference with adjacent railroads from the electrical current generated by the HSR system
- **Impact EMF/EMI-9:** Interference with sensitive equipment at one receptor location within the RSA
- **Impact EMF/EMI-10:** EMI effects at six schools and one daycare for the Shared Passenger Track Alternatives
- **Impact EMF/EMI-11:** Radio interference with airport communications and navigation systems from the HSR control and communications equipment

With incorporation of project IAMFs (**EMF/EMI-IAMF#1** and **EMF/EMI-IAMF#2**) and implementation of the identified mitigation measure (**EMF/EMI-MM#1**), effects from EMFs as a result of operation of the Shared Passenger Track Alternatives will be minimized.

Table 3.5-15 presents a comparison of the potential impacts of the project alternatives followed by a summary of the impacts.

Table 3.5-15 Comparison of Project Alternative Impacts for EMF/EMI

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	With Inclusion of HSR Station Option: Fullerton	NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative A	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative B	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Fullerton
Impact EMF/EMI-1: Temporary Impacts from Use of Heavy Construction Equipment	Substantial EMF fluctuations caused by construction vehicle movements would be limited to within 50 feet of the construction footprint, and radio communications systems would comply with FCC regulations designed to prevent EMI. EMF fluctuations caused by construction vehicle movements would be limited to within 50 feet of the construction easement. However, no receptors sensitive to this type of interference were identified and, with incorporation of project features and, when necessary for specific sensitive equipment, implementation of mitigation, for those identified sensitive receptors included in Table 3.5-12, effects will be addressed. The potential for impacts on sensitive equipment applies at receptor Site 13 (Nutrilite Health Institute) in Buena Park.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Adverse effect (all alternatives and HSR station options)	EMF/EMI-MM#1	No adverse effect	No adverse effect	No adverse effect	No adverse effect
Impact EMF/EMI-2: Temporary Impacts from Communications Equipment	There would be no exposure of people to a substantial EMF risk generated by radio transmissions between construction personnel because the project would adhere to 47 CFR Part 15 and compliance means that interference with other radio-based service would be avoided.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact EMF/EMI-3: Temporary Impacts from Operation of Electrical Equipment	Potential, although unlikely, for a temporary impact applies at receptor location 13 (Nutrilite Health Institute) in Buena Park. Project features that require compliance with international guidelines and federal and state regulations would address potential impacts. Any remaining impacts on specific sensitive equipment would be addressed through mitigation established by this Draft EIR/EIS.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Adverse effect (all alternatives and HSR station options)	EMF/EMI-MM#1	No adverse effect	No adverse effect	No adverse effect	No adverse effect
Impact EMF/EMI-4: Permanent Human Exposure to Electromagnetic Fields	There would be no exposure of a person to documented EMF levels to which passengers or members of the public would be exposed in exceedance of thresholds of MPE limits of 5 kV/m and 9,040 mG for the public.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	With Inclusion of HSR Station Option: Fullerton	NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative A	NEPA Conclusion Post Mitigation: Shared Passenger Track Alternative B	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Norwalk/Santa Fe Springs	NEPA Conclusion Post Mitigation: With Inclusion of HSR Station Option: Fullerton
Impact EMF/EMI-5: People with Implanted Medical Devices and Exposure to Electromagnetic Fields	Impacts from exposure to EMF in interconnection facilities will be avoided through compliance with international guidelines and federal and state regulations. These facilities that could interfere with implanted medical devices will be inaccessible to the public, and the provisions of the Authority's EMCPP will restrict workers with implanted medical devices from accessing traction power facilities and emergency power generators.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact EMF/EMI-6: Potential for Corrosion of Underground Pipelines, Cables, and Adjoining Rail	Ground currents generated by project operation could result in corrosion of underground pipelines and cables. However, project features that require compliance with international guidelines and federal and state regulations would include the grounding of nearby ungrounded linear metal structures or insulating metallic pipes to prevent flow of leakage current, such that corrosion will be minor.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact EMF/EMI-7: Potential for Nuisance Shocks	Electrical currents generated by project operation could result in nuisance shocks from ungrounded metal structures. However, through compliance with international guidelines and federal and state regulations, the Authority will identify and ground nearby ungrounded linear metal structures to prevent possible risks.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact EMF/EMI-8: Effects on Adjacent Existing Rail Lines	Operation would generate electrical currents that could result in minor interference with adjacent existing rail lines. However, interference would be avoided by application of standard design practices that a nonelectric railroad must use when an electric railroad or electric power lines are installed next to its tracks and through coordination with adjacent railroads to prevent EMI/EMF interference prior to operations.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Impacts	Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option		NEPA Conclusion Before Mitigation	Mitigation	NEPA Conclusion Post Mitigation			
							Shared Passenger Track Alternative A	Shared Passenger Track Alternative B	With Inclusion of HSR Station Option	
			Norwalk/Santa Fe Springs	Fullerton					Norwalk/Santa Fe Springs	Fullerton
Impact EMF/EMI-9: Permanent Interference with Sensitive Equipment	EMFs generated during project operation could interfere with sensitive equipment, including high-tech electronic devices and police and fire radio services. Site 13 (Nutrilite Health Institute) in Buena Park was identified as having potential for impact. However, interference will be avoided with the use of dedicated frequency blocks and procurement of communications equipment meeting FCC regulations, as well as through coordination with adjacent railroads to prevent EMI/EMF interference prior to operations, and implementation of mitigation established by this Draft EIR/EIS.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Adverse effect (all alternatives and HSR station options)	EMF/EMI-MM#1	No adverse effect	No adverse effect	No adverse effect	No adverse effect
Impact EMF/EMI-10: Electromagnetic Interference Effects on Schools	Radio systems used during project operation could interfere with communication systems at nearby schools. However, interference will be avoided by the use of dedicated frequency blocks and procurement of equipment meeting FCC regulations.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A
Impact EMF/EMI-11: Effects Related to Adjacent Airports	The potential to interfere with airport systems would be avoided with the use of dedicated frequency blocks, procurement of communications equipment meeting FCC regulations and coordination with FAA.	Same as Shared Passenger Track Alternative A.	Same impacts as the Shared Passenger Track Alternatives within the station area.	Same impacts as the Shared Passenger Track Alternatives within the station area.	No adverse effect (all alternatives and HSR station options)	No mitigation needed	N/A	N/A	N/A	N/A

Authority = California High-Speed Rail Authority; CFR = Code of Federal Regulations; EIR/EIS = environmental impact report/environmental impact statement; EMCPP = Electromagnetic Compatibility Program Plan; EMF = electromagnetic field; EMI = electromagnetic interference; FAA = Federal Aviation Administration; FCC = Federal Communications Commission; HSR = high-speed rail; kV/m = kilovolt per meter; mG = milligauss; MPE = maximum permissible exposure; N/A = not applicable; NEPA = National Environmental Policy Act

3.5.9 CEQA Significance Conclusions

As described in Section 3.5.4.5, Method for Determining Significance Under CEQA, the impacts of project actions under CEQA are evaluated against thresholds to determine whether a project action would result in no impact, a less-than-significant impact, or a significant impact. Table 3.5-16 provides a summary of the CEQA determination of significance for construction and operational impacts for the project.

Table 3.5-16 CEQA Significance Conclusions for EMF/EMI

Impacts	Impact Description and CEQA Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation	Source of Impact
Construction				
Impact EMF/EMI-1: Temporary Impacts from Use of Heavy Construction Equipment	Potentially significant for both project alternatives: Movement of heavy construction and electrical equipment would cause EMI with nearby sensitive land uses. However, potential interference would be minimal and would not expose people to a documented EMF health risk. Construction could interfere with high-tech sensitive equipment.	EMF/EMI-MM#1	Less than significant	All alternatives and options
Impact EMF/EMI-2: Temporary Impacts from Communications Equipment	Less than significant for both project alternatives: Through compliance with 47 CFR Part 15, EMFs generated by radio transmissions during construction activity would not exceed the thresholds identified in Table 3.5-9, and would not cause EMI with nearby radio services or expose people to an EMF health risk.	No mitigation measures are required	Not applicable	All alternatives and options
Impact EMF/EMI-3: Temporary Impacts from Operation of Electrical Equipment	Potentially significant for both project alternatives: EMFs would exceed thresholds identified in Table 3.5-9 at one receptor location (Nutrilite Health Institute).	EMF/EMI-MM#1	Less than significant	All alternatives and options
Operation				
Impact EMF/EMI-4: Permanent Human Exposure to Electromagnetic Fields	No impact for both project alternatives: EMF exposure would be below the IEEE standard limit of 9,040 mG and would not exceed thresholds identified in Table 3.5-9.	No mitigation measures are required	Not applicable	All alternatives and options

Impacts	Impact Description and CEQA Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation	Source of Impact
Impact EMF/EMI-5: People with Implanted Medical Devices and Exposure to Electromagnetic Fields	Less than significant for both project alternatives: EMF would not exceed thresholds identified in Table 3.5-9. Accordingly, the public and workers with implanted medical devices would not be exposed to an EMF health risk. Passengers and members of the public will not have access to facilities that can produce EMF levels that could interfere with implanted medical devices and project design requires implementation of a safety program that will preclude workers with implanted medical devices from entering facilities with electrical equipment that could endanger them.	No mitigation measures are required	Not applicable	All alternatives and options
Impact EMF/EMI-6: Potential for Corrosion of Underground Pipelines, Cables, and Adjoining Rail	Less than significant for both project alternatives: Project features will avoid and address the potential for corrosion from ground currents.	No mitigation measures are required	Not applicable	All alternatives and options
Impact EMF/EMI-7: Potential for Nuisance Shocks	No impact for both project alternatives: The project design requires grounding nearby ungrounded linear metal structures or insulating purposely electrified fences to prevent current flow, thereby avoiding nuisance shocks. Consequently, people would not be exposed to a documented EMF health risk.	No mitigation measures are required	Not applicable	All alternatives and options
Impact EMF/EMI-8: Effects on Adjacent Existing Rail Lines	No impact for both project alternatives: Interference would be avoided by application of standard design practices that a nonelectric railroad must use when an electric railroad or electric power lines are installed next to its tracks and coordination with adjacent railroads to prevent EMI/EMF interference prior to operations.	No mitigation measures are required	Not applicable	All alternatives and options
Impact EMF/EMI-9: Permanent Interference with Sensitive Equipment	Potentially significant for both project alternatives: Interference with sensitive equipment during project operation would be significant before mitigation at one facility identified in the RSA: Site 13 Nutrilite Health Institute (Buena Park).	EMF/EMI-MM#1	Less than significant	All alternatives and options

Impacts	Impact Description and CEQA Level of Significance Before Mitigation	Mitigation Measures	Level of Significance After Mitigation	Source of Impact
Impact EMF/EMI-10: Electromagnetic Interference Effects on Schools	No impact for both project alternatives: Interference with communication systems at nearby schools would be avoided because the project would use dedicated frequency blocks and procurement of communications equipment meeting FCC regulations. The potential for interference with high-tech equipment will be addressed through project design.	No mitigation measures are required	Not applicable	All alternatives
Impact EMF/EMI-11: Effects Related to Adjacent Airports	No impact for both project alternatives: Radio systems used during operations will use dedicated frequency blocks and will meet FCC regulations.	No mitigation measures are required	Not applicable	All alternatives and options

CFR = Code of Federal Regulations; CEQA = California Environmental Quality Act; EMF = electromagnetic field; EMI = electromagnetic interference; FCC = Federal Communications Commission; mG = milligauss; RSA = resource study area