PhaseLine LLC

Electric and Magnetic Field Considerations for the Paradise Valley Community
A Technical Review

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Introduction and Summary of Findings

Introduction

To support preparation of an Environmental Impact Report (EIR) for the Paradise Valley Community Specific Plan, PhaseLine LLC developed this technical report to address the existing environment, as it relates to Electric and Magnetic Fields (EMF), in the vicinity of the existing electric transmission corridors within the boundaries of the area to be developed, as well as along the corridor for a potential future Imperial Irrigation District (IID) double-circuit 92 kV transmission line, one of several possibilities identified for providing power to the community. Some combination of other alternatives for electric power supply such as, on-site electric generation or interconnection with existing Southern California Edison (SCE) transmission lines, are not considered in this report but would be addressed in the future, should one of these alternatives be adopted for power supply.

The purpose and intended use of this report is to summarize and inform readers and decision makers as to the nature of EMF from electric power lines, the status of ongoing research into potential public health impacts, to identify any relevant standards, regulations or policies and to characterize any potential EMF impacts from the existing and planned electric transmission lines in the area of the proposed development of the Paradise Valley Community. For any potential impacts this report also addresses whether there are any measures that could be incorporated in the development and planning of the Paradise Valley Community, which might effectively address EMF in the vicinity of transmission corridors.

Summary of Findings

As explained in this report, there is no adopted federal, state of California or local regulatory standard for use as a threshold of significance in a CEQA analysis. California standards exist only as setback distances mandated for siting of new school facilities in the vicinity of electric power lines. (California Department of Education). This report provides a discussion of the nature of EMF and the existing and estimated potential future levels of EMF, compared against several professional associations’ suggested standards, as well as standards held by several states other than California. This report finds that potential EMF levels from the existing and planned electric transmission lines in the area of the proposed development of the Paradise Valley Community would be well below levels suggested as standards by several international organizations and by several states outside of California, and accordingly, no significant EMF impacts are identified in this report. The California Department of Education siting guidelines could be met by the project, by siting the schools beyond the required setback distance.
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Electric and Magnetic Fields and Associated Phenomenon

Defining EMF

Electric and magnetic fields are separate phenomena and occur both naturally and as a result of human activity across a broad electrical spectrum. The weather and the earth’s geomagnetic field cause naturally occurring electric and magnetic fields. The fields caused by human activity result from technological application of the electromagnetic spectrum for uses such as communications, the generation, transmission, and local distribution of electricity and from the use of electrical equipment in the work place or electrical appliances in the home.

The frequency of electromagnetic energy is a critical parameter in how EMF interacts with the physical environment including living organisms. The higher the frequency of electromagnetic fields the shorter their wavelength, and the shorter the wavelength the greater the energy that is imparted when interacting with physical objects.

The frequency of electric power lines is determined by the rate at which electric and magnetic fields change their direction each second. For power lines in the United States, the frequency of change is 60 times per second and is defined as 60-Hertz (Hz) power, which is considered an extremely low frequency (ELF). Power frequency EMF carries very little energy and has no ionizing effects. In comparison radio and communication waves operate at much higher frequencies, 500,000 Hz to 1 billion Hz and microwaves at 2 billion Hz. The information presented in this report is limited to the ELF-EMF from power lines operating at frequencies of 60Hz.

Electric power flows across power line systems from generating sources to serve electrical loads within the community. From an EMF perspective the relevant parameters of a power line are its voltage and current. These two parameters determine the power flowing over a power line. The higher the voltage level of the power line, the lower the amount of current needed to deliver the same amount of power. For example, a 115 kV transmission line with 200 amps of current will transmit approximately 40,000 kilowatts (kW), and a 230 kV transmission line requires only 100 amps of current to deliver the same 40,000 kW. The voltage and current levels of a transmission line also dictate the magnitude of the electric and magnetic fields produced by the line.

Electric Fields

Electric fields from power lines are created whenever the lines are energized, with the strength of the field dependent directly on the voltage of the line creating it. Electric field strength is typically described in terms of kilovolts per meter (kV/m). Electric field strength attenuates (reduces) rapidly as the distance from the source increases. Electric fields are reduced at many receptors because most objects or materials such as trees or houses effectively shield them.

Unlike magnetic fields, which penetrate almost everything and are unaffected by buildings, trees, and other obstacles, electric fields are distorted by any object that is within the electric field including the human body. Even trying to measure an electric field with electronic instruments is difficult because the devices themselves may alter the levels recorded. Determining an individual’s exposure to electric fields requires an understanding of many
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variables, one of which is the electric field itself, with others including how effectively the person is grounded and their body surface area within the electric field.

Electric fields in the vicinity of power lines can cause the same phenomena as the static electricity experienced on a dry winter day, or with clothing just removed from a clothes dryer, and may result in small nuisance electric discharges when touching long metal fences, pipelines, or large vehicles.

Potential health effects from exposure to electric fields from power lines is typically not of concern since electric fields are effectively shielded as noted above. Therefore, the majority of the following information related to EMF focuses primarily on exposure to magnetic fields from power lines.

Magnetic Fields

Magnetic fields from power lines are created whenever current flows through power lines at any voltage. The strength of the field is directly dependent on the current in the line. In the United States magnetic field strength is typically measured in milliGauss (mG). Similar to electric fields, magnetic field strength attenuates rapidly with distance from the source. However, unlike electric fields, objects or materials do not easily shield magnetic fields.

The nature of a magnetic field can be illustrated by considering a household appliance. When the appliance is energized by being plugged into an outlet but not turned on, no current flows through it. Under such circumstances, an electric field is generated around the cord and appliance, but no magnetic field is present. If the appliance is switched on, the electric field would still be present and a magnetic field would also be created. The electric field strength is directly related to the magnitude of the voltage from the outlet and the magnetic field strength is directly related to the magnitude of the current flowing in the cord and appliance.

Induced Voltage and Current

EMF from power lines can induce voltages and currents on conductive objects, such as metal roofs or buildings, fences, and vehicles in the vicinity of the line. The National Electrical Safety Code (NESC) includes requirements for the design of transmission lines to limit the short circuit current, from conductive items beneath a transmission line, to a safe level (less than 5 milliampere). The height of the transmission line wires above ground is a primary factor affecting the strength of induced currents below a transmission line. It is also typical for owners of electric transmission lines to install grounding for large metal objects near the line. Grounding creates a path between the metal object and ground that will draw off any build up of electric potential. Even when induced currents are kept below the level stipulated by the NESC when a person or animal comes in contact with a conductive object a perceptible current or small electric shock may occur. These small electric shocks cause no physiological harm; however, they may present a nuisance.
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EMF Research

Overview

For more than 35 years, questions have been asked regarding the potential effects within the environment of EMFs from power lines, and research has been conducted to provide some basis for response. Early studies focused primarily on interactions with the electric fields from power lines. Since 1979, public interest and concern specifically regarding magnetic fields from power lines has increased. This increase has generally been attributed to publication of the results of a single epidemiological study (Wertheimer and Leeper, 1979). This study observed an association between the wiring configurations on electric power lines outside of homes in Denver and the incidence of childhood cancer. Following publication of the Wertheimer and Leeper study, many epidemiological, laboratory, and animal studies regarding magnetic fields have been conducted.

Research related to EMF can be grouped into three general categories: laboratory studies conducted at the cellular level to understand biological mechanisms and using animals to observe effects under controlled conditions; clinical studies that monitor human physiological responses when exposed to EMF; and epidemiological studies that compare human population groups to identify differences between exposed and unexposed populations.

As outlined below a substantial amount of research investigating EMF has been conducted over the past several decades. The following discussion is not a recounting of the results of numerous individual studies but rather characterizes the body of research and whether there is any generally accepted consensus or conclusion from scientists and researchers that identify an EMF public health impact.

Laboratory Studies

Extremely low frequency (ELF) magnetic fields have been shown to interact with tissues and cells by inducing electric fields and electric currents when in these fields. However, the electric currents induced in cells by magnetic fields at levels commonly found in the environment are normally much lower than the strongest electric currents naturally occurring in the body, such as those that control the beating of the heart. Laboratory studies have identified various other cellular level effects from exposure to EMF. It is important to note that a cellular interaction or biological effect from a magnetic field does not necessarily translate to a health effect since the biological response may fall within the normal range of variation.

Further, in vivo (live) studies have not found that magnetic fields induce or promote cancer in animals exposed for their entire lifespan under highly controlled conditions, nor have in vitro studies found a cellular mechanism by which magnetic fields could induce carcinogenesis.

The lack of a biological mechanism indicating alteration that harms cells or tissue results in laboratory studies not being able to identify a cause-effect relationship between EMF exposure and health impacts. Laboratory studies of cancer outcomes in groups of animals have provided mixed results and often utilize magnetic field exposures well in excess of field levels that would be experienced in the vicinity of electric power lines. To date the results of these animal studies have not supported a conclusion of health impacts from power frequency EMF.
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Clinical Studies

Clinical studies consider the results of laboratory testing and explore theories of biological mechanisms, to try to quantify effects on persons. In clinical studies, human volunteers are exposed with different treatments, such as static or time-varying fields, to measure the actual effects on them accurately. Clinical studies do provide an opportunity to closely control the exposure level of subjects and directly measure physiological responses. For studies of EMF effects, medical researchers use controlled exposure rates on volunteers to look for measurable changes such as brain activity and hormonal levels.

Clinical studies with human individuals rely on volunteers in a last step toward determining the degree of an agent’s ability to cause affects on physiology in a way that may affect health. Clinical studies have varying degrees of rigor and can depend in part on how the volunteer study participants cooperate with the researchers as well as the researchers’ control over the volunteer participants. Human responses have been demonstrated in clinical studies at magnetic field levels generally much higher than experienced by the general public or workers and have not demonstrated an association with health hazards. In a recent 2014 update on the results of clinical studies of ELF-EMF, the Swedish Radiation Safety Authority’s Council on EMF noted that new studies underline the conclusion from the previous Council report that ELF magnetic fields do not seem to have any effects on general physiology.

Epidemiology Studies

Epidemiology is the study of patterns of disease in populations. It searches for statistical links or associations between exposures, such as EMF, and disease in human populations. Epidemiological studies are usually observational in nature looking at historical data for groups of individuals, meaning that researchers investigate what happens as people go about their daily lives. Epidemiologists work to interpret health outcomes by comparing populations that are “exposed versus non-exposed” to a given vector; in the case of EMF populations, data on field strengths either from calculations or measurement cannot be representative of the time frame involved in Epidemiology studies so in some instances surrogates of exposure have been utilized such as wire-codes or living in close proximity to transmission line corridors.

Remaining uncertainty and controversy surrounding magnetic fields is still related to the research on childhood leukemia. Some epidemiology studies reported that children with leukemia were more likely to live closer to power lines, or have higher estimates of magnetic field exposure, compared to children without leukemia; other epidemiology studies did not report this statistical association. When a number of the relevant studies were combined in a single analysis, no association was evident at lower exposure levels but a weak association (odds ratio 2.0) was reported between childhood leukemia and estimates of average magnetic field exposures greater than 4 mG.

The epidemiology pooled analyses provide some evidence for an association between magnetic fields and childhood leukemia; however, because of the inherent uncertainty associated with observational epidemiology studies, the results of these pooled analyses were considered to provide only limited epidemiologic support for a causal relationship; chance, bias and confounding could not be ruled out with reasonable confidence.

In addition to the uncertainty regarding the level of health risk posed by EMF, individual studies and scientific panels have not been able to determine or reach consensus regarding what level of magnetic field exposure might
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constitute a health risk. In some early epidemiological studies, increased health risks were discussed for average field levels greater than 2 mG. However, the IARC scientific working group indicated that studies with average magnetic field levels of 3 to 4 mG played a pivotal role in their classification of EMF as a possible carcinogen.

Considering all the evidence together, the World Health Organization (WHO), as well as other scientific panels, classified magnetic fields as a possible cause of childhood leukemia (NRPB, 2001; IARC, 2002; ICNIRP, 2001; HCN, 2004; WHO, 2007). The term “possible” denotes an exposure for which epidemiologic evidence points to a statistical association, but other explanations cannot be ruled out as the cause of that statistical association (e.g., bias and confounding) and experimental evidence does not support a cause-and-effect relationship.

Despite additional research, it has not prompted scientific organizations to recommend that the classification of "possible carcinogen" be changed to any other IARC category such as " probable" or "known human carcinogen" (SSI, 2008; ICNIRP, 2009; SCENIHR, 2009). The WHO and these more recent views have stressed the importance of reconciling the epidemiologic data on childhood leukemia and the lack of evidence from experimental studies through innovative research. Just like any other cancer, researchers believe that the development of childhood leukemia is influenced by a multitude of different factors, e.g., genetics, environmental exposures, and infectious agents (Buffler et al., 2005; McNally et al., 2006).

Scientific Panel Reviews of EMF Studies

In an effort to understand the phenomenon of EMF from electric power lines and its interaction with the public, scientific, health and regulatory organizations worldwide have convened numerous panels of experts to review the data relevant to the question of whether exposure to power-frequency EMF is associated with adverse health effects. In many instances these evaluations have been conducted in order to advise governmental agencies or professional standard-setting groups. These panels of scientists first evaluate the available studies individually, not only to determine what specific information they can offer, but also in terms of the validity of their experimental design, methods of data collection, analysis, and suitability of the authors’ conclusions to the nature and quality of the data presented. Subsequently, the individual studies, with their previously identified strengths and weaknesses, are evaluated collectively in an effort to identify whether there is a consistent pattern or trend in the data that would lead to a determination of possible or probable hazards to human health resulting from exposure to these fields.

These reviews include those prepared by international agencies such as the World Health Organization (WHO, 1984, WHO, 1987, and WHO, 2001) and the international Non-Ionizing Radiation Committee of the International Radiation Protection Association (IRPA/INIRC, 1990) as well as governmental agencies of a number of countries, such as the National Radiological Protection Board of the United Kingdom, the Swedish Radiation Safety Authority, the Health Council of the Netherlands, and the French and Danish Ministries of Health.

As noted below these scientific panels have varied conclusions on the strength of the scientific evidence suggesting that power frequency EMF exposures pose any health risk.

In May 1999 the National Institute of Environmental Health Sciences (NIEHS) submitted to Congress its report titled, Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields, containing the following conclusion regarding EMF and health effects:
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Using criteria developed by the International Agency for Research on Cancer (IARC), none of the Working Group considered the evidence strong enough to label ELF-EMF exposure as a known human carcinogen or probable human carcinogen. However, a majority of the members of this Working Group concluded that exposure to power-line frequency ELF-EMF is a possible carcinogen.

In 2002, a scientific working group of IARC (an agency of WHO) reviewed studies related to the carcinogenicity of EMF. Using standard IARC classification, magnetic fields were classified as “possibly carcinogenic to humans” based on epidemiological studies. “Possibly carcinogenic to humans” is a classification used to denote an agent for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals. Other agents identified as “possibly carcinogenic to humans” include gasoline exhaust, styrene, welding fumes, and coffee (WHO 2001).

On behalf of the California Public Utilities Commission (CPUC), the California Department of Health Services (DHS) completed a comprehensive review of existing studies related to EMF from power lines and potential health risks. This review was conducted with a significantly smaller group of scientists who lacked diversity in scientific background. The three staff scientists with the DHS who undertook this risk evaluation were all epidemiologists. Each of these scientists is identified in the review results as an epidemiologist, and their work took place from 2000 to 2002. The results of this review titled, An Evaluation of the Possible Risks From Electric and Magnetic Fields (EMFs) From Power Lines, Internal Wiring, Electrical Occupations, and Appliances, were published in June 2002. The conclusions contained in the executive summary are provided below:

- To one degree or another, all three of the DHS scientists are inclined to believe that EMFs can cause some degree of increased risk of childhood leukemia, adult brain cancer, Lou Gehrig’s Disease, and miscarriage.
- They strongly believe that EMFs do not increase the risk of birth defects, or low birth weight.
- They strongly believe that EMFs are not universal carcinogens, since there are a number of cancer types that are not associated with EMF exposure.
- To one degree or another they are inclined to believe that EMFs do not cause an increased risk of breast cancer, heart disease, Alzheimer’s disease, depression, or symptoms attributed by some to sensitivity to EMFs. However, all three scientists had judgments that were “close to the dividing line between believing and not believing” that EMFs cause some degree of increased risk of suicide.
- For adult leukemia, two of the scientists are “close to the dividing line between believing or not believing” and one was “prone to believe” that EMFs cause some degree of increased risk.

The report indicates that the DHS scientists are more inclined to believe that EMF exposure increased the risk of the above health problems than the majority of the members of scientific committees that have previously convened to evaluate the scientific literature. With regard to why the DHS review’s conclusions differ from those of other recent reviews, the report states:

*The three DHS scientists thought there were reasons why animal and test tube experiments might have failed to pick up a mechanism or a health problem; hence, the absence of much support from such animal and test
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tube studies did not reduce their confidence much or lead them to strongly distrust epidemiological evidence from statistical studies in human populations. They therefore had more faith in the quality of the epidemiological studies in human populations and hence gave more credence to them.

While the results of the DHS report indicate these scientists believe that EMF can cause some degree of increased risk for certain health problems, the report did not quantify the degree of risk or make any specific recommendations to the CPUC.

As noted above these scientific panels have varied conclusions on the strength of the scientific evidence suggesting that power frequency EMF exposures pose any health risk. However, none of the reviews, that have included a large panel of independent scientists with a broad spectrum of expertise from multiple organizations, have arrived at a conclusion that electric or magnetic fields are a known or likely cause of any adverse health effect at long-term low-level exposures found in the environment.
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EMF Exposures

One, if not the greatest, challenge related to understanding the interaction of EMF with the public is being able to determine the magnitude and duration of EMF exposures that the public encounters, in general or when in the vicinity of electric power lines. In the man-made environment EMF is pervasive and originates from many sources ranging from; electrical wiring in homes, electric equipment in the workplace, the use of personal appliances such as: hand held hair dryers, stoves, personal computers, and from the overhead and underground electric distribution systems throughout communities.

General Public Exposures

In undeveloped and natural areas, measurable EMFs are not present except in the vicinity of existing power line corridors. In developed areas public exposure to EMFs is more widespread and encompasses a very broad range of field intensities and durations. Research on ambient magnetic fields in homes and buildings in several western states found average magnetic field levels within most rooms to be approximately 1 mG, while in a room with appliances present, the measured values ranged from 9 to 20 mG (Severson et al., 1988, and Silva, 1988). Immediately adjacent to appliances (within 12 inches), field values are much higher. Table 1 below indicates typical sources and levels of magnetic field exposure the general public experiences from appliances.

Table 1 - Typical Magnetic Field from Household Appliances

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Magnetic Field (mG) - 12&quot; Distant</th>
<th>Magnetic Field (mG) - Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Range</td>
<td>3 - 30</td>
<td>100 - 1,200</td>
</tr>
<tr>
<td>Garbage Disposal</td>
<td>10 - 20</td>
<td>850 - 1,250</td>
</tr>
<tr>
<td>Clothes Washer</td>
<td>1 - 3</td>
<td>10 - 400</td>
</tr>
<tr>
<td>Toaster</td>
<td>0.6 - 8</td>
<td>70 - 150</td>
</tr>
<tr>
<td>Vacuum Cleaner</td>
<td>20 - 200</td>
<td>2,000 - 8,000</td>
</tr>
<tr>
<td>Hair Dryer</td>
<td>1 - 70</td>
<td>60 - 20,000</td>
</tr>
<tr>
<td>Electric Shaver</td>
<td>1 - 100</td>
<td>150 - 15,000</td>
</tr>
<tr>
<td>Fluorescent Desk Lamp</td>
<td>6 - 20</td>
<td>400 - 3,500</td>
</tr>
<tr>
<td>Circular Saw</td>
<td>10 - 250</td>
<td>2,000 - 10,000</td>
</tr>
<tr>
<td>Electric Drill</td>
<td>25 - 35</td>
<td>4,000 - 8,000</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>0.3 - 3</td>
<td>4 - 15</td>
</tr>
</tbody>
</table>

Source: Gauger, 1985

As a result of legislation in 1992 the U.S. EMF Research and Public Information Dissemination (EMF RAPID) Program was established and administered by the U.S. Department of Energy (DOE). Working with the DOE the National Institute of Environmental Health Sciences (NIEHS) oversaw numerous studies including assessment of public exposures to EMF. A study of typical personal exposures measured the exposure of 1,000 randomly selected
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individuals utilizing a personal exposure meter that measured magnetic field continuously (at least every 1.5 seconds) over a 24-hour period. The study found magnetic field exposures to be similar for different regions of the country and for both men and women. Table 2 below provides a breakdown of the proportion of the U. S. population experiencing various levels of average magnetic field exposure. Average (mean) magnetic field exposure is calculated as the summation of each measurement of magnetic field strength divided by the number of measurements.

Table 2 – Estimated Average Magnetic Field Exposure of the U.S. Population

<table>
<thead>
<tr>
<th>Average field (mG)</th>
<th>Population Exposed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 0.5</td>
<td>76.3</td>
</tr>
<tr>
<td>&gt; 1</td>
<td>43.6</td>
</tr>
<tr>
<td>&gt; 2</td>
<td>14.3</td>
</tr>
<tr>
<td>&gt; 3</td>
<td>6.3</td>
</tr>
<tr>
<td>&gt; 4</td>
<td>3.6</td>
</tr>
<tr>
<td>&gt; 5</td>
<td>2.4</td>
</tr>
<tr>
<td>&gt; 7.5</td>
<td>0.6</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>0.5</td>
</tr>
<tr>
<td>&gt; 15</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Source: Zaffanella, 1993

The above table illustrates there is considerable variation in exposure among the population. In the case of the lowest average exposure, that is representative of over 75% of the population, the exposure record for an individual with this average exposure is shown in Figure 1 below.

Figure 1 - Magnetic Field Personal Exposure Record
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Although the average exposure of this individual is less than 0.5 mG, review of the exposure record identifies multiple clusters of short exposure spikes reaching as high as 20 mG. A significant proportion of the exposure spikes are clustered around the time of rising in the morning and departing for work, during the lunch period outside of work, and in the evening returning from work until 6 p.m. The two in-home spike periods correspond to times typically associated with heavy in-home electricity use due to more intense home heating or cooling periods and increased use of appliances for meal preparation. The mid-day spike corresponds to movement, outside of home or work, within the community where multiple sources of EMF are encountered.

Workplace Exposures

Exposure assessments for workers have shown that the source of EMF exposure is primarily from electrical appliances and tools, as well as from the buildings power supply. Initially information on occupational exposures focused on electric utility workers and early studies did not utilize actual measurements of EMF but rather relied on job titles to estimate EMF. A report of workers in Los Angeles (London et al, 1994) that did utilize measurements showed that electrical workers had average EMF exposure of 9.6 mG while other workers had exposure of 1.7 mG.

EMF exposures for workers depend heavily upon the actual equipment used in the workplace. EMF exposure is expected to be higher for occupations where workers use or are in close proximity to equipment that utilizes high electric current such as large industrial motors, welding machines, or magnetic imaging devices.

Exposures in the Vicinity of Transmission Corridors

Due to the often high-visibility and recognition by the public of their purpose, electric transmission lines typically are the focal point of public interest regarding exposure to EMF. The magnetic field exposure in the vicinity of a transmission line can be extremely complex as there are a significant number of variables affecting the strength of the magnetic field within or adjacent to a transmission line corridor. The primary variables are the amount of electric current flowing in the transmission line and the proximity of the transmission line conductors (wires) to the point of interest.

Unlike the voltage level of a transmission line, which remains essentially constant, the electric current of a transmission line is continuously changing over time, resulting in a corresponding variation in the public's magnetic field exposure. The change in electric current is determined by the amount of power actually flowing in the transmission line at any given time and is driven by the electrical demand (use of electricity) on the interconnected electric utility system. The amount of power flowing over electric transmission systems will vary throughout the day and generally utilities experience a couple of periods of high electric use, referred to as daily peaks. Although referred to as peaks, these periods of high electric usage may last several hours. These daily peaks are often first thing in the morning and in late afternoon to early evening. These daily peaks will also vary from day to day and season to season depending upon multiple factors such as day of the week, local weather conditions (winter vs. summer), etc.

Further, over the life of a given transmission line the magnitude of the daily peaks will increase year over year as a result of the utilities load growth. Load growth can be tied to multiple factors within the community that are a
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reflection of changes such as an increase in number of homes, new commercial or industrial development or trends of increased personal use of electricity due to adoption of technology.

The distance from the transmission line will also dictate variations in the magnetic field exposure. Typically the highest magnetic field occurs within the right-of-way and directly below the transmission line. However, due to the sag of the conductor, the height of the transmission line continuously varies within any given span between structures. Therefore, even under the same electric current flow conditions the magnetic field exposure will continuously vary along the line and will be higher directly below the transmission line at mid-span (lowest conductor point) than at the structure location, where the conductor is at its greatest height. Additionally, the strength of the magnetic field decreases as one moves laterally from the transmission line. This lateral drop in magnetic field exposure can be relatively rapid as it is dictated by the square of the distance from the transmission line.

Another complicating factor potentially affecting the public’s magnetic field exposure in the vicinity of a transmission line corridor is the presence of other power lines (magnetic field source). Magnetic fields from adjacent lines can interact in a number of ways but cannot be assumed to be additive. In the case where power is flowing in different directions on adjacent lines there may be a substantial decrease in the level of magnetic field than if the lines were not in proximity to each other. The arrangement of the conductors on adjacent lines will also affect the magnetic field exposure and could be additive or subtractive. When more than one transmission line is in the same right-of-way, utilities often strive to manage the magnetic field levels by arranging the phases of the different circuits to optimize magnetic field cancelation.

The Bonneville Power Administration (BPA), one of four federal power-marketing agencies within the Department of Energy, with more than 15,000 miles of electric power lines, conducted a study utilizing measurement and calculation of magnetic fields in the vicinity of their facilities in order to characterize magnetic field phenomenon. The variability in power flow and associated magnetic field levels was demonstrated by measurements BPA took of the magnetic field level within the right-of-way of one of its 500 kV lines every 5 minutes over a one-week period and yielded a minimum strength of 22.4 mG and a peak of 62.7 mG.

While it is tenuous to indicate typical magnetic field levels from transmission lines of different classes, BPA did calculate the mean magnetic field directly beneath 321 of their transmission lines under the mean electric loads experienced during 1990. These calculations indicated a magnetic field of 29.7 mG for 115 kV lines, 57.5 mG for 230 kV lines and 86.7 mG for 500 kV lines. BPA also noted that peak loads occurred approximately 1% of the year and the magnetic field under peak conditions are about twice as strong as the calculated mean levels.

The graphs included in Figure 2 below depict the magnetic field strength calculated for transmission lines, carrying the same current, in order to illustrate several characteristics of magnetic field for both overhead and underground transmission lines. First, the two plots demonstrate how the strength of magnetic field varies with increasing distance from a transmission line. Second, the plots also show how current flow on transmission lines increases over time, due to growth in electricity consumption, and that this increase would result in higher magnetic field on any given transmission line over time. Finally, comparing the plots for the overhead versus underground transmission line illustrates a number of points, one being that magnetic field is not eliminated by burying transmission lines. The underground plot also reflects the fact that, for a given current flow, the peak magnetic field can be expected to be higher directly above an underground line since the cables are much closer to the ground than overhead wires. However, the typical arrangement of underground transmission line cables does result in increased magnetic field.
cancellation and a much more rapid drop in the strength of the magnetic field as one moves away from the transmission line.

**Figure 2 - Magnetic Field versus Lateral Distance**

Contrary to the public’s perception, magnetic fields near transmission lines may be lower than the magnetic field in the vicinity of lower voltage distribution lines within a community since distribution conductors can be closer to the ground, due to their lower voltage, and distribution lines often carry a high electrical current. Information prepared by the NIEHS related to distribution lines shows typical magnetic field levels directly below main feeder lines to vary from 10 to 20 mG but note that field levels as high as 70 mG have been measured below overhead lines and 40 mG above underground lines under peak conditions.

**Paradise Valley Transmission Corridor Exposures**

There are presently two transmission corridors that cross the area planned for the Paradise Valley community. Southern California Edison (SCE) operates the transmission lines in these corridors. A third transmission corridor, which would be operated by Imperial Irrigation District (IID), would potentially include new transmission lines to serve Paradise Valley. In order to characterize EMF in the area of the existing and planned transmission lines each of the utilities was contacted. Information obtained from each of the utilities is summarized below.

**Southern California Edison**

SCE has three existing transmission lines within Paradise Valley, one 220 kV Line and two 500 kV lines. The 220 kV transmission line is identified by SCE as the Julian Hinds-Mirage line. The two 500 kV transmission lines, originally planned as the Devers-Palo Verde #1 and #2 lines, are identified by SCE as the Devers-Red Bluff #1 line and the Devers-Red Bluff #2 line.
Electric and Magnetic Field Considerations for the Paradise Valley Community

The right-of-way (ROW) for the Julian Hinds-Mirage 220 kV line transmission line generally runs east to west through Paradise Valley. This ROW is 260 feet wide from the east edge of Paradise Valley until it intersects with the 500 kV ROW described below. The 220 kV line is supported by single-circuit lattice steel towers.

The ROWs for the two 500 kV lines are side-by-side. The ROW of the Devers-Red Bluff #1 500 kV line is 200 feet wide and the adjacent Devers-Red Bluff #2 500 kV line ROW is 130 feet wide resulting in a total width of 330 feet. Each of the 500 kV transmission lines is supported by single-circuit lattice steel towers. Devers-Red Bluff #1 is generally located 100-feet from boundary of the ROW and Devers-Red Bluff #12 is located 100-feet from the other boundary of the ROW.

The ROWs for the two 500 kV lines enter the Paradise Valley area near the southeast corner of the planned development, extending northwesterly to a crossing of Interstate 10 where it encounters the ROW for the Julian Hinds-Mirage 220 kV line. At this point the 500 kV lines cross the 220 kV line and the ROW turn to the west and parallels the Julian Hinds-Mirage 220 kV line such that the combined ROW width for the three lines is 443 feet wide.

SCE has not provided magnetic field information for the Julian Hinds-Mirage 220 kV line. Limited calculated magnetic field information for the two 500 kV lines is available from the Field Management Plan (SCE, 2005) developed by SCE as part of the EIR for the development of the DPV2 line now identified as the Devers-Red Bluff #2 500 kV line. When SCE prepared this magnetic field modeling it was noted that the purpose of the modeling was for comparison and evaluation of potential magnetic field reduction measures and could not be assumed to represent actual mG levels at any particular point. It is also noted that the modeling was prepared for a summer peak load forecast. Figure 3 below illustrates the result of SCE modeling in the area where the two 500 kV transmission lines run southeast to northwest within the Paradise Valley Community. As discussed above peak loading may occur less than 1% of the time throughout the year.

**Figure 3 - 500 kV Lines - Magnetic Field Model**

![Magnetic Field Model](image_url)

Source: Appendix B – Field Management Plan, Devers-Palo Verde No 2 Transmission Line Project, 2005
Electric and Magnetic Field Considerations for the Paradise Valley Community

In November 2013 a series of magnetic field measurements were made (Paradise Valley, 2014) at five locations in the area of Paradise Valley and at a substation in Coachella as shown in Figure 4.

**Figure 4 – Magnetic Field Measurement Locations**

The highest EMF values recorded in the vicinity of the 500 kV right-of-way, near where the 500 kV lines cross from the south side of Interstate 10 to the north (Location 3), was 11.5 mG at 50 feet from the easement centerline as shown in Table 3 below. EMF measurements taken at offsite locations included a maximum of 4.5 mG recorded at IID’s Coachella Substation, where the proposed line would originate (Location 1). At Cactus City Rest Area (Location 2), in the vicinity of the proposed IID transmission line alignment to serve the Paradise Valley Community, the field measurements were less than the 0.2 mG sensitivity of the recording instrument. The field measurements were taken when only one of the 500 kV lines was energized and at a time of year when power flow and current levels would be expected to be well below peak values. When compared with the modeling information in Figure 3, these measurements illustrate how widely magnetic field exposure can vary depending upon the operating conditions of the transmission line.
Electric and Magnetic Field Considerations for the Paradise Valley Community

Table 3 – Measured Magnetic Field 500 kV Right-of-Way (Location 3)

<table>
<thead>
<tr>
<th>MAGNETIC FIELD MEASUREMENTS @ ONE METER ABOVE GROUND</th>
</tr>
</thead>
<tbody>
<tr>
<td>50' West</td>
</tr>
<tr>
<td>25' West</td>
</tr>
<tr>
<td>10' West</td>
</tr>
<tr>
<td>Center of Easement</td>
</tr>
<tr>
<td>10' East</td>
</tr>
<tr>
<td>25' East</td>
</tr>
<tr>
<td>50' East</td>
</tr>
</tbody>
</table>

Imperial Irrigation District

Imperial Irrigation District (IID) is in the early planning stages for providing electric power to the Paradise Valley community, via a potential new 92 kV double circuit line, which would extend from an existing IID substation in Coachella to the project site. The proposed route for the transmission line is conceptual and has not been finalized. In the future, as a part of selecting the 92 kV transmission line route, a project specific evaluation will be performed. One conceptual alignment for the 92 kV power line would primarily follow the I-10, a possible route to the south that is currently occupied by an IID distribution line is also being evaluated as an alternative. Referring to Figure 5, both the proposed and alternative route for the 92 kV power lines proceed to the east from an existing IID substation on Avenue 52 at the eastern edge of Coachella and then pass through open undeveloped lands until reaching the Paradise Valley site.
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Figure 5 – Proposed and Alternate Route IID 92 kV Lines

Tubular steel poles are under consideration as the structure type for the double-circuit transmission line. From an EMF perspective it is not possible to forecast EMF levels for a future IID double circuit line. Although the line voltage is known, the power flow capacity, and associated current level, is still to be determined. It can be noted that configuration of the 92 kV power lines as a double circuit on one structure would provide the opportunity to manage magnetic field levels through the use of an optimal phase arrangement, resulting in magnetic field levels that would be less than currently published standards and guidelines.
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Relevant Policies and Standards

A number of local governments, states, and national and international bodies have adopted or considered guidelines, regulations or policies related to EMF exposure. The reasons for these actions have been varied; in some cases the guidelines draw upon the experience of specific groups, such as industrial hygienists, to establish worker protections in environments where EMF levels are far in excess of exposures experienced by the general public. In other cases, related to limits for general public exposure, the actions can be attributed to maintaining a status quo of existing exposures or addressing public reaction to and perception of EMF as opposed to responding to the findings of any specific scientific research. In some cases specific setback distances or magnetic field levels are specified, however, the basis for these specific values is generally not provided. Following is a brief summary of the guidelines and regulatory activity regarding EMF.

International Guidelines

The International Commission on Non-Ionizing Radiation Protection, in cooperation with the World Health Organization, has published recommended guidelines (ICNIRP, 1998, updated 2010) for electric and magnetic field exposures. Neither of these organizations has any governmental authority nor recognized jurisdiction to enforce these guidelines. However, because a broad base of scientists developed them, these guidelines have been given merit, particularly in Europe, and may be considered by utilities and regulators when reviewing EMF levels from electric power lines.

The International Committee on Electromagnetic Safety (ICES) is a committee under the sponsorship of the United States based Institution of Electrical and Electronic Engineers, (IEEE Standards Coordinating Committee 28). It develops different standards for different frequency ranges, and has published IEEE Standard C95.6 that provides recommendations to prevent harmful effects in human beings exposed to electromagnetic fields. Although the ICES standard is generally based on the same body of evidence as ICNIRP, they indicate use of a more detailed approach in developing the standard. In any event, no countries have adopted the ICES standards.

The focus of the ICNIRP guidelines and ICES standard is not to set exposure levels related to effects from long-term exposure to low levels of EMF. Rather, the guidelines developed by these organizations are characterized as setting limits to protect against acute health effects (i.e., perception or the stimulation of nerves and muscles), those effects that occur upon direct exposure to EMF at the values specified. Although ICNIRP and ICES have the same objectives and used similar methods, the safety factors used by these two entities differ substantially with the recommended limits for magnetic field exposure of the general public differing accordingly. These organizations identify exposure standards, shown in Table 4, for short-term exposure to high levels of EMF.
## Electric and Magnetic Field Considerations for the Paradise Valley Community

### Table 4 – Various Guideline Limits for EMF Exposure

<table>
<thead>
<tr>
<th>Organization/Agency</th>
<th>Magnetic Field</th>
<th>Electric Field</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>General Public</td>
<td>Occupational</td>
</tr>
<tr>
<td>International</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICNIRP</td>
<td>2,000 mG</td>
<td>10,000 mG</td>
</tr>
<tr>
<td>ICES</td>
<td>9,040 mG</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICGIH</td>
<td>N/A</td>
<td>10,000</td>
</tr>
<tr>
<td>OSHA</td>
<td>N/A</td>
<td>No adopted limits</td>
</tr>
<tr>
<td>California</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPUC</td>
<td>No adopted limits</td>
<td>No adopted limits</td>
</tr>
<tr>
<td>Dept. of Education</td>
<td>Lines from 50 kV to 133 kV</td>
<td>100 feet</td>
</tr>
<tr>
<td>School property setbacks from electric power lines -</td>
<td>Lines from 220 kV to 230 kV</td>
<td>150 feet</td>
</tr>
<tr>
<td></td>
<td>Lines from 500 kV to 550 kV</td>
<td>350 feet</td>
</tr>
</tbody>
</table>

(a) within ROW

**National Guidelines**

Although the U.S. EPA has conducted investigations into EMF related to power lines and public health risks, no national standards have been established. There have been a number of studies sponsored by the U.S. EPA, the Electric Power Research Institute (EPRI), and other institutions. Several bills addressing EMF have been introduced at the congressional level and have provided funding for research; however, no bill has been enacted that would regulate EMF levels.

The 1999 NIEHS report to Congress suggested that the evidence supporting exposure to EMF as a health hazard was insufficient to warrant aggressive regulatory actions. The report did suggest passive measures to educate the public and regulators on means aimed at reducing exposures. NIEHS also suggested the power industry continue its practice of siting lines to reduce public exposure to EMF and to explore ways to reduce the creation of magnetic fields around lines.

The American Conference of Governmental Industrial Hygienists (ACGIH) is a professional association of industrial hygienists and practitioners of related professions. ACGIH has developed a suggested standard for limiting work place exposures to magnetic fields to 10,000 mG and to electric fields of 25 kV/m. ACGIH has not developed any information related to public exposures and in any event the ACGIH this standard is not a regulatory requirement. The Occupational Safety and Health Administration (OSHA) is the main federal agency that sets and enforces...
Electric and Magnetic Field Considerations for the Paradise Valley Community

protective workplace safety and health standards. There are currently no specific OHSA standards that address EMF.

California Public Utilities Commission Guidelines

The California Public Utility Commission (CPUC) has jurisdiction over privately owned electric utility companies in the state. In 1991, the CPUC initiated an investigation into electric and magnetic fields associated with electric power facilities. This investigation explored the approach to potential mitigation measures for reducing public health impacts and possible development of policies, procedures or regulations. Following input from interested parties the CPUC implemented a decision (D.93-11-013) that requires that privately owned utilities use “low-cost or no-cost” mitigation measures for facilities requiring certification under General Order 131-D.1. The decision directed the utilities to use a 4% benchmark on the low-cost mitigation. This decision also implemented a number of EMF measurement, research, and education programs, and provided the direction that led to the preparation of the California Department of Health Services study described previously.

Most recently the CPUC issued Decision D.06-01-042, on January 26, 2006, affirming the low-cost/no-cost policy to mitigate EMF exposure from new utility transmission and substation projects. This decision also adopted rules and policies to improve utility design guidelines for reducing EMF. The CPUC stated “at this time we are unable to determine whether there is a significant scientifically verifiable relationship between EMF exposure and negative health consequences.” The CPUC has not adopted any specific limits or regulation on EMF levels related to electric power facilities.

California Department of Education Guidelines

The California Department of Education (CDE) does not have any EMF guidelines that apply to existing school sites, however; CDE does evaluate potential school sites under a range of criteria, including environmental and safety issues. Exposures to power-frequency electric and magnetic fields (EMF) is one of the criteria. Title 5, California Code of Regulations has established the following “setback” limits for locating any part of a school site property line near the edge of easements for any electrical power lines rated 50 kV and above:

100 feet for lines from 50 to 133 kV
150 feet for lines from 220 to 230 kV
350 feet for lines from 500 to 550 kV

Other State Requirements

Several states have adopted limits for electric field strength within transmission line ROWs. Florida and New York are the only states that currently limit the intensity of magnetic fields from transmission lines. These regulations include limits within the ROW as well as at the edge of the ROW and cover a broad range of values. Table 5 lists the states regulating EMF and their respective limits. The magnetic field limits were based on an objective of preventing field levels from increasing beyond levels currently experienced by the public and are not based upon
any link between scientific data and health risks (Morgan, 1991). Given that these are preventative measures they are presented separately from those in Table 4, above.

Table 5 – Other States’ Regulated Limits to Avoid Increases in EMF Exposure

<table>
<thead>
<tr>
<th>State</th>
<th>Electric Field (kV/M)</th>
<th>Magnetic Field (mG)</th>
<th>Location</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 kV Lines</td>
<td>10</td>
<td>N/A</td>
<td>In ROW</td>
<td>Single-circuit</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>200</td>
<td>Edge ROW</td>
<td>Single-circuit</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>250</td>
<td>Edge Row</td>
<td>Double-Circuit</td>
</tr>
<tr>
<td>230 kV Lines</td>
<td>8</td>
<td>N/A</td>
<td>In Row</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>150</td>
<td>Edge ROW</td>
<td></td>
</tr>
<tr>
<td>Minnesota</td>
<td>8</td>
<td>N/A</td>
<td>Edge ROW</td>
<td>&gt; 200 kV</td>
</tr>
<tr>
<td>Montana</td>
<td>1</td>
<td>N/A</td>
<td>In ROW</td>
<td>&gt; 69 kV</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>N/A</td>
<td>In ROW</td>
<td>Road Crossings</td>
</tr>
<tr>
<td>New Jersey</td>
<td>3</td>
<td>N/A</td>
<td>Edge of ROW</td>
<td>Guideline for Complaints</td>
</tr>
<tr>
<td>New York</td>
<td>1.6</td>
<td>200</td>
<td>Edge of ROW</td>
<td>&gt;125 kV</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>N/A</td>
<td>In ROW</td>
<td>Public roads</td>
</tr>
<tr>
<td></td>
<td>11.8</td>
<td></td>
<td>In ROW</td>
<td>Other Terrain</td>
</tr>
<tr>
<td>North Dakota</td>
<td>9</td>
<td>N/A</td>
<td>In ROW</td>
<td></td>
</tr>
<tr>
<td>Oregon</td>
<td>9</td>
<td>N/A</td>
<td>In ROW</td>
<td>230 kV, 10 miles</td>
</tr>
</tbody>
</table>

Source: Public Utilities Commission Texas

Other Jurisdictions

Elsewhere in the United States, several agencies and municipalities have taken action regarding EMF policies. These actions have been varied and include requirements that the fields be considered in the siting of new facilities. The manner in which EMF is considered has taken several forms. In some instances, a concept referred to as "prudent avoidance" has been formally adopted. Prudent avoidance, a concept proposed by Dr. Granger Morgan of Carnegie-Mellon University, is defined as “…limiting exposures which can be avoided with small investments of money and effort” (Morgan, 1991).

Some municipalities or regulating agencies have instituted limitations on field strength, requirements for siting of lines away from residences and child intensive locations (schools, day care, playgrounds) and, in some instances, requirements for underground construction of new transmission lines. The origin of these individual actions has varied widely, with some initiated by agencies at the time of new transmission line proposals within their community and some as a result of induced voltage issues in the vicinity of existing transmission lines. There is a lack of consistency in the requirements of these jurisdictions. For example, some setback requirements rely on the transmission line right-of-way to be the minimum buffer, some are based on a distance from the edge of transmission line right-of-way, others are based on a distance from the transmission lines themselves and in one instance placing transmission lines adjacent to a public highway or railroad negates the building setback requirement.
Electric and Magnetic Field Considerations for the Paradise Valley Community

As discussed below there are no national or state regulations pertaining to general public exposures to EMF from electric transmission lines that would apply to the proposed project. Further, although existing guidelines from ICNIRP do include suggested limits on short-term public exposures, it is noted that the EMF levels in these guidelines are an order of magnitude higher than those associated with the existing and planned transmission lines within the Paradise valley Community.
Electric and Magnetic Field Considerations for the Paradise Valley Community

Potential Range of EMF Impacts and Potential Mitigation

EMF Impacts

As related in this report there remains a lack of consensus in the scientific community in regard to public health impacts due to EMF at the levels expected from electric power facilities. International standards or guidelines have not been adopted by any jurisdiction relevant to the Paradise Valley Community, however, these international standards establish EMF thresholds that are an order of magnitude above the levels of EMF that would be expected from transmission lines. The proposed project would therefore not place new development within areas exceeding these standards and guidelines, assuming the school sites are required to be placed within the CDE requirements for setback from power lines (see mitigation measure below). Further, the future addition of the IID 92kV lines would not increase EMF levels above the cited standards and guidelines along either the proposed or alternative routes for the lines.

Potential Mitigation / Adherence to Standards and Suggested Guidelines

None of the agencies, with jurisdiction over transmission facilities, and the utilities planning or operating the transmission lines within Paradise Valley stipulate requirements for any setbacks from the edge of transmission line right-of-ways, nor do they have any limitations for land use adjacent to the right of ways in order to maintain public safety. Therefore, with the exception of school siting requirements, there are no adopted EMF limits or development constraints along transmission line right-of-ways.

In the case of development of new school sites it is reasonable to adopt the requirements stipulated by the California Department of Education as reiterated below. This is a regulatory requirement placed upon the CDE for school site selection and therefore is to be incorporated into the Paradise Valley Specific Plan.

Setback limits for locating any part of a school site property line near the edge of easements for any electrical power lines rated 50 kV and above are:

- 100 feet for lines from 50 to 133 kV
- 150 feet for lines from 220 to 230 kV
- 350 feet for lines from 500 to 550 kV

The substantial majority of attenuation of EMF levels from transmission lines occurs within close proximity of the transmission lines themselves and typically within their own right-of-way. In light of continuing public interest and concern regarding EMF, it is appropriate to encourage utilities to follow a Precautionary Principle approach and utilize no-cost measures to manage EMF levels, such as optimal phasing, where practicable in the planning, design and development of new transmission lines.

In view of the degree of scientific uncertainty it is impossible identify setbacks or exposure limits to adopt in relation to public health. The Paradise Valley Specific Plan does include edge conditions along several areas within
the community, including along existing transmission line right-of-way and along the Interstate 10 Freeway, the proposed route of the IID 92 kV line. In the case of the SCE ROW the Specific Plan calls for a 15-foot development/desert interface buffer between the edge of the SCE ROW and any development. Along the Interstate 10 Freeway the Specific Plan calls for a 100-foot buffer adjacent to residential development and 75-foot buffer adjacent to non-residential development.

Cumulative Impacts

For the off-site portion of the potential future IID 92kV lines, there are no existing residences or other sensitive land uses in the vicinity of either the currently proposed alignment or the alternative alignment. Therefore, the addition of the 92 kV lines would not result in a substantial increase in EMF exposure to persons that could exceed the suggested guidelines of the multiple professional organizations and agencies, as noted above (Table 4). With regard to the La Entrada Community that is potentially located adjacent to the 92kV project power line, any project school sites would similarly be subject to the California Department of Education’s setback limits for locating any part of a school site property line near the edge of easements for any electrical power lines rated 50 kV and above.
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- American Conference of Governmental Industrial Hygienists, 1999: Occupational Threshold Limit Values for 60-Hz EMF.
- California Department of Health Services (DHS) 2002: An Evaluation of the Possible Risks From Electric and Magnetic Fields (EMFs) From power Lines, Internal Wiring, Electrical Occupations, and Appliances.
- IEEE Standard C95.6, Standard for Safety Levels With Respect to Human Exposure to Electromagnetic Fields, 0-3 kHz.
- Institute of Electrical and Electronics Engineers (IEEE) and American National Standards Institute (ANSI): National Electrical Safety Code (NESC).
- International Commission on Non-Ionizing Radiation Protection, Standing Committee on Epidemiology (ICNIRP)
  - 2009: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields up to 300 GHz, Health Physics.
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- Paradise Valley Master Planned Community, 2014: Magnetic Field Measurements Report.
- Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR), 2009: Health Effects of Exposure to EMF.
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- Title 5, California Code of Regulations, Division 1, Chapter 13, Subchapter 1. School Facilities Construction, Article 2. School Sites, 14010. Standards for School Site Selection, subparagraph c.


- World Health Organization (WHO).


Glossary, Abbreviations

**AC** – Alternating current.

**ACGIH** – American Conference of Governmental Industrial Hygienists.

**ANSI** – American National Standards Institute.

**BPA** – Bonneville Power Administration.

**CDE** – California Department of Education.

**CEQA** – California Environmental Quality Act.

**CPUC** – California Public Utilities Commission.

**DC** – Direct current.

**DHS** – Department of Health Services.

**DOE** – Department of Energy.

**EIR** – Environmental Impact Report; an environmental impact assessment document prepared in accordance with the California Environmental Quality Act (CEQA).

**ELF** – Extremely low frequency, from 1 Hz to 300 Hz.

**EMF** – Electric and Magnetic Field.

**EPA** – U.S. Environmental Protection Agency; a federal agency that works to protect the environment.

**EPRI** – Electric Power Research Institute.

**Hz** – Hertz; a measure of frequency in cycles per second.

**IARC** – International Agency for Research on Cancer.

**ICES** – International Committee on Electromagnetic Safety.

**ICNIRP** – International Commission on Non-Ionizing Radiation Protection

**IEEE** – Institute of Electrical and Electronic Engineers.

**IID** – Imperial Irrigation District.
Electric and Magnetic Field Considerations for the Paradise Valley Community

IRPA – International Radiation Protection Association.

kV – Kilovolt; a measure of electric voltage, one thousand volts.

kV/m – Kilovolts per meter; a measure of electric field strength.

kW – Kilowatt; a measure of electric power equal to 1,000 watts.

mG – Milligauss; a measure of magnetic field strength, one thousandth of a gauss.

Milligauss (mG) - A measure of magnetic field strength.


NIEHS – National Institute of Environmental Health Sciences.

Non-Ionizing Radiation – Radiation that does not have enough energy to ionize molecules or atoms.

NRPB. – National Radiation Protection Board.

OSHA – U.S. Occupational Safety and Health Administration.

Precautionary Principle – Where there are threats of serious or irreversible damage, precautionary measures should be taken even if cause-and-effect relationships are not clearly established.

RAPID - Research and Public Information Dissemination.

Right-of-way (ROW) – an easement, lease, permit, or license across an area or strip of land to allow access or to allow a utility to pass thought lands.

SCE – Southern California Edison Company.

WHO – World Health Organization.
Electric and Magnetic Field Considerations for the Paradise Valley Community

List of Preparers

This report was prepared by Charles Williams of PhaseLine LLC, for inclusion in the Paradise Valley Community Specific Plan EIR prepared by Envicom Corporation.

Mr. Williams has completed a wide range of power planning, routing, design, and construction projects for distribution class circuits through 500-kV ac and 100-kV dc. He has over 35 years of professional experience, including the development of project concepts and design criteria; identification of line routing and substation siting. Mr. Williams has extensive experience dealing with the environmental issues associated with transmission and substation projects and has prepared environmental documents, including feasibility evaluations for project alternatives and full environmental impact reports. He has prepared analysis of electric and magnetic fields (EMFs) from power lines and is versed in the body of research related to EMF and potential health effects. He served on the Washington State Legislature’s EMF Task Force Technical Committee. Mr. Williams has been involved in evaluating and communicating transmission line issues with diverse groups of stakeholders including state and federal agencies, regulatory bodies and public interest groups, and has participated in public hearings. He has been instrumental on more than 75 transmission line and substation projects in 20 states and overseas.