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Electric and Magnetic Fields

Electric and magnetic fields (EMF) exist wherever there is electricity, including transmission lines, distribution lines (even underground), household wiring, and appliances. Regardless of the source of the fields, the strength of the field reduces rapidly with increasing distance from the source. Similar to how the heat from a campfire decreases with distance. For both electric and magnetic fields, strength decreases more quickly with distance from "point" sources like appliances than from "line" sources such as power lines (CDHSPHI 1999).

For "line" sources, the voltage on the conductors of transmission lines generates an electric field in the space between the conductors and other conducting objects (e.g. ground). The electric field is calculated or measured in units of volts-per-meter (V/m) or kilovolts-per-meter (kV/m) at a distance of 1 meter (3 feet) above the ground. The current flowing in the conductors on transmission lines generates a magnetic field in the air and earth near the transmission line. The magnetic field is expressed in milligauss (mG) and is usually measured for "line" sources at 3 feet above the ground. The electric field at the surface of the conductors causes a phenomenon known as corona. Corona is the electrical breakdown or ionization of air in strong electric fields and is the source of audible noise, electromagnetic radiation, visible light and very small quantities of ozone.

Like sound, electric and magnetic fields are made of a mixture of components and can be described in many different ways. Both have wave-like properties such as strength and "frequency." Similar to sound, EMF can be strong or weak, have a high or low frequency, have sudden increases in strength or be constant. For example, the strength of a field can be weak and constant, as in most nighttime home environments, or it can be strong and vary from high to low every few seconds, as is the case with an electric blanket set on high (CDHSPHI 1999).

There are standard techniques and principles for calculating electric and magnetic fields. For both electric and magnetic fields, the maximum or peak field occurs in areas near the centerline and at the mid-span of the transmission line where the conductors are closest to the ground. Electric fields can be shielded or weakened by surrounding vegetation, topography, building and even the human skin. Magnetic fields are not so easily weakened by these elements. Table 33 illustrates predicted magnetic field strengths at a height of 3 feet above ground at various distances away from a similarly constructed 115kV line.

A typical American home has a background magnetic field level ranging from 0.5 mG to 4 mG, with an average value of 0.6 mG. Most ordinary electrical equipment produces higher magnetic fields closer to the source (USDE 1996). For comparison purposes, Table 34 provides magnetic field strengths at various distances from typical household appliances. Both tables use milliGauss as the unit of measure.

Table 33. Predicted mean magnetic field strengths from centerline for a 115kV power line (NIEHS 2002)

Distance in Feet Three Feet Above Ground	Predicted Fields (mG)
0 (centerline)	29.7
50 (edge of right-of-way)	6.5
100	1.7
200	0.4
300	0.2

Table 34. Examples of magnetic fields at particular distances from appliances

Appliance	At 1 foot (mG)	At 3 feet (mG)
Can opener	7.19-163.02	1.3-6.44
Coffee machine	0.09-7.30	0-0.61
Computer monitor	0.20-134.7	0.01-9.37
Dishwasher	4.98-8.91	0.84-1.63
Microwave oven	0.59-54.33	0.11-4.66
Radio	0.43-4.07	0.03-0.98
Refrigerator	0.12-2.99	0.01-0.60
Television	1.80-12.99	0.07-1.11
Toaster	0.29-4.63	0.01-0.47
Vacuum	7.06-22.62	0.51-1.28

While research has not indicated that exposure to any specific field strength results in an adverse health effect, the above comparative data illustrates the fields from the proposed 115 kV line are similar to many typical fields people encounter daily. Using standard epidemiological practices, several EMF human health studies have used average exposures of 2 or 3 mG as an arbitrary cut-off point to define broad categories of exposures. Below this level, subjects were considered “un-exposed,” and above this level, they were considered “exposed” (USDE 1996).

Affected Environment

Possible effects associated with the interaction of transmission line EMF with people on and near a right-of-way fall into two categories: short-term effects that can be perceived and may represent a nuisance and potential long-term health effects. Short-term effects from transmission line electric fields are associated with the perception of induced currents and voltages or perception of the field. Induced current or spark discharge shocks can be experienced under certain conditions when a person contacts objects in an electrical field. Such effects occur in fields associated with transmission lines with voltages of 230 kV or higher, thus would not occur under this proposal.

Short-term effects from magnetic fields are not anticipated. There is no evidence that suggests people, animals or plants can respond to or be harmed by magnetic fields at levels associated with this project. Electric fields greater than 2 kV/m in theory may interfere with cardiac pacemakers.

Most pacemakers, however, are designed to be immune to such interference, and few people wear susceptible pacemakers (USDA 1996, pp. 4.16-10).

Concern about possible long-term health hazards from electric power use is supported by results from some scientific studies, but the evidence they provide is still incomplete and inconclusive and even, in some cases, contradictory (CDHSPHI 1999). Scientific research has studied the potential effects from long-term exposure to EMF. Questions about cancer and reproductive effects have been raised on the basis of biological responses observed in cells or in animals, or on the basis of associations between surrogate measures of power line fields and cancer reported in some of the epidemiological studies.

In 1998, a working group of experts gathered by the EMF – Research and Public Information Dissemination (EMF-RAPID) program met to review research that has been done on the possible health risks associate with EMF. This group reviewed studies that had been completed on the subject. They released their final report to Congress in 1999, which explains the program's findings, including the results of its working group and many research projects. The final report states the National Institute of Environmental Health Sciences believes there is weak evidence for possible health effects from ELF-EMF exposures, and until stronger evidence changes this opinion, inexpensive and safe reductions should be encouraged.

> *After reviewing all the data, the U.S. National Institute of Environmental Health Sciences (NIEHS) concluded in 1999 that the evidence was weak, but that it was still sufficient to warrant limited concern. The NIEHS rationale was that no individual epidemiological study provided convincing evidence linking magnetic field exposure with childhood leukemia, but the overall pattern of results for some methods of measuring exposure suggested a weak association between increasing exposure to EMF and increasing risk of childhood leukemia. The small number of cases in these studies made it impossible to firmly demonstrate this association. However, the fact that similar results had been observed in studies of different populations using a variety of study designs supported this observation (NIEHS 2002).*

In a report prepared by the Virginia Department of Health (1995), it was determined that "it is not yet possible to ascribe EMF from high voltage transmission lines as an etiologic factor for cancers in humans." Moreover, these reviews indicate that apart from suggesting some biological responses, particularly in higher strength fields, the data do not indicate exposures, such as those encountered in daily life, can be said to have adverse effects. For additional information, see *Summary of Electric and Magnetic Field (EMF) Studies* and *Bibliography*. [275]

Environmental Consequences

Table 35. Number of homes within proposed 115 kV centerline by alternatives and the option

Land Status	Alternative				Option
	A	B	C	D	
Private residences within 50 feet of centerline	8	0	8	0	0
Private residences within 50-300 feet of centerline	0	0	0	0	0

Alternative C is the only action alternative that would be in proximity of residences. Homes in the vicinity of the existing 25 kV line (Alternative A) would not change under any of the action alternatives. Alternatives B and D or the Option would have no potential EMF effects on residents.

Fire

Affected Environment

General fire hazards and risk to forest land are based on several factors: local climate, vegetation type and density, accessibility and response time from local fire protection agencies. The study area for fire is the southern half of the Tres Piedras Ranger District. NM 567 bisects the study area, and U.S. 285 passes through the area making an approximate 90-degree bend upon crossing Comanche Rim. Many National Forest System roads and user-created, two-track roads exist in the study area. The forest cover type is piñon-juniper woodland. Interspersed within the woodland areas are low elevation grasslands, revegetated areas and sagebrush.

Usually the higher portions of the Tres Piedras District experience deep snowpack during winters and frequent rain during the months of June through early August. The general climate is warm with small amounts of snow in winter and scattered thunderstorms June through August. Since 1996, the study area has experienced drought weather conditions. Past history using tree ring evidence has shown that the southwestern portion of the study area underwent extended droughts. The weather pattern since 1996 mimics a long drought period in the 1950s. Historically, wildfires have occurred during these drought periods. According to Forest Service fire personnel, any type of vegetation is susceptible to fire during periods of local drought. Tree density, downed fuels, and ground cover influence the rate of spread and the intensity of the fire.

Trees in the piñon-juniper woodland are dense with ground vegetation covering up to 40 percent of the surface with minimal downed fuels. The extensive outbreak of the *Ips* beetle will contribute to woody debris and potential fuels in the project area over the next few years. Insects (mainly ants) or other organisms tend to rapidly decompose downed fuels. Woody material over about 2 inches in diameter is likely to be collected and used for domestic firewood. In short, downed woody material normally disappears from the site quickly and ground cover is not sufficient to permit extensive ground fires.

Fire History: The study area has no recorded wildfires in the past 20 years (personal discussion with Loren Suazo, Tres Piedras Ranger District fire management officer). Prescribed burning to improve range conditions by reducing big sagebrush or preserving revegetation areas has proven to be difficult. The large interspaces between grasses, which carry a fire, and sagebrush, which is the vegetation that needs to be burned, have contributed to the difficulty in completing prescribed

burns. Consequently, current vegetation conditions are also unlikely to permit wildfires to burn or even become large in size. However, a wind driven event could occur that may cause a large fire to develop.

Table 36. Estimated firefighter response times in minutes

Station	North End of Study Area (Tres Piedras Connection to Comanche Rim)	South End of Study Area (Ojo Caliente to Comanche Rim)	Middle of Study Area (Tres Piedras/Ojo Caliente to Carson)
Tres Piedras District Office (FS)	20 to 40	20 to 40	35 to 45
Taos Pueblo (BIA)	75 to 105	90 to 130	75 to 105
Taos Field Office (BLM)	75 to 105	90 to 130	90 to 130
Tres Piedras Volunteer Fire Dept.	20 to 40	20 to 40	35 to 45
Ojo Caliente Volunteer Fire Dept.	15 to 30	30 to 40	15 to 30

Fire Protection Services: Forest Service and Bureau of Land Management fire crews, and two volunteer fire departments (Tres Piedras and Ojo Caliente) are available for assistance in the event of a wildfire or a fire started by a downed power line. The New Mexico State Forestry Department is the umbrella agency for all New Mexico rural volunteer fire departments. The Forest Service has a Joint Powers Agreement with the Bureau of Indian Affairs (BIA), Bureau of Land Management and the New Mexico State Forestry Department to fight fires regardless of jurisdiction. The Bureau of Land Management's Taos Resource Area office is located in Taos, New Mexico. Although the majority of the proposed project falls outside of their land jurisdiction, they do have firefighting resources, which are at the disposal of the Carson National Forest because of the Joint Powers Agreement.

Environmental Consequences

In any of the alternative locations, the proposed 115 kV transmission line could affect future fire events in several ways. Normally, a transmission corridor removes the vegetation down to low shrubs and ground cover. However, the tree canopy of the piñon-juniper in the study area has a maximum height of about 30 plus feet. The removal of vegetation is not expected for the alternative corridors. The development of a two-track under the line would be needed to access the area for construction and would act as a firebreak. The height of the proposed transmission line (approximately 55 plus feet above ground) poles would make it susceptible to lightning strikes. Consequently, the transmission line would be equipped with a static wire as the uppermost line. The static wire is designed to ground out lightning strikes before ignition. As with all electric lines, there is the possibility that the line or the pole could be knocked down by wind or some other natural cause which could result in arcing and lead to a fire start. The fire history of the area indicates any arcing would not lead to a wildfire affecting other than a few trees and a small area of vegetation.

Alternative Comparison: Alternative A would result in no changes to the existing fire risk. In case of fire occurrence along the Alternative B route, Forest Road 558 and U.S. 285 would provide access to anywhere along its location. Since the existing corridor runs almost entirely along NM 567 and U.S. 285, accessing a fire caused by the possible downing of Alternative C would

not be a problem. Forest Road 285P and then a two-track under the line north of U.S. 285 would provide access for firefighters to Alternative D. The Tres Piedras Connection would be fully accessible from U.S. 285.

The height of the transmission line proposed in any of the alternatives would be above the tree canopy. Safety features built into the line would likely prevent a first start from a broken line. Without continuous forest canopies and downed fuels the rate of fire spread is slowed down, making it much easier to control the fire event. In the event a fire started, history shows minimal spread. The result would be minimal changes to the existing fire risk for any action alternative.

Roads 1/

A forest roads analysis report was released in April 2003. [271] The roads analysis provides information regarding arterial and collector roads, as well as highways. It is designed to identify the components of an optimum road system, one that reflects land management objectives. The primary objective of the report is to provide the forest supervisor and district rangers with information necessary to implement road systems that are efficiently managed, have minimal ecological effects, and are in balance with available funding.

Roads maintained for high clearance vehicles, closed roads and unidentified roads are not included in the forest roads analysis. This project-level analysis includes existing roads that may be used for construction or maintenance of a new power line located in existing or proposed utility corridors. Since the most relevant effects of roads are associated with watershed conditions, a more detailed effects analysis regarding roads is found in that section.

Affected Environment

The area of consideration for this project-level roads analysis is limited to the alternatives for the proposed power line to Ojo Caliente from an existing 115 kV line west of the Rio Grande Gorge in Taos County, New Mexico. Three alternatives leave the existing line at different locations, proceeding north and/or west to a proposed substation location near the intersection of NM 111 and U.S. 285 in Ojo Caliente. The study area is bounded on the east by private lands near Carson; the north along NM 567; the south by the Carson National Forest boundary; and the west by the Rio Ojo Caliente. The study area is on the Tres Piedras Ranger District of the Carson National Forest and Bureau of Land Management lands on the western edge. A portion of the study area is located adjacent to U.S. 285 north of the existing microwave tower (where U.S. 285 makes a 90-degree bend) to the existing power line coming south from Tres Piedras.

The topography of the study area is fairly flat, interspersed with low, broad ridges and wide drainage bottoms. Comanche Rim is the most abrupt change in the topography. This rim does not continue south of U.S. 285.

The general area south of U.S. 64, including the study area, is an unrestricted off-road vehicle travel area. This designation was made during the forest planning process and is included in the Carson National Forest Plan implemented in 1986. This designation has not been changed for the study area. This project does not propose to modify or otherwise change the current unrestricted off-road designation for the study area.

The study area contains portions of four roads included in the forest roads analysis. Three of these roads are paved roads maintained by the State of New Mexico—U.S. 285, NM 567 and NM 111. The fourth is FR 97, a National Forest System road, a native surface road maintained by the Forest Service (Figure 17). Other major roads not in the forest roads analysis are Maintenance Level 2 roads. The Forest Service maintains these roads. User-created, two-track roads are not numbered and are not part of the national forest road system.

Currently Forest Service system and nonsystem roads provide access for a variety of uses. These uses include firewood gathering, hiking, hunting, as well as, access to private lands, electronic sites and existing utility lines. The roads in this area are not seasonally closed, except Forest Road 97 to protect wildlife resources.

An old service road is located on National Forest System lands immediately beneath the existing 25 kV distribution line, running from Carson west along NM 567 through the national forest to BLM lands, approximately 2 miles east of Ojo Caliente. Although Kit Carson Electric Cooperative maintenance crews utilize the road for access, several stretches are too rough to be used by vehicles so crews hike in. The remainder of the service road is more accessible and can be used by maintenance crews. Some portions of the distribution line are accessed from other existing roads and highways.

There are 2.2 miles that are considered to be associated with the existing 25 kV line on BLM land. Only about one-half mile of these roads is directly under the existing line. Although the remainder of these roads are in the vicinity of the line and are likely to be used if maintenance or repairs were required, it is uncertain as to the origin of the road, and the majority of the use is likely not to be associated with the power line.

Due to the relatively flat, open terrain and the open policy to motorized use, forest users have developed numerous two-track roads within the study area. These roads may be used once to access sick livestock, hunting successes, fences, and firewood or for cross-country driving. Other two-track roads were developed for the same reasons, but now exist due to others driving the same route. These roads are unplanned and may be poorly located. There is no proposal in this project to close any of these unnumbered and mostly unmapped two-track roads. Usually within one season of a road closure, a new two-track road forms within a few feet of the closed road.

The topography of the study area is fairly flat, interspersed with low, broad ridges and wide drainage bottoms. Comanche Rim is the most abrupt change in the topography. This rim does not continue south of U.S. 285. Travel is basically unrestricted. A new two-track road within a few feet of the closed road would follow closure of a road usually within one season.

Environmental Consequences

Since cross-county travel is unlimited, additional two-track roads may be developed during construction and/or maintenance of a utility corridor. Any two-track roads developed for construction and/or maintenance of a utility corridor will have measures taken to minimize travel (MM SW5, SW 6 and SW17). This effects analysis assumes these mitigation measures will be applied under any of the action alternatives and the option.

The mileage of anticipated two-track roads that may be developed is predicated on driving the entire length of the utility corridor in a high clearance vehicle. Use of low ground pressure vehi-

cles or equipment would reduce the impacts and estimated mileage (MM SW4). The travel route would not be as noticeable as two distinct tracks across the landscape. Since the area is unrestricted on the national forest for off-road travel, there would be no restriction from traveling under a new utility corridor. To the extent possible, existing roads would be used for corridor inspection. Hence two-track roads that may be developed during construction could disappear through nonuse.

Alternatives B and D were developed considering access for construction and maintenance of the proposed line. The alternative routes were identified in close proximity to existing roads wherever possible. Any new two-track roads developed to place poles and string lines would be restricted to vehicular use after line construction. Line maintenance activities would use any two-track roads developed during line construction. Placement of slash and reseeding would aid in restricting vehicular use to minimal levels. Other National Forest System roads provide access to many parts of the proposed locations and short walking access to much of the remainder of the proposed line locations. These roads would remain open.

Road use can cause direct, indirect and cumulative effects on watershed resources and forest user access. The *Soil and Water* section of this chapter identifies the number of miles of estimated two-track road development that would occur for each alternative and discusses the effects on watershed values. This section discusses the direct, indirect and cumulative effects of roads resulting from each alternative on forest user access.

Alternative A - No Action

Alternative A would result in no effects to existing roadways. No new roads would be developed and public access to the national forest would not change. No increased forest user access would be associated with this alternative.

Alternative B - Black Mesa-Cerro Azul Tap

Alternative B would tap into the existing 115 kV Hernandez to Taos transmission line approximately 1.5 miles northeast of Black Mesa on the Carson National Forest. The line would run north/northwest along Forest Road 558 for about 6.7 miles and connect into the existing 25 kV distribution line, located just north of U.S. 285—also located on the Carson National Forest. It would follow the 25 kV right-of-way for about 1 mile, where it would leave the Carson National Forest and enter lands administered by the BLM. Then the line would follow the existing corridor west and slightly south for 1.9 miles to the location of the proposed substation just north of the intersection of U.S. 285 and NM 111.

Existing roads would be the main access for most of the proposed corridor. Construction vehicles would need to cross some unroaded terrain near where Alternative B taps into the existing 115 kV line. Once the route aligns with the existing 25 kV corridor, current access routes would be utilized. It is likely that the newly created access would be open during the full construction period, estimated to be approximately 1 year. Forest Service roads currently open that are used for construction would remain open.

Alternative C - Existing Corridor

Alternative C would result in no effects to existing roadways. No new roads would be developed and public access to the national forest would not change. No increased forest user access would be associated with this alternative.

Alternative D - 285P Tap

Alternative D would tap into the existing 115 kV Hernandez to Taos transmission line on National Forest System lands where it intersects Forest Road 285P. A new 115 kV transmission line would proceed north, following the bottom of Cañada Embudo, along existing Forest Road 285P, for 4.8 miles. It would swing west and cross U.S. 285 where the highway turns westward to Ojo Caliente. It would run parallel to U.S. 285 for about 5.7 miles on national forest, at a distance of up to one-half mile north from the highway. It would then enter BLM lands and intersect with the existing 25 kV distribution line. The line would follow the existing corridor west and slightly south to the location of the proposed substation just north of the intersection of U.S. 285 and NM 111 for 1.9 miles on BLM lands.

Existing Forest Road 285P would provide access to pole locations along almost 5 miles of corridor. After crossing U.S. 285, mostly other existing two-track roads and FR 97 would be used to access the proposed utility corridor. Once the route aligns with the existing corridor, current access routes would be utilized. It is likely that the newly created access would be open during the full construction period, estimated to be approximately 1 year. Forest Service roads currently open that are used for construction would remain open.

Option – Tres Piedras Connection

This route would use the existing U.S. 285 highway right-of-way for access during construction. There would be no need to construct or use other roads. The disturbed right-of-way provides room to place poles and maintain the power line connection to Tres Piedras.

Cumulative Effects

The above effects analysis took into consideration the past and present road system in the study area for each alternative. Cumulative effects also include any actions that are reasonably foreseeable that may, along with the implementation of an alternative, have a cumulative effect on road access in the study area. The forest roads analysis reviewed the existing road system and did not recommend closing existing roads or creating any new roads. It is, therefore, anticipated that no additional cumulative impacts on public land access would occur as a result of any of the action alternatives or the Tres Piedras Connection. Chapter 3, *Soil and Water* provides a comprehensive cumulative impact analysis of the physical impacts of roads relative to each of the alternatives.