3.15 PUBLIC HEALTH AND SAFETY

This section describes the potential public health and safety effects that could occur during construction and operation of the proposed Project facilities. The primary potential threats to public health and safety include fire hazards, the accidental release of hazardous materials, aviation hazards including military operations, and the low level exposure to electric and magnetic fields (EMF). Potential effects to public health and safety from each of these sources for each alternative, including No Action, are described below.

3.15.1 Methodology

The analysis incorporated comments from the public scoping process that was conducted from July to September 2009 and the DEIS comment period from July through September 2010. Comments from agency representatives, local organizations and private citizens requested that the following issues be addressed with regards to public health and safety:

- Discussion of whether a plan would be developed to manage potential hazardous waste spills.
- Potential effects to human and bird health from Project generation of electromagnetic fields.

In addition to issues identified during scoping, comments received on the DEIS from the Regional Environmental Coordinator, Region 10, Department of Defense requested that the FEIS consider the effects of the proposed Project on aviation, specifically low-level military air operations.

3.15.1.1 Fire Hazards

The area of analysis (Project Area) for fire hazards was comprised of a 150-foot wide corridor along the route alternatives (i.e., 75 feet on each side of the right-of-way (ROW) centerline), in addition to the access roads, interconnection stations, substation, and the Echanis Wind Energy Project (Echanis Project). The methodology for analyzing effects included evaluating Project activities and equipment that could pose fire hazards.

3.15.1.2 Hazardous Materials

The area of analysis (Project Area) for hazardous materials was the same as described for fire hazards and is comprised of a 150-foot wide corridor along the route alternatives (i.e., 75 feet on each side of the ROW centerline), access roads, interconnection stations, substation, and the Echanis Project. The methodology for analyzing effects included identifying general types of hazardous materials and techniques that would likely be used during Project construction, operation, and maintenance, as well as determining the likelihood that contaminated sites would be encountered during Project construction.

No Phase 1 Environmental Site Assessments (ESAs) were conducted as part of this analysis. Phase I ESAs would be used as part of due diligence inquiries of property to identify potential environmental liabilities. The standards require site reconnaissance and research to identify any past or present environmental concerns that could pose a threat to the property related to hazardous materials and petroleum products, including effects from neighboring properties. While this type of investigation was not conducted for this Project, existing and past land use activities would be recognized indicators of potential hazardous materials storage and use. The likelihood of encountering hazardous materials sites based on the land uses in the Project Area was therefore described. In addition, the Oregon Department of Environmental Quality (ODEQ) maintains an Environmental Cleanup Site Information (ECSI) database that discloses sites located within the state with known or potential contamination from hazardous substances. This database was used to determine the proximity of potentially contaminated sites to the Project Area in order to determine the likelihood of hazardous materials discovery during Project construction.

3.15.1.3 Electric and Magnetic Fields

The EMF analysis describes and quantifies the electrical effects of all potential phases of the proposed North Steens transmission line project. These effects include the following:

- The levels of 60-hertz (Hz; cycles per second) EMF at 3.28 feet (ft.) or 1 meter (m) above the ground,
- The effects associated with those fields,
- The levels of audible noise produced by the line, and
- Electromagnetic interference associated with the line.

Electrical effects occur near all transmission lines, including existing 115- and 230-kV lines in Oregon. Levels of these quantities for the proposed line are computed and compared with those from existing lines in Oregon.

The line would be constructed on double-circuit steel-pole towers. During Phase I, a single-circuit would be installed on one side of each pole and operated at 115-kV. During Phase II, a second circuit would be installed on the other side of each pole and operated at 230-kV. During Phase III, the operational voltage of the Phase I 115-kV line would be increased to 230-kV. All of the Project components installed with the first circuit would meet 230-kV design standards. The second circuit would be added in the future, if needed, to serve other wind energy projects developed in the area.

Two alternative routes are being considered for the proposed line – the West Route and the North Route. Both of these routes would entail construction on new ROW with no existing parallel high-voltage transmission lines. For the purposes of assessing electrical effects, both routing alternatives are equivalent, since the line design and operating characteristics would be the same for both. Thus, the three configurations of interest for this report are the proposed line design with the operational characteristics of Phases I, II and III. There are no electrical effects associated with the No Action (no-build) Alternative that can be compared with the action of constructing the proposed transmission line.

The voltage on the conductors of transmission lines generates an electric field in the space between the conductors and the ground. The electric field is calculated or measured in units of volts-per-meter (V/m) or kilovolts-per-meter (kV/m) at a height of 3.28 ft. (1 m) above the ground. The electric current flowing in the conductors of the transmission line generates a magnetic field in the air and earth near the transmission line; current is expressed in units of amperes (A). The magnetic field is expressed in milligauss (mG), and is also usually measured or calculated at a height of 3.28 ft. (1 m) above the ground. The relatively high electric field at the surface of the conductors causes the phenomenon of corona. Corona is the electrical breakdown or ionization of air in very strong electric fields, and is the source of audible noise, electromagnetic radiation, and sometimes visible light.

To quantify EMF levels along the route, the electric and magnetic fields from the proposed transmission line were calculated using the Bonneville Power Administration (BPA) Corona and Field Effects Program (USDOE n.d.). In this program, the calculation of 60-Hz fields uses standard superposition techniques for vector fields from several line sources: in this case, the line sources are transmission-line conductors. (Vector fields have both magnitude and direction: these must be taken into account when combining fields from different sources.) Important input parameters to the computer program are voltage, current, and geometric configuration of the line. The transmission-line conductors are assumed to be straight, parallel to each other, and located above and parallel to an infinite flat ground plane. Although such conditions do not occur under real lines because of conductor sag and variable terrain, the validity and limitations of calculations using these assumptions have been well verified by comparisons with measurements. This approach was used to estimate fields for the proposed North Steens line, where minimum clearances were assumed to provide worst-case (highest) estimates for the fields.

Electric fields are calculated using an imaging method. Fields from the conductors and their images in the ground plane are superimposed with the proper magnitude and phase to produce the total field at a selected location.

The total magnetic field is calculated from the vector summation of the fields from currents in all the transmission-line conductors. Balanced (equal) currents are assumed for each three-phase circuit; the contribution of induced image currents in the conductive earth is not included. Estimates of peak and average currents were estimated by the Echanis Project engineering team for years when the various phases of the project would be operational.

Electric and magnetic fields for the proposed line were calculated at the standard height (3.28 ft. or 1 m) above the ground (IEEE 1994). Calculations were performed out to 300 ft. (91 m) from the centerline of the existing corridor. The validity and limitations of such calculations have been well verified by measurements. Because maximum voltage, maximum current, and minimum conductor height above-ground are used, the calculated maximum or peak values given here represent worst-case conditions: i.e., the calculated fields are higher than they would be in practice. Such worst-case conditions would seldom occur. Fields were also calculated for more typical or average conditions of average clearance along a span, average voltage and average current to characterize the fields expected along the entire line over a year.

Levels of corona-generated audible noise, radio interference, and television interference were also predicted. See Appendix C "North Steens EMF Report" for a discussion of those potential effects.

3.15.2 Affected Environment

3.15.2.1 Fire Hazards

The Project Area is located in a region susceptible to large-scale wildfires. This Project would be subject to state, county, and federally enforced laws, ordinances, rules, and regulations that pertain to prevention and suppression of fire activities.

3.15.2.2 Hazardous Materials

For the purposes of this discussion, hazardous materials are defined as those chemicals listed in the EPA Consolidated List of Chemicals Subject to Reporting under Title III of the Superfund Amendments and Reauthorization Act of 1986. Extremely hazardous materials are defined by federal regulation in 40 CFR Part 355. Use, storage, and disposal of hazardous materials are regulated by numerous local, state, and federal laws. Existing laws that the Applicant would be required to comply with for the Project include, but are not limited to, local emergency planning laws and programs; U.S. Department of Transportation regulations related to the transport of hazardous substances; the Resource Conservation and Recovery Act (RCRA); Toxic Substances Control Act; Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); Superfund Amendments and Reauthorization Act (SARA); Emergency Planning and Community Right-to-Know Act; Clean Water Act; Clear Air Act; and 40 CFR 260-302.

Existing and past land use activities would be potential indicators of hazardous materials storage and use. The Project would be located in a rural area that is designated as Farm & Ranch Use under the Harney County Land Use Planning Zones. Unknown contamination could have resulted from farms that commonly have old or inactive underground storage tanks or from pesticide-laden runoff from agricultural properties. However, given the Project Area remains largely undeveloped, it is unlikely a notable amount of environmental contamination is present along the route alternatives.

A records search of ODEQ's ECSI database reveals 52 sites with known or potential contamination from hazardous materials located within Harney County (ODEQ). Of these, four sites would be located within one mile of the proposed transmission line under Alternative C:

- Anderson Valley Supply, Crane (Site ID: 5186).
- Crane Bulk Plant, Crane (Site ID: 2779).
- Crane Disposal, Crane (Site ID: 5187).
- Crane Gas Station (Site ID: 3109).

These sites would be located north of the Project Area within the community of Crane. None of these sites would be traversed by the proposed developments.

Only a few rural ranch houses near the transmission line route alternatives could potentially be exposed to hazardous materials associated with Project construction and operation. If the West Route is selected, only two residences would be closer than 1,300 feet with the nearest at 550 feet. If the North Route is selected only five residences would be within 1,300 feet of the line, with the nearest residence at 75 feet. The other four houses would be 200 feet or greater from the line.

3.15.2.3 Electric and Magnetic Fields

Regulations

Regulations that apply to transmission-line electric and magnetic fields fall into two categories. Safety standards or codes are intended to limit or eliminate electric shocks that could seriously injure or kill persons. Field limits or guidelines are intended to limit electric- and magnetic-field exposures that can cause nuisance shocks or that might cause health effects. In no case has a limit or standard been established because of a known or demonstrated health effect.

The proposed line would be designed to meet the National Electric Safety Code (NESC) (IEEE 2002), which specifies how far transmission-line conductors must be from the ground and other objects. The clearances specified in the code provide safe distances that prevent harmful shocks to workers and the public. In addition, people who live and work near transmission lines must be aware of safety precautions to avoid electrical (which is not necessarily physical) contact with the conductors. For example, farmers should not up-end irrigation pipes under a transmission or other electrical line or direct the water stream from an irrigation system into or near the conductors. In addition, as a matter of safety, the NESC specifies that electric-field-induced currents from transmission lines must be below the 5 mA ("let go") threshold deemed a lower limit for primary shock. Safety practices to protect against shock hazards near power lines are described in a brochure available from the Bonneville Power Administration (USDOE 2007).

Field limits or guidelines have been adopted in several states and countries and by national and international organizations (Maddock 1992). Electric-field limits have generally been based on minimizing nuisance shocks or field perception. The intent of magnetic-field limits has been to limit exposures to existing levels, given the uncertainty of their potential for health effects.

General guidelines for EMF exposure have been established for occupational and public exposure by national and international organizations. Three sets of such guidelines are described in Table 3.15-1.

Table 3.15-1 Electric and Magnetic Field Exposure Guidelines

Organization	Type of Exposure	Electric Field kV/m	Magnetic Field mG
ACGIH	Occupational	25[a]	10,000
ICNIRP	Occupational	8.3[b]	4,200
	General Public	4.2	833
IEEE	Occupational	20	27,100
	General Public	5[c]	9,040

[a] Grounding is recommended above 5 –7 kV/m and conductive clothing is recommended above 15 kV/m.
[b] Increased to 16.7 kV/m if nuisance shocks are eliminated.
[c] Within power line rights-of-way, the guideline is 10 kV/m.
Sources: ACGIH 2008; ICNIRP 1998; ICES 2002.

The American Conference of Governmental Industrial Hygienists (ACGIH) sets guidelines (Threshold Limit Values or TLV) for occupational exposures to environmental agents (ACGIH 2008). In general, a TLV represents the level below which it is believed that nearly all workers may be exposed repeatedly without adverse health effects. For EMF, the TLVs represent ceiling levels. For 60-Hz electric fields, occupational exposures should not exceed the TLV of 25 kV/m. However, the ACGIH also recognizes the potential for startle reactions from spark discharges and short-circuit currents in fields greater than 5-7 kV/m, and recommends implementing grounding practices. They recommend the use of conductive clothing for work in fields exceeding 15 kV/m. The TLV for occupational exposure to 60-Hz magnetic fields is a ceiling level of 10 G (10,000 mG) (ACGIH 2008). These ACGIH occupational levels are all above the electric fields that would be present on the ROW.

The International Committee on Non-ionizing Radiation Protection (ICNIRP), working in cooperation with the World Health Organization (WHO) has developed guidelines for occupational and public exposures to EMF (ICNIRP 1998). For occupational exposures at 60 Hz, the recommended limits to exposure are 8.3 kV/m for electric fields and 4.2 G (4,200 mG) for magnetic fields. The electric-field level can be exceeded, provided precautions are taken to prevent spark discharge and induced current shocks. For the general public, the ICNIRP guidelines recommend exposure limits of 4.2 kV/m for electric fields and 0.83 G (830 mG) for magnetic fields (ICNIRP 1998).

More recently the International Committee on Electromagnetic Safety (ICES) under the auspices of the IEEE has established exposure guidelines for 60-Hz electric and magnetic fields (ICES 2002). The ICES recommended limits for occupational exposures are 20 kV/m for electric fields and 27,100 mG for magnetic fields. The recommended limits for the general public are lower: 5 kV/m for the general public to electric fields, except on power line rights-of-way where the limit is 10 kV/m; and 9,040 mG for magnetic fields.

Electric and magnetic fields from various sources (including automobile ignitions, appliances and, possibly, transmission lines) can interfere with implanted cardiac pacemakers. In light of this potential problem, manufacturers design devices to be immune from such interference. However, research has shown that these efforts have not been completely successful and that a few models of older pacemakers still in use could be affected by 60-Hz fields from transmission lines. There were also numerous models of pacemakers that were not affected by fields larger than those found under transmission lines. Because of the known potential for interference with pacemakers by 60-Hz fields, field limits for pacemaker wearers have been established by the ACGIH. They recommend that, lacking additional information about their pacemaker, wearers of pacemakers and similar medical-assist devices limit their exposure to electric fields of 1 kV/m or less and to magnetic fields to 1 G (1,000 mG) or less (ACGIH 2008). Additional discussion of interference with implanted devices is given in the accompanying technical report on health effects (Exponent 2009).

There are currently no national standards in the United States for 60-Hz electric and magnetic fields. Oregon's formal rule in its transmission-line-siting procedures specifically addresses field limits. The Oregon limit of 9 kV/m for electric fields is applied to areas accessible to the public (State of Oregon 1980). The Oregon rule also addresses grounding practices, audible noise, and radio interference. Oregon does not have a limit for magnetic fields from transmission lines.

Besides Oregon, several states have been active in establishing mandatory or suggested limits on 60-Hz electric and (in two cases) magnetic fields. Five other states have specific electric-field limits that apply to transmission lines: Florida, Minnesota, Montana, New Jersey, and New York. Florida and New York have established regulations for magnetic fields. These regulations are summarized in Table 3.15-2.

Government agencies and utilities operating transmission systems have established design criteria that include EMF levels. BPA has maximum allowable electric fields of 9 and 5 kV/m on and at the edge of the ROW, respectively (USDOE 1996). BPA also has maximum-allowable electric-field strengths of 5 kV/m, 3.5 kV/m, and 2.5 kV/m for road crossings, shopping center parking lots, and commercial/ industrial parking lots, respectively. These levels are based on limiting the maximum short-circuit currents from anticipated vehicles to less than 1 mA in shopping center lots and to less than 2 mA in commercial parking lots.

Table 3.15-2 States with Transmission Line Field Limits

State Agency	Within ROW	At Edge of ROW	Comments
a. 60-Hz Electric Field Limit (kV/m)			
Florida Department of Environmental Regulation	8 (230 kV) 10 (500 kV)	2	Codified regulation, adopted after a public rulemaking hearing in 1989.
Minnesota Environ- mental Quality Board	8	–	12-kV/m limit on the high voltage direct current (HVDC) nominal electric field.
Montana Board of Natural Resources and Conservation	7[a]	1[b]	Codified regulation, adopted after a public rulemaking hearing in 1984.
New Jersey Department of Environmental Protection	–	3	Used only as a guideline for evaluating complaints.
New York State Public Service Commission	11.8 (7,11)[c]	1.6	Explicitly implemented in terms of a specified ROW width.
Oregon Facility Siting Council	9	—	Codified regulation, adopted after a public rulemaking hearing in 1980.
b. 60-Hz MAGNETIC-FIELD LIMIT (mG)			
Florida Department of Environmental Regulation	–	150 (230 kV) 200 (500 kV)	Codified regulations, adopted after a public rulemaking hearing in 1989.
New York State Public Service Commission	–	200	Adopted August 29, 1990.

[a] At road crossings.

[b] Landowner may waive limit.

[c] At highway and private road crossings, respectively.

Source: USDOE 1996

Electric Fields Overview

BASIC CONCEPTS

An electric field is said to exist in a region of space if an electrical charge, at rest in that space, experiences a force of electrical origin (i.e., electric fields cause free charges to move). Electric field is a vector quantity: that is, it has both magnitude and direction. The direction corresponds to the direction that a positive charge would move in the field. Sources of electric fields are unbalanced electrical charges (positive or negative) and time-varying magnetic fields. Transmission lines, distribution lines, house wiring, and appliances generate electric fields in their vicinity because of unbalanced electrical charge on energized conductors. The unbalanced charge is associated with the voltage on the energized system. On the power system in North America, the voltage and charge on the energized conductors are cyclic (plus to minus to plus) at a rate of 60 times per second. This changing voltage results in electric fields near sources that are also time-varying at a frequency of 60 hertz (Hz; a frequency unit equivalent to cycles per second).

As noted earlier, electric fields are expressed in units of volts per meter (V/m) or kilovolts (thousands of volts) per meter (kV/m). Electric- and magnetic-field magnitudes in this report are expressed in root-mean-square (rms) units. For sinusoidal waves, the rms amplitude is given as the peak amplitude divided by the square root of two.

The spatial uniformity of an electric field depends on the source of the field and the distance from that source. On the ground, under a transmission line, the electric field is nearly constant in magnitude and direction over distances of several feet (one meter). However, close to transmission- or distribution-line conductors, the field decreases rapidly with distance from the conductors. Similarly, near small sources such as appliances, the field is not uniform and falls off even more rapidly with distance from the device. If an energized conductor (source) is inside a grounded conducting enclosure, then the electric field outside the enclosure is zero, and the source is said to be shielded.

Electric fields interact with the charges in all matter, including living systems. When a conducting object, such as a vehicle or person, is located in a time-varying electric field near a transmission line, the external electric field exerts forces on the charges in the object, and electric fields and currents are induced in the object. If the object is grounded, then the total current induced in the body (the "short-circuit current") flows to earth. The distribution of the currents within, say, the human body, depends on the electrical conductivities of various parts of the body: for example, muscle and blood have higher conductivity than bone and would therefore experience higher currents.

At the boundary surface between air and the conducting object, the field both in the air and perpendicular to the conductor surface is much, much larger than the field in the conductor itself. For example, the average surface field on a human standing in a 10 kV/m field is 27 kV/m; the internal fields in the body are much smaller: approximately 0.008 V/m in the torso and 0.45 V/m in the ankles.

TRANSMISSION LINE ELECTRIC FIELDS

The electric field created by a high-voltage transmission line extends from the energized conductors to other conducting objects such as the ground, towers, vegetation, buildings, vehicles, and people. The calculated strength of the electric field at a height of 3.28 ft. (one m) above an unvegetated, flat earth is frequently used to describe the electric field under straight, parallel transmission lines. The most important transmission-line parameters that determine the electric field at a 1-m height are conductor height above ground and line voltage.

Calculations of electric fields from transmission lines are performed with computer programs based on well-known physical principles (cf., Deno and Zaffanella 1982). The calculated values under these conditions represent an ideal situation. When practical conditions approach this ideal model, measurements and calculations agree. Often, however, conditions are far from ideal because of variable terrain and vegetation. In these cases, fields are calculated for ideal conditions, with the lowest conductor clearances to provide upper bounds on the electric field under the transmission lines. With the use of more complex models or empirical results, it is also possible to account accurately for variations in conductor height, topography, and changes in line direction. Because the fields from different sources add vectorially, it is possible to compute the fields from several different lines if the electrical and geometrical properties of the lines are known. However, in general, electric fields near transmission lines with vegetation below are highly complex and cannot be calculated. Measured fields in such situations are highly variable.

For evaluation of EMF from transmission lines, the fields must be calculated for a specific line condition. The NESC states that the condition for evaluating electric-field-induced short-circuit current for lines with voltage above 98 kV, line-to-ground, as follows: conductors are at a minimum clearance from ground corresponding to a conductor temperature of 122°F (50°C), and at a maximum voltage (IEEE 2002). The Applicant has supplied the information for calculating electric and magnetic fields from the proposed transmission line: the maximum operating voltage, the estimated peak currents, and the minimum conductor clearances.

There are standard techniques for measuring transmission-line electric fields (IEEE 1994). Provided that the conditions at a measurement site closely approximate those of the ideal situation assumed for calculations, measurements of electric fields agree well with the calculated values. If the ideal conditions are not approximated, the measured field can differ substantially from calculated values. Usually the actual electric field at ground level is reduced from the calculated values by various common objects that act as shields.

Maximum or peak field values occur over a small area at midspan, where conductors are closest to the ground. As the location of an electric-field profile approaches a tower, the conductor clearance increases, and the peak field decreases. A grounded tower would reduce the electric field considerably, by shielding.

For traditional transmission lines, such as the proposed line, where the ROW extends laterally well beyond the conductors, electric fields at the edge of the ROW are not as sensitive as the peak field to conductor height. Computed values at the edge of the ROW for any line height are fairly representative of what can be expected all along the transmission-line corridor. However, the presence of vegetation on and at the edge of the ROW would reduce actual electric-field levels below calculated values.

ENVIRONMENTAL ELECTRIC FIELDS

The electric fields associated with the North Steens transmission line can be compared with those found in other environments. Sources of 60-Hz electric (and magnetic) fields exist everywhere electricity is used; levels of these fields in the modern environment vary over a wide range. Electric-field levels associated with the use of electrical energy are orders of magnitude greater than naturally occurring 60-Hz fields of about 0.0001 V/m, which stem from atmospheric and extraterrestrial sources.

Electric fields in outdoor, publicly accessible places range from less than 1 V/m to 12 kV/m; the large fields exist close to high-voltage transmission lines of 230-kV or higher. In remote areas without electrical service, 60-Hz field levels can be much lower than 1 V/m. Electric fields in home and work environments generally are not spatially uniform like those of transmission lines; therefore, care must be taken when making comparisons between fields from different sources such as appliances and electric lines. In addition, fields from all sources can be strongly modified by the presence of conducting objects. However, it is helpful to know the levels of electric fields generated in domestic and office environments in order to compare commonly experienced field levels with those near transmission lines.

Numerous measurements of residential electric fields have been reported for various parts of the United States, Canada, and Europe. Although there have been no large studies of residential electric fields, sufficient data are available to indicate field levels and characteristics. Measurements of domestic 60-Hz electric fields indicate that levels are highly variable and source-dependent. Electric-field levels are not easily predicted because walls and other objects act as shields, because conducting objects perturb the field, and because homes contain numerous localized sources. Internal sources (wiring, fixtures, and appliances) seem to predominate in producing electric fields inside houses. Average measured electric fields in residences are generally in the range of 5 to 20 V/m. In a large occupational exposure monitoring project that included electric-field measurements at homes, average exposures for all groups away from work were generally less than 10 V/m (Bracken 1990).

Electric fields from household appliances are localized and decrease rapidly with distance from the source. Local electric fields measured at 1 ft. (0.3 m) from small household appliances are typically in the range of 30 to 60 V/m. In a survey, reported by Deno and Zaffanella (1982), field measurements at a 1-ft. (0.3-m) distance from common domestic and workshop sources were found to range from 3 to 70 V/m. The localized fields from appliances are not uniform, and care should be taken in comparing them with transmission-line fields.

Electric blankets can generate higher localized electric fields. Sheppard and Eisenbud (1977) reported fields of 250 V/m at a distance of approximately 1 ft. (0.3 m). Florig et al. (1987) carried out extensive empirical and theoretical analysis of electric-field exposure from electric blankets and presented results in terms of uniform equivalent fields such as those near transmission lines. Depending on what parameter was chosen to represent intensity of exposure and the grounding status of the subject, the equivalent vertical 60-Hz electric-field exposure ranged from 20 to over 3500 V/m. The largest equivalent field corresponds to the measured field on the chest with the blanket-user grounded. The average field on the chest of an ungrounded blanket-user yields an equivalent vertical field of 960 V/m. As manufacturers have become aware of the controversy surrounding EMF exposures, electric blankets have been redesigned to reduce magnetic fields. However, electric fields from these “low field” blankets are still comparable with those from older designs (Bassen et al. 1991).

Generally, people in occupations not directly related to high-voltage equipment are exposed to electric fields comparable with those of residential exposures. For example, the average electric field measured in 14 commercial and retail locations in rural Wisconsin and Michigan was 4.8 V/m (ITT Research Institute 1984). Median electric field was about 3.4 V/m. These values are about one-third the values in residences reported in the same study. Electric-field levels in public buildings such as shops, offices, and malls appear to be comparable with levels in residences.

In a survey of 1,882 volunteers from utilities, electric-field exposures were measured for 2,082 work days and 657 non-work days (Bracken 1990). Electric-field exposures for occupations other than those directly related to high-voltage equipment were equivalent to those for non-work exposure.

Thus, except for the relatively few occupations where high-voltage sources are prevalent, electric fields encountered in the workplace are probably similar to those of residential exposures. Even in electric-utility occupations where high field sources are present, exposures to high fields are limited on average to minutes per day.

Electric fields found in publicly accessible areas near high-voltage transmission lines can typically range up to 3 kV/m for 230-kV lines, to 10 kV/m for 500-kV lines, and to 12 kV/m for 765-kV lines. Although these peak levels are considerably higher than the levels found in other public areas, they are present only in limited areas on rights-of-way.

The calculated electric fields for the proposed North Steens transmission line are consistent with the levels reported for other 230-kV transmission lines in Oregon, Washington, and elsewhere. The calculated electric fields on the ROW of the proposed transmission line are generally much higher than levels normally encountered in residences and offices.

Only a few rural ranch houses are located near the transmission line route alternatives. If Alternative B is selected, only two residences would be closer than 1300 feet with the nearest at 550 feet. If Alternative C is selected only five residences would be within 1300 feet of the line, with the nearest residence at 75 feet. The other four houses would be 200 feet or greater from the line.

Magnetic Fields

BASIC CONCEPTS

Magnetic fields can be characterized by the force they exert on a moving charge or on an electrical current. As with the electric field, the magnetic field is a vector quantity characterized by both magnitude and direction. Electrical currents generate magnetic fields. In the case of transmission lines, distribution lines, house wiring, and appliances, the 60-Hz electric current flowing in the conductors generates a time-varying, 60-Hz magnetic field in the vicinity of these sources. The strength of a magnetic field is measured in terms of magnetic lines of force per unit area, or magnetic flux density. The term "magnetic field," as used here, is synonymous with magnetic flux density and is expressed in units of Gauss (G) or milligauss (mG).

The uniformity of a magnetic field depends on the nature and proximity of the source, just as the uniformity of an electric field does. Transmission-line-generated magnetic fields are quite uniform over horizontal and vertical distances of several feet near the ground. However, for small sources such as appliances, the magnetic field decreases rapidly over distances comparable with the size of the device.

The interaction of a time-varying magnetic field with conducting objects results in induced electric field and currents in the object. A changing magnetic field through an area generates a voltage around any conducting loop enclosing the area (Faraday's law). This is the physical basis for the operation of an electrical transformer. For a time-varying sinusoidal magnetic field, the magnitude of the induced voltage around the loop is proportional to the area of the loop, the frequency of the field, and the magnitude of the field. The induced voltage around the loop results in an induced electric field and current flow in the loop material. The induced current that flows in the loop depends on the conductivity of the loop.

TRANSMISSION LINE MAGNETIC FIELDS

The magnetic field generated by currents on transmission-line conductors extends from the conductors through the air and into the ground. The magnitude of the field at a height of 3.28 ft. (1 m) is frequently used to describe the magnetic field under transmission lines. Because the magnetic field is not affected by non-ferrous materials, the field is not influenced by normal objects on the ground under the line. The direction of the maximum field varies with location. (The electric field, by contrast, is essentially vertical near the ground.) The most important transmission-line parameters that determine the magnetic field at 3.28 ft. (1 m) height are conductor height above ground and magnitude of the currents flowing in the conductors. As the distance from the transmission line conductors increases, the magnetic field decreases.

Calculations of magnetic fields from transmission lines are performed using well-known physical principles (cf., Deno and Zaffanella 1982). The calculated values usually represent the ideal straight parallel-conductor configuration. For simplicity, a flat earth is usually assumed. Balanced currents (currents of the same magnitude for each phase) are also assumed. This is usually valid for transmission lines, where loads on all three phases are maintained in balance during operation. Induced image currents in the earth are usually ignored for calculations of magnetic field under or near the ROW. The resulting error is negligible. Only at distances greater than 300 ft. (91 m) from a line do such contributions become significant (Deno and Zaffanella 1982). The clearance for magnetic-field calculations for the proposed line was the same as that used for electric-field evaluations.

Standard techniques for measuring magnetic fields near transmission lines are described in ANSI IEEE Standard No. 644-1994 (IEEE 1994). Measured magnetic fields agree well with calculated values, provided the currents and line heights that go into the calculation correspond to the actual values for the line. To realize such agreement, it is necessary to get accurate current readings during field measurements (because currents on transmission lines can vary considerably over short periods of time) and also to account for all field sources in the vicinity of the measurements.

As with electric fields, the maximum or peak magnetic fields occur in areas near the centerline and at midspan where the conductors are the lowest. The magnetic field at the edge of the ROW is not very dependent on line height. For a double-circuit line or if more than one line is present, the peak field would depend on the relative electrical phasing of the conductors and the direction of power flow.

ENVIRONMENTAL MAGNETIC FIELDS

Transmission lines are not the only source of magnetic fields; as with 60-Hz electric fields, 60-Hz magnetic fields are present throughout the environment of a society that relies on electricity as a principal energy source. The magnetic fields associated with the proposed North Steens line can be compared with fields from other sources. The range of 60-Hz magnetic-field exposures in publicly accessible locations such as open spaces, transmission-line rights-of-way, streets, pedestrian walkways, parks, shopping malls, parking lots, shops, hotels, public transportation, and so on range from less than 0.1 mG to about 1 G, with the highest values occurring near small appliances with electric motors. In occupational settings in electric utilities, where high currents are present, magnetic-field exposures for workers can be above 1 G. At 60-Hz, the magnitude of the natural magnetic field is approximately 0.0005 mG.

Several investigations of residential fields have been conducted. In a large study to identify and quantify significant sources of 60-Hz magnetic fields in residences, measurements were made in 996 houses, randomly selected throughout the country (Zaffanella 1993). The most common sources of residential fields were power lines, the grounding system of residences, and appliances. Field levels were characterized by both point-in-time (spot) measurements and 24-hour measurements. Spot measurements averaged over all rooms in a house exceeded 0.6 mG in 50 percent of the houses and 2.9 mG in 5 percent of houses. Power lines generally produced the largest average fields in a house over a 24-hour period. On the other hand, grounding system currents proved to be a more significant source of the highest fields in a house. Appliances were found to produce the highest local fields; however, fields fell off rapidly with increased distance. For example, the median field near microwave ovens was 36.9 mG at a distance of 10.5 in. (0.27 m) and 2.1 mG at 46 in. (1.17 m). Across the entire sample of 996 houses, higher magnetic fields were found in, among others, urban areas (vs. rural); multi-unit dwellings (vs. single-family); old houses (vs. new); and houses with grounding to a municipal water system.

In an extensive measurement project to characterize the magnetic-field exposure of the general population, over 1000 randomly selected persons in the United States wore a personal exposure meter for 24 hours and recorded their location in a simple diary (Zaffanella and Kalton 1998). Based on the measurements of 853 persons, the estimated 24-hour average exposure for the general population is 1.24 mG and the estimated median exposure is 0.88 mG. The average field "at home, not in bed" is 1.27 mG and "at home, in bed" is 1.11 mG. Average personal exposures were found to be highest "at work" (mean of 1.79 mG and median of 1.01 mG) and lowest "at home, in bed" (mean of 1.11 mG and median of 0.49 mG). Average fields in school were also low (mean of 0.88 mG and median of 0.69 mG). Factors associated with higher exposures at home were smaller residences, duplexes and apartments, metallic rather than plastic water pipes, and nearby overhead distribution lines.

As noted above, magnetic fields from appliances are localized and decrease rapidly with distance from the source. Localized 60-Hz magnetic fields have been measured near about 100 household appliances such as ranges, refrigerators, electric drills, food mixers, and shavers (Gauger 1985). At a distance of 1 ft. (0.3 m), the maximum magnetic field ranged from 0.3 to 270 mG, with 95% of the measurements below 100 mG. Ninety-five percent of the levels at a distance of 4.9 ft. (1.5 m) were less than 1 mG. Devices that use light-weight, high-torque motors with little magnetic shielding exhibited the largest fields. These included vacuum cleaners and small hand-held appliances and tools. Microwave ovens with large power transformers also exhibited relatively large fields. Electric blankets have been a much-studied source of magnetic-field exposure because of the length of time they are used and because of the close proximity to the body. Florig and Hoburg (1988) estimated that the average magnetic field in a person using an electric blanket was 15 mG, and that the maximum field could be 100 mG. "Low-field" blankets introduced in the 1990s have magnetic fields at least 10 times lower than those from conventional blankets (Bassen et al. 1991).

In a domestic magnetic-field survey, Silva et al. (1989) measured fields near different appliances at locations typifying normal use (e.g., sitting at an electric typewriter or standing at a stove). Specific appliances with relatively large fields included can openers (n = 9), with typical fields ranging from 30 to 225 mG and a maximum value up to 2.7 G; shavers (n = 4), with typical fields from 50 to 300 mG and maximum fields up to 6.9 G; and electric drills (n = 2), with typical fields from 56 to 190 mG and maximum fields up to 1.5 G. The fields from such appliances fall off very rapidly with distance and are only present for short periods. Thus, although instantaneous magnetic-field levels close to small hand-held appliances can be quite large, they do not contribute to average area levels in residences.

In a study with 162 subjects, Mezei et al. (2001) employed magnetic-field exposure measurements, simultaneous record-keeping of appliance proximity, and an appliance-use questionnaire to investigate the contributions of appliances to overall exposure. They found that individual appliance use did not contribute significantly to time-weighted-average exposure, unless the use was prolonged during the day of measurements. Use of small appliances did not contribute significantly to accumulated exposure but did contribute to the relatively short periods when high-field exposures were observed.

Although studies of residential magnetic fields have not all considered the same independent parameters, the following consistent characterization of residential magnetic fields emerges from the data:

- External sources play a large role in determining residential magnetic-field levels. Transmission lines, when nearby, are an important external source. Unbalanced ground currents on neutral conductors and other conductors, such as water pipes in and near a house, can represent a significant source of magnetic field. Distribution lines per se, unless they are quite close to a residence, do not appear to be a traditional distance-dependent source.
- Homes with overhead electrical service appear to have higher average fields than those with underground service.
- Appliances represent a localized source of magnetic fields that can be much higher than average or area fields. However, fields from appliances approach area levels at distances greater than 3.28 ft. (1 m) from the device.

Although important variables in determining residential magnetic fields have been identified, quantification and modeling of their influence on fields at specific locations is not yet possible. However, a general characterization of residential magnetic-field level is possible: average levels in the United States are in the range of 0.5 to 1.0 mG, with the average field in a small number of homes exceeding this range by as much as a factor of 10 or more. Average personal exposure levels are slightly higher, possibly due to use of appliances and varying distances to other sources. Maximum fields can be much higher.

Magnetic fields in commercial and retail locations are comparable with those in residences. As with appliances, certain equipment or machines can be a local source of higher magnetic fields. Utility workers who work close to transformers, generators, cables, transmission lines, and distribution systems clearly experience high-level fields. Other sources of fields in the workplace include motors, welding machines, and computers. In publicly accessible indoor areas, such as offices and stores, field levels are generally comparable with residential levels, unless a high-current source is nearby.

Because high-current sources of magnetic field are more prevalent than high-voltage sources, occupational environments with relatively high magnetic fields encompass a more diverse set of occupations than do those with high electric fields. For example, in occupational magnetic-field measurements reported by Bowman et al. (1988), the geometric mean field from 105 measurements of magnetic field in "electrical worker" job locations was 5.0 mG. "Electrical worker" environments showed the following elevated magnetic-field levels (geometric mean greater than 20 mG): industrial power supplies, alternating current (ac) welding machines, and sputtering systems for electronic assembly. For secretaries in the same study, the geometric mean field was 3.1 mG for those using old style VDTs (n = 6) and 1.1 mG for those not using VDTs (n = 3).

Measurements of personal exposure to magnetic fields were made for 1,882 volunteer utility workers for a total of 4,411 workdays (Bracken 1990). Median workday mean exposures ranged from 0.5 mG for clerical workers without computers to 7.2 mG for substation operators. Occupations not specifically associated with transmission and distribution facilities had median workday exposures less than 1.5 mG, while those associated with such facilities had median exposures above 2.3 mG. Magnetic-field exposures measured in homes during this study were comparable with those recorded in offices.

Magnetic fields in publicly accessible outdoor areas seem to be, as expected, directly related to proximity to electric-power transmission and distribution facilities. Near such facilities, magnetic fields are generally higher than indoors (residential). Higher-voltage facilities tend to have higher fields. Typical maximum magnetic fields in publicly accessible areas near transmission facilities can range from less than a few milligauss up to 300 mG or more, near heavily loaded lines operated at 230 to 765-kV. The levels depend on the line load, conductor height, and location on the ROW. Because magnetic fields near high-voltage transmission lines depend on the current in the line, they can vary daily and seasonally.

Fields near distribution lines and equipment are generally lower than those near transmission lines. Measurements in Montreal indicated that typical fields directly above underground distribution systems were 5 to 19 mG (Heroux 1987). Beneath overhead distribution lines, typical fields were 1.5 to 5 mG on the primary side of the transformer, and 4 to 10 mG on the secondary side. Near ground-based transformers used in residential areas, fields were 80 to 1000 mG at the surface and 10 to 100 mG at a distance of 1 ft. (0.3 m).

The magnetic fields from the proposed transmission line would be comparable to or less than those from existing 230-kV lines in Oregon, Washington, and elsewhere. On and near the ROW of the proposed line, magnetic fields would be above average residential levels. However, the fields from the line would decrease rapidly and approach common ambient levels (2 mG) at a distance of about 165 feet or less from the edge of the ROW under maximum current conditions and at about 70 feet or less from the edge under average current conditions. Furthermore, the fields at the edge of the ROW would not be above those encountered during normal activities near common sources such as hand-held appliances.

3.15.2.4 Aviation and Military Operations

The primary aviation activities in the project area are land management and military air operations. The BLM, Oregon Department of Fish and Wildlife (ODFW), and other land management agencies utilize helicopter and fixed wing aircraft to census and gather wildlife, wild horses, monitor habitat, haul material and for wildland fire operations. In addition, some ranchers utilize aircraft to check cattle and monitor water and range conditions. Much of this flying can occur at elevations below 500 feet above ground level (AGL).

The military utilizes parts of the Project Area for flight operations, including training and point to point travel through Military Training Routes (MTR) to larger Military Operating Areas (MOA) where more intensive training occurs. Several MTRs cross through the Project Area. The only MOA that is in the Project Area is the Saddle B MOA. Military jets and helicopters typically utilize these flight paths for training. There are no military ground activities occurring in the Project Area.

The DoD regularly publishes and updates the *DoD Flight Information Publications*, which establishes authorized flight levels by segments for each of the MTRs. Table 3.15-3 shows MTRs and MOAs that lie within the Project Area, their authorized flight levels, route corridor width, and the EIS Project components that lie within these operating areas.

Table 3.15-3 Military Training Routes (MTRs) and Military Operating Areas (MOAs) in the Project Area

MOA/MTR Name	Authorized Flight Levels	Route Corridor Width Each Side of Centerline / Total Width	EIS Project Component
Saddle B MOA	100 feet AGL to 9000 feet above Mean Sea Level (MSL)	Not Applicable	Alternative C – North Route of transmission line
Visual Route (VR) 316	100 feet AGL to 10000 feet above MSL	12 / 24 Miles	All transmission line alternatives
VR 319	100 feet AGL to 9,000 feet above MSL	12 / 24 Miles	All transmission line alternatives
VR 1352	200 feet AGL to 1,500 feet AGL	5 / 10 Miles	All transmission line alternatives, and the Echanis Project
Instrument Route (IR) 304 Section H to N	100 feet AGL to 11,000 feet above MSL	10 / 20 Miles	Alternative B – West Route and Alternative C – North Route of transmission line, Echanis Project
VR 1301	100 feet AGL to 1,500 AGL	6 / 12 Miles	South end of the Echanis Project

In July 2008, BLM and DoD entered into a Memorandum of Understanding that established a protocol for BLM to consult with DoD about wind energy projects on Public Lands. The protocol does not require BLM to consult with DoD on transmission line projects related to wind energy nor does it require consultation regarding connected wind projects on private lands, such as the case with this proposed Project. Although not required, BLM has been informally consulting with the military on the North Steens Transmission Line Project since September 2010, when the DoD comments were received on the DEIS.

3.15.3 Environmental Effects and Mitigation

3.15.3.1 Alternative A – No Action

Under the No Action Alternative, no new transmission lines, substations, interconnection stations, or related wind energy facilities would be constructed. Improvements to existing access roads would not be needed and new access roads would not be constructed. No new ROW would be obtained from BLM or USFWS. The Echanis Project site would remain undeveloped and would continue to be used for livestock grazing. No new fire or aviation hazards or sources of EMF would be developed, nor would new hazardous materials be introduced to the Project Area.

3.15.3.2 Echanis Project Effects Common to All Action Alternatives

Fire Hazards

PERMANENT EFFECTS

The Echanis Project would involve the deployment and operation of 40 to 69 wind turbines on a 10,500 acre privately owned site in rural Harney County, including several miles of 34.5-kV underground power collection cables, a new 100-foot by 200-foot substation, and a 24-foot by 48-foot operations and maintenance building. While unlikely, a potential fire risk from malfunction of the wind turbine generators and transformers exists. To minimize these effects, the Project Applicant proposes the design features described in Appendix A (A.1.9 and A.3.10).

TEMPORARY EFFECTS

Temporary effects to public health and safety related to fire hazards could occur if sparks from equipment used during construction made contact with combustible material. However, to reduce these potential fire hazards, the Project Applicant proposes the design features described in Appendix A (A.1.9 and A.3.10).

MITIGATION

The proposed design features (PDFs) and best management practices (BMPs) that were taken into account in the effects analysis in this section (see Section 2 and Appendix A.1.9 and A.3.10) would ensure permanent and temporary effects to public health and safety related to fire hazards would be minimized. Therefore, no additional mitigation is proposed.

Hazardous Materials

PERMANENT AND TEMPORARY EFFECTS

Potential effects from the Echanis Project involving hazardous materials would be associated with the release of hazardous materials to the environment due to improper use, storage, or disposal of hazardous materials. Direct effects of such releases could include contamination of vegetation, soil, and water, which could result in indirect effects to human and wildlife populations. These effects have the potential to occur during construction, operation, maintenance, and decommissioning of the Echanis Project.

Use of hazardous materials during Project construction, operation, maintenance, and decommissioning would pose potential health and safety hazards to construction and maintenance workers and nearby residents. All major components of the wind turbines would undergo routine maintenance which would involve the use of small amounts of hazardous materials, such as grease, lubricants, paint, corrosion control coatings, and glycol-based coolants.

Effects would be associated with use of hazardous substances during construction, maintenance, and decommissioning activities, the potential for spills, and blasting during tower installation. The following list illustrates hazardous materials that are typically associated with wind energy projects (BLM 2001a).

Diesel Fuel	Painting and coatings
Gasoline	Dielectric fluids
Propane	Pesticides
Air tool oil	Explosives
Lubricating oils/grease	Glycol-based antifreeze
Hydraulic fluid/gear oils	Lead-acid storage batteries and electrolyte solution
Other batteries	Lubricating grease
Cleaning solvents	

Construction of the Echanis Project would also produce solid wastes such as containers, packaging materials, and miscellaneous wastes. Other wastes such as food scraps and debris would result from construction crews. Solid wastes produced by Project operations would be primarily composed of office-related and food wastes from maintenance crews. In general, these waste products would be expected to be non-hazardous, discarded in the proper containers, and regularly removed by a commercial hauler to a permitted, off-site, disposal facility. Food service and housing would not be provided at the wind farm.

To reduce potential effects to public health and safety from the use of hazardous materials, the Project Applicant proposes the design features specified in Appendix A (A.1.9 and A.3.10).

MITIGATION

The proposed design features (PDFs) and best management practices (BMPs) that were taken into account in the effects analysis in this section (see Section 2 and Appendix A.1.9 and A.3.10) would minimize the risk of environmental contamination from the use of hazardous materials by the Project. No additional mitigation measures are proposed.

ELECTRIC AND MAGNETIC FIELDS

No EMFs would be generated by the Echanis Project; therefore, no project design features or mitigation measures are proposed. EMFs associated with wind projects occur during the transmission of the energy produced by the turbines to the main electricity transmission grid for distribution. The generation of EMFs by the proposed North Steens 230-kV transmission line is discussed for Alternative B and Alternative C below.

Aviation and Military Operations

PERMANENT EFFECTS

The Echanis Project would involve the construction and operation of 40 to 69 wind turbines having a maximum height of 415 feet on a 10,500-acre privately-owned site in rural Harney County. Other features having potential effects on aviation within the Echanis Project Area include the proposed 230-kV transmission line with towers 70 to 80 feet tall. The Applicant has secured No Hazard to Air Navigation Determinations from the Federal Aviation Administration for each of the proposed wind turbines. At the request of the FAA, the Applicant consulted with Department of Defense (DoD) officials prior to the issuance of these determinations. FAA determinations are not required for the transmission line component of the Project because they would be less than 200 feet tall, the minimum height that triggers FAA approval.

Although the FAA has determined that the wind turbines would not constitute a hazard to air navigation, the agency did recognize that the structures would be in or near military training routes. Specifically, MTR VR1352 and IR304 and their authorized corridors cross the Echanis Project Area. The edge of the VR1301 corridor also intersects the extreme southern end of the Echanis Project. Vertically, the turbines would encroach 215 feet into VR1352 and 315 feet into IR304 and VR1301. These structures might become a collision hazard to military aircraft during low level, high speed maneuvers. Development of the Echanis Project would require the military to raise their authorized flight floor to a safe level above turbine height. This might have an effect upon their ability to conduct effective low-level training exercises within the MTRs in and around the Echanis Project.

The turbines would also pose a collision hazard to local, low-level civilian aircraft. This potential hazard would be somewhat less than to military aviation because civilian aircraft are typically flying at slower speeds, not focused on training, and there are fewer numbers of these kinds of aircraft utilizing the area. Little effect is expected to point to point private and commercial air transportation because it occurs in higher altitudes than the maximum height of the wind turbines.

The section of the transmission line within the Echanis Project would be below authorized flight floors and, by itself, would pose no hazard to military aircraft. Because the turbines would be a taller feature on the landscape, the additional hazard to low level land management and civilian aircraft posed by the associated transmission line would be nullified. Any aircraft avoiding the turbines would also be flying well above the maximum height of the transmission line.

TEMPORARY EFFECTS

During construction, temporary structures such as cranes necessary to assemble the turbines and meteorological towers might pose an additional but temporary hazard to low-level aircraft.

MITIGATION

In addition to the proposed design features (PDFs) and best management practices (BMPs) that were taken into account in the effects analysis in this section (see Section 2 and Appendix A.1.9 and A.3.10), the following measures would reduce the avian and military operations effects of the Project:

- Consultation by the Applicant with the DoD would ensure that the appropriate avoidance measures, such as raising authorized flight levels, are in place prior to construction of the Echanis Project.

- As required by FAA, the Applicant should notify the FAA, DoD, BLM Fire and Aviation, and other air space users and managers when construction of the turbines has commenced, so that these features can be incorporated into aerial hazard maps and warnings.

3.15.3.3 Alternative B – West Route (Proposed Action)

Fire Hazards

PERMANENT EFFECTS

When the transmission line is energized during operation, it could potentially cause a fire hazard if a conducting object were to come into proximity of the transmission line, resulting in a flashover to ground, or if an energized phase conductor were to fall to the earth and remain in contact with combustible material long enough to heat this material and cause a fire. The mechanical and structural design, selection of materials, and construction of transmission lines takes into account normal and unusual structural loads, such as ice and wind, which could cause the phase conductors to break. It is theoretically possible that an energized phase conductor could cause a fire if it were to fall to the ground and create an electrical arc that could ignite combustible material; however, this is a very unlikely event. If, for some reason, an energized phase conductor were to fall to the ground and create a line-ground fault, high-speed relay equipment is designed to sense that condition and actuate circuit breakers that can de-energize the line in less than about one-tenth of a second. This procedure has proven to be a reliable safety measure and reduces the risk of fire from high voltage transmission lines to a low level.

Sparks from equipment used during operation and maintenance (O&M) of the transmission line, interconnection stations, and substation also pose a risk of fire. Permanent effects from operation of the transmission line, interconnection stations, and substation could also include increased risk of fire due to inadequate clearance between vegetative fuel loads and Project facilities. However, to reduce these potential fire hazards, the Project Applicant proposes the design features described in Appendix A (A.1.9 and A.3.10).

TEMPORARY EFFECTS

Temporary effects to public health and safety related to fire hazards could occur if sparks from equipment used during construction of the transmission line, access roads, interconnection stations, and substation made contact with combustible material. However, to reduce these potential fire hazards, the Project Applicant proposes the design features described in Appendix A (A.1.9 and A.3.10).

FUTURE CONSTRUCTION PHASE – UPGRADE TO 230-KV

Future installation of the second 115-kV circuit would not require additional ROW, access roads, or new permanent features outside of areas already affected by installation of the initial 115-kV line. The effects from installation of the second circuit would be similar to those described above and would be associated primarily with the use of temporary laydown areas, pulling/tensioning sites, and the installation of temporary guard structures. Installation of the second 115-kV line would require equipment upgrades at the interconnection station adjacent to the Harney Electric Company (HEC) 115-kV line to accommodate the second circuit.

MITIGATION

The proposed design features (PDFs) and best management practices (BMPs) that were taken into account in the effects analysis in this section (see Section 2 and Appendix A.1.9 and A.3.10) would ensure permanent and temporary effects to public health and safety related to fire hazards would be minimized. Therefore, no additional mitigation measures would be proposed.

Hazardous Materials

PERMANENT & TEMPORARY EFFECTS

In general, most potential effects associated with hazardous materials would involve the release of toxic materials into the environment from improper use, storage, or disposal of these materials. Direct effects of such releases could include contamination of vegetation, soil, and water, which could result in indirect effects to human and wildlife populations. These effects have the potential to occur during construction, operation, and maintenance activities; therefore, the effects described below would be both permanent and temporary.

Use of hazardous materials during Project construction, operation, and maintenance would pose potential health and safety hazards to construction and maintenance workers and nearby residents. These effects would be associated with blasting during tower installation, use of hazardous substances during construction and maintenance activities, and the potential for spills. The following list displays hazardous materials typically used for transmission line projects (BLM 2001a).

- 2-cycle oil (contains distillates and hydrotreated heavy paraffinic).
- ABC fire extinguisher.
- Acetylene gas.
- Air tool oil.
- Ammonium hydroxide.
- Automatic transmission fluid.
- Battery acid (in vehicles and in the meter house of the substations).
- Bee Bop Insect Killer.
- Canned spray paint.
- Chain lubricant (contains methylene chloride).
- Connector grease (penotox).
- Contact cleaner 2000.
- Diesel de-icer.

- Diesel fuel additive.
- Explosives (detonators, detonator assemblies – non-electric, tubular primers, cap-type primers, ammonium nitrate fertilizers).
- Eye glass cleaner (contains methylene chloride).
- Gasoline.
- Gasoline treatment.
- Herbicides (used for vegetation control).
- Hot Stick Cleaner (cloth treated with polydimethylsiloxane).
- Insulating oil (inhibited, non-PCB).
- Lubricating grease.
- Mastic coating.
- Methyl alcohol.
- North wasp and hornet spray (1,1,1-trichloroethene).
- Oxygen.
- Paint thinner.
- Petroleum products (gasoline, diesel fuel, jet fuel A, lubricants, brake fluid, hydraulic fluid).
- Prestone 11 Antifreeze.
- Propane.
- Puncture Seal Tire Inflator.
- Safety Fuses.
- Starter Fluid.
- Sulfur Hexaflouride (within the circuit breakers in the substations).
- Wagner Brake Fluid.
- WD-40.
- ZEP (safety solvent).
- ZIP (1,1,1-tricholorethane).

Use, storage, and disposal of hazardous materials are regulated by numerous local, state, and federal laws. Existing laws the Project Applicant are required to comply with include, but are not limited to, local emergency planning laws and programs; U.S. Department of Transportation regulations related to the transport of hazardous substances; the Resource Conservation and Recovery Act, Toxic Substances Control Act; Comprehensive Environmental Response, Compensation and Liability Act; Superfund Amendments and Reauthorization Act; Emergency Planning and Community Right-to-Know Act; Clean Water Act; Clear Air Act; and 40 CFR 260-302. To reduce potential effects to public health and safety from the use of hazardous materials, the Project Applicant proposes the design features described in Appendix A (A.1.9 and A.3.10).

In addition to the potential for improper storage, use, and disposal of hazardous materials, unknown contamination could be present within the boundaries of the proposed transmission line ROW, access roads, interconnection stations, or substation sites due to past and current land use activities. While land uses within the Project Area indicate a low probability of hazardous materials discovery during construction, and while no site with known or potential hazardous materials contamination registered within ODEQ's ECSI database would be disturbed by the Project, a small possibility remains contaminated sites could be discovered during construction of the Project.

Disturbance of contaminated sites during construction could result in the mobilization of contaminants currently in the soil, resulting in the potential exposure of workers or the public or both to hazardous materials at levels in excess of those permitted by the Federal Occupational Safety and Health Administration (OSHA) in Title 29 CFR Part 1910. To reduce potential effects to public health and safety from discovery of hazardous materials during construction, the Project Applicant proposes the design features described in Appendix A (A.1.9 and A.3.10).

Future installation of the second 115-kV circuit would not require additional ROW, access roads, or new permanent features outside of areas already affected by installation of the initial 115-kV line. The effects from installation of the second circuit would be similar to those described above and would be associated primarily with the use of temporary laydown areas, pulling/tensioning sites, and the installation of temporary guard structures. Installation of the second 115-kV line would require equipment upgrades at the interconnection station adjacent to the HEC 115-kV line to accommodate the second circuit.

MITIGATION

In addition to the proposed design features (PDFs) and best management practices (BMPs) that were taken into account in the effects analysis in this section (see Section 2 and Appendix A.1.9 and A.3.10), the following mitigation measures are recommended:

- In the event of an accident release of hazardous materials or waste into the environment, the Project Applicant would document the event, investigate the root cause, take appropriate corrective actions, and report on the characterization of the resulting environmental health or safety effects. Documentation of the event would be provided to BLM or USFWS (depending upon the location of the accidental release) and other appropriate local, state, and federal agencies.
- If visual evidence of contamination appears during grading or excavation, the material would be characterized and appropriate measures taken to protect human health and the environment before work would be permitted to continue. All local, state, and federal requirements for sampling and testing, and subsequent removal, transport, and disposal of hazardous materials would be observed.
- Contaminated soil or groundwater determined to be hazardous waste would be removed by personnel trained through the OSHA recommended 40-hour safety program (29CFR1910.120) with an approved plan for groundwater extractions, soil excavation, control of contaminant releases to the air, and off-site transport or on-site treatment.

Electric and Magnetic Fields

PERMANENT EFFECTS

Possible effects associated with the interaction of EMF from transmission lines with people on and near a ROW fall into two categories: short-term effects that can be perceived and may represent a nuisance, and possible long-term health effects. Only short-term effects are discussed here. The issue of whether long-term health effects are associated with transmission-line fields is controversial. In recent years, considerable research on possible biological effects of EMF has been conducted. A review of these studies and their implications for health-related effects is provided in a separate technical report for the environmental assessment of the proposed North Steens transmission line (Exponent 2009).

ELECTRIC FIELDS: SHORT-TERM EFFECTS

Short-term effects from transmission-line electric fields are associated with 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 electric field. Such effects occur in the fields associated with transmission lines that have voltages of 230-kV or higher. These effects could occur infrequently under the proposed North Steens transmission line.

Steady-state currents are those that flow continuously after a person contacts an object and provides a path to ground for the induced current. The amplitude of the steady-state current depends on the induced current to the object in question and on the grounding path. The magnitude of the induced current to vehicles and objects under the proposed line would depend on the electric-field strength and the size and shape of the object. When an object is electrically grounded, the voltage on the object is reduced to zero, and it is not a source of current or voltage shocks. If the object is poorly grounded or not grounded at all, then it acquires some voltage relative to earth and is a possible source of current or voltage shocks.

The responses of persons to steady-state current shocks have been extensively studied, and levels of response documented (Keesey and Letcher 1969; IEEE 1978). Primary shocks are those that can result in direct physiological harm. Such shocks would not be possible from induced currents under the existing or proposed lines, because clearances above ground required by the NESC preclude such shocks from large vehicles and grounding practices eliminate large stationary objects as sources of such shocks.

Secondary shocks are defined as those that could cause an involuntary and potentially harmful movement, but no direct physiological harm. Secondary shocks could occur under the proposed line when making contact with ungrounded conducting objects such as large vehicles or equipment. However, such occurrences are anticipated to be very infrequent, especially during Phase I with the lower fields under the 115-kV line. Even the infrequent shocks under the 230-kV line during Phases II and III are most likely to be below the nuisance level. Induced currents would not be perceived off the ROW.

Induced currents are always present in electric fields under transmission lines and would be present near the proposed line. A booklet is available from BPA describing how to live and work safely near transmission lines (USDOE 2007). It describes safe practices for installation and maintenance of irrigation systems, underground pipes and cables, and fences on or near the ROW. For example, during initial construction, metal objects, such as fences, that are located on the ROW could be grounded to eliminate them as sources of induced current and voltage shocks. Multiple grounding points are used to provide redundant paths for induced current flow. After construction, prompt response to complaints and installation or repair of appropriate grounding can also mitigate nuisance shocks.

Unlike fences or buildings, mobile objects such as vehicles and farm machinery cannot be grounded permanently. Limiting the possibility of induced currents from such objects to persons is accomplished in several ways. First, required clearances for above-ground conductors tend to limit field strengths to levels that do not represent a hazard or nuisance. The NESC (IEEE 2002) requires that, for lines with voltage exceeding 98 kV line-to-ground (170 kV line-to-line), sufficient conductor clearance be maintained to limit the induced short-circuit current in the largest anticipated vehicle under the line to 5 milliamperes (mA) or less. The proposed line would be designed and operated to be in compliance with the NESC.

For the proposed line, conductor clearances (50°C) would be at least 32.25 ft. (9.8 m) over road crossings along the route, resulting in a maximum field of 2.1 kV/m or less at the 3.28 ft. (1 m) height for all phases. The largest truck allowed on roads in Oregon without a special permit is 14 ft. high by 8.5 ft. wide by 75 ft. long (4.3 x 2.6 x 22.9 m). The induced currents to such a vehicle oriented perpendicular to the line in a maximum field of 2.1 kV/m (at 3.28-ft. height) would be less than 2.1 mA (Reilly 1979).

For smaller trucks, the maximum induced currents for perpendicular orientation to the proposed line would be less than this value. (Larger special-permitted trucks, such as triple trailers, can be up to 105 feet in length. However, because they average the field over such a long distance, the maximum induced current to a 105-ft. vehicle oriented perpendicular to the line at a road crossing would be less than that for the 75-foot truck.) These large vehicles are not anticipated to be off highways on the right-of-way or oriented parallel and directly under the proposed line. Thus, the NESC 5-mA criterion would be met for road crossings of the proposed line during all phases of operation. Line clearances would also be in accordance with the NESC over other areas, such as railroads, orchards and water suitable for sail boating, where additional clearance might be required.

The computed induced currents at road crossings are for worst-case conditions that occur rarely. Several factors tend to reduce the levels of induced current shocks from vehicles at road crossings and elsewhere:

- Activities are distributed over the whole ROW, and only a small percentage of time is spent in areas where the field is at or close to the maximum value.
- At road crossings, vehicles are aligned perpendicular to the conductors, resulting in a substantial reduction in induced current.
- The conductor clearance at road crossings may not be at minimum values because of lower conductor temperatures and/or location of the road crossing away from midspan.
- The largest vehicles are permitted only on certain highways.
- Off-road vehicles are in contact with soil or vegetation, which reduces shock currents substantially.

Induced voltages occur on objects, such as vehicles, in an electric field where there is an inadequate electrical ground. If the voltage is sufficiently high, then a spark discharge shock can occur as contact is made with the object. Such shocks are similar to "carpet" shocks that occur, for example, when a person touches a doorknob after walking across a carpet on a dry day. The number and severity of spark discharge shocks depend on electric-field strength and generally of concern under lines with voltages of 345-kV or higher. Nuisance shocks, which are primarily spark discharges, are not anticipated to be a present under the proposed line.

In electric fields higher than those that would occur under the proposed line, it is theoretically possible for a spark discharge from the induced voltage on a large vehicle to ignite gasoline vapor during refueling. The probability for exactly the right conditions for ignition to occur is extremely remote. Even so, some utilities, including BPA, recommend that vehicles should not be refueled under the transmission lines unless specific precautions are taken to ground the vehicle and the fueling source (USDOE 2007).

Under certain conditions, the electric field can be perceived through hair movement on an upraised hand or arm of a person standing on the ground under high-voltage transmission lines. The median field for perception in this manner was 7 kV/m for 136 persons; only about 12% could perceive fields of 2 kV/m or less (Deno and Zaffanella 1982). In limited areas under the conductors at midspan during Phase II operation, the fields at ground level would exceed the levels where field perception can occur. However it is very unlikely that field perception would be common under the proposed line because fields would generally be below the perception level. Where vegetation provides shielding, the field would not be perceived.

Conductive shielding reduces both the electric field and induced effects such as shocks. Persons inside a vehicle cab or canopy are shielded from the electric field. Similarly, a row of trees or a lower-voltage distribution line reduces the field on the ground in the vicinity. Metal pipes, wiring, and other conductors in a residence or building shield the interior from the transmission-line electric field.

The electric fields from the proposed line would be comparable to or less than those from existing 230-kV lines in the Project Area and elsewhere. Potential impacts of electric fields can be mitigated through grounding policies and adherence to the NESC. Worst-case levels are used for safety analyses but, in practice, induced currents and voltages are reduced considerably by unintentional grounding. Shielding by conducting objects, such as vehicles and vegetation, also reduces the potential for electric-field effects.

CALCULATED VALUES OF ELECTRIC FIELDS

Table 3.15-4 shows the calculated maximum and average values of electric field at 3.28 ft. (1 m) above ground for the proposed North Steens transmission lines operated at maximum voltages. The peak value on the ROW and the value at the edge of the ROW are given for the proposed lines at minimum conductor clearance and at the estimated average clearance over a span. Figure 3.15-1 shows lateral profiles for the electric field from the proposed line at the minimum (32.25 ft.) and average (38.4 ft.) line heights.

Table 3.15-4 Calculated Peak and Edge of ROW Electric Fields for the Proposed North Steens Transmission Line Operated at Maximum Voltage

	Electric Field, kV/M					
Phase	I		II		III	
Field[1]	Maximum	Average	Maximum	Average	Maximum	Average
Peak on ROW	1.3	1.0	2.1	1.5	1.8	1.2
At Edge of ROW[2]	0.02, 0.04	0.3, 0.02	0.05, 0.04	0.05, 0.08	0.05	0.09

[1] Maximum = Maximum voltage and minimum clearance; Average = Maximum voltage and average clearance.

[2] Fields at west edge of ROW adjacent to the Phase I circuit are given first.

The calculated peak electric field expected on the ROW of the proposed Phase I line is 1.3 kV/m. During Phases II and III, the peak electric fields on the ROW would increase to 2.1 and 1.8 kV/m, respectively. For average clearance, the peak field for Phase I would be 1.0 kV/m and for Phases II and III it would be 1.5 kV/m or less. As shown in Figure 3.15-1, the peak values would be present only at locations directly under the line, near mid-span, where the conductors are at the minimum clearance. The conditions of minimum conductor clearance at maximum current and maximum voltage occur very infrequently. The calculated peak levels are rarely reached under real-life conditions, because the actual line height is generally above the minimum value used in the computer model, because the actual voltage is below the maximum value used in the model, and because vegetation within and near the edge of the ROW tends to shield the field at ground level. Maximum electric fields on existing 230-kV corridors are typically 2.5 to 3 kV/m. On 500-kV transmission line corridors, the maximum electric fields range from 7 to 9 kV/m.

The largest value expected at the edge of the ROW with 230-kV operation would be about 0.1 kV/m, occurring for average conductor heights. Fields with the edge of the ROW adjacent to a 115-kV line (Phases I and II) are less than this as shown in Table 3.15-4 and Figure 3.15-1.

The electric fields from the proposed transmission line would meet the ACGIH, ICNIRP, and IEEE standards, provided wearers of pacemakers and similar medical-assist devices are discouraged from unshielded ROW use. (A passenger in an automobile under the line would be shielded from the electric field.) The electric fields present on the ROW could induce currents in ungrounded vehicles that exceeded the ICNIRP and IEEE levels of 0.5 mA. The estimated peak electric fields on the ROW of the proposed transmission line would meet the limits of all states and the BPA electric field criteria (see Table 3.15-2). The edge-of-ROW electric fields from the proposed line would be below the edge-of-ROW limits set by all states.

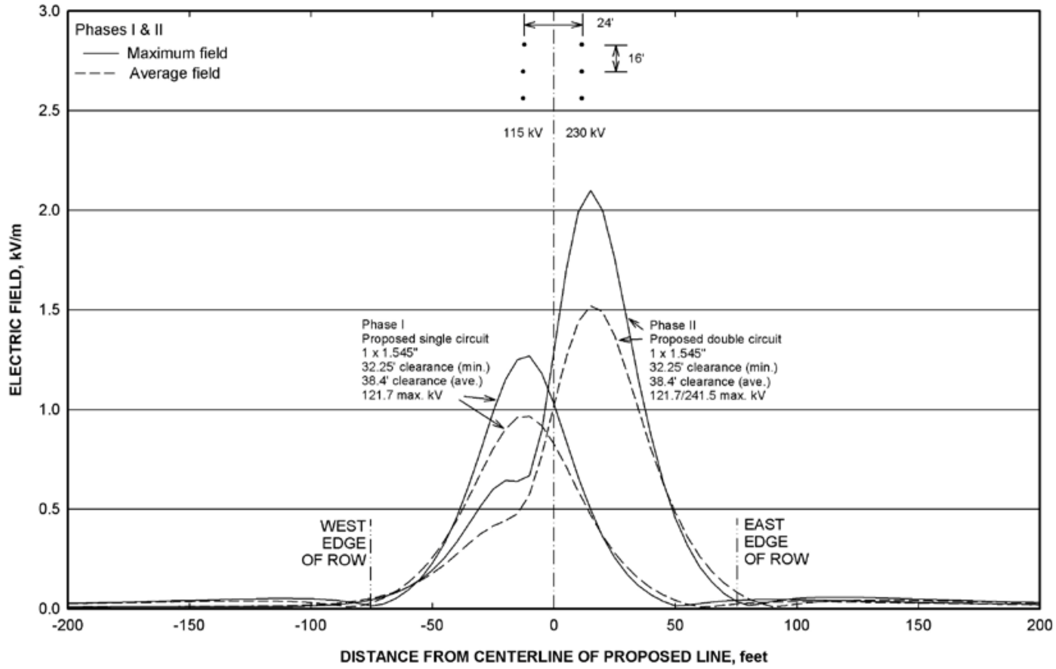
MAGNETIC FIELDS: SHORT-TERM EFFECTS

Magnetic fields associated with transmission and distribution systems can induce voltage and current in long conducting objects that are parallel to the transmission line. As with electric-field induction, these induced voltages and currents are a potential source of shocks. A fence, irrigation pipe, pipeline, electrical distribution line, or telephone line forms a conducting loop when it is grounded at both ends. The earth forms the other portion of the loop. The magnetic field from a transmission line can induce a current to flow in such a loop if it is oriented parallel to the line. If only one end of the fence is grounded, then an induced voltage appears across the open end of the loop. The possibility for a shock exists if a person closes the loop at the open end by contacting both the ground and the conductor. The magnitude of this potential shock depends on the following factors: the magnitude of the field; the length of the object (the longer the object, the larger the induced voltage); the orientation of the object with respect to the transmission line (parallel as opposed to perpendicular, where no induction would occur); and the amount of electrical resistance in the loop (high resistance limits the current flow).

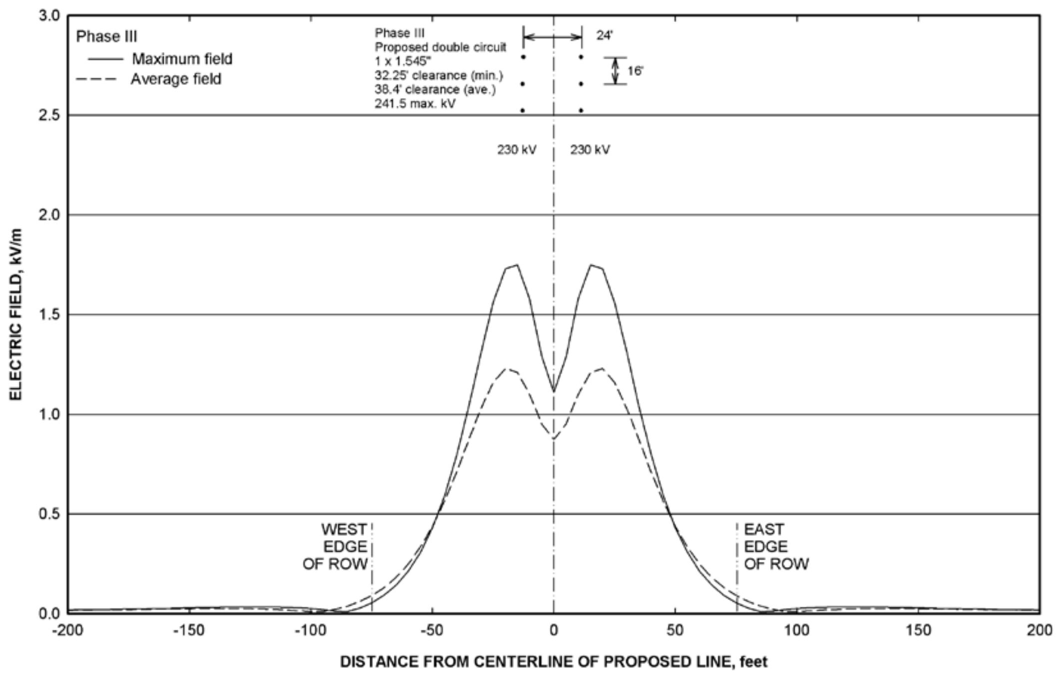
Magnetically induced currents from power lines have been investigated for many years; calculation methods and mitigating measures are available. A comprehensive study of gas pipelines near transmission lines developed prediction methods and mitigation techniques specifically for induced voltages on pipelines (Dabkowski and Taflove 1979; Taflove and Dabkowski 1979). Similar techniques and procedures are available for irrigation pipes and fences. Grounding policies employed by utilities for long fences reduce the potential magnitude of induced voltage.

The magnitude of the coupling with both pipes and fences is very dependent on the electrical unbalance (unequal currents) among the three phases of the line. Thus, a distribution line where a phase outage may go unnoticed for long periods of time can represent a larger source of induced currents than a transmission line where the loads are well-balanced (Jaffa and Stewart 1981).

Knowledge of the phenomenon, grounding practices, and the availability of mitigation measures mean that magnetic-induction effects from the proposed transmission line would be minimized.



a) Phases I and II



b) Phase II

Figure 3.15-1: Calculated maximum and average electric-field profiles for the proposed North Steens transmission line: a) Phases I and II; b) Phase III. Line configurations are described in Table 3.15-5.

Magnetic fields from transmission and distribution facilities can interfere with certain electronic equipment. Magnetic fields can cause distortion of the image on older style VDTs and computer monitors that employ cathode-ray tubes. This can occur in fields as low as 10 mG, depending on the type and size of the monitor (Baishiki et al. 1990; Banfai et al. 2000). Generally, the problem arose when computer monitors were in use near electrical distribution facilities in large office buildings. Display devices using flat-panel technologies, such as liquid-crystal or plasma displays are not affected.

Interference from magnetic fields can be eliminated by shielding the affected device or moving it to an area with lower fields. Interference from 60-Hz fields with computers and control circuits in vehicles and other equipment is not anticipated at the field levels found under and near the proposed 230-kV transmission line.

The magnetic fields from the proposed line would be comparable to those from existing 230-kV lines in the area of the proposed line and elsewhere in Oregon.

CALCULATED VALUES FOR MAGNETIC FIELDS

Table 3.15-5 gives the calculated values of the magnetic field at 3.28 ft. (1 m) height for the proposed North Steens transmission line. Field values on the ROW and at the edge of the ROW are given for projected maximum currents, for minimum and average conductor clearances. The maximum and average currents for the three phases of the North Steens line are given in Table 3.15-6, along with the phasing of the two circuits.

Table 3.15-5 Calculated Peak and Edge of ROW Magnetic Fields for the Proposed North Steens Transmission Line Operated at Maximum Voltage

	Magnetic Field, mG					
Phase	I		II		III	
Field[1]	Maximum	Average	Maximum	Average	Maximum	Average
Peak on ROW	52	14	93	23	97	25
At Edge of ROW[2]	15, 9	5, 3	7, 21	2, 7	12, 25	4, 8

[1] Maximum = Maximum voltage and minimum clearance; Average = Maximum voltage and average clearance.

[2] Fields at west edge of ROW adjacent to the Phase I circuit are given first.

The actual magnetic-field levels would vary, as currents on the lines change daily and seasonally and as ambient temperature changes. Average currents over the year would be about 35% of the maximum values. The maximum levels shown in the figures represent the highest magnetic fields expected for the proposed North Steens line. Average fields over a year would be considerably reduced from the peak values, as a result of reduced average currents and increased clearances above the minimum value.

Figure 3.15-1 shows lateral profiles of the magnetic field under maximum current and minimum clearance conditions for the three phases of the proposed transmission line. A field profile for average height under average current conditions is also included in Figure 3.15-1.

For the proposed line during Phase I, the maximum calculated magnetic field on the ROW is 52 mG for the maximum current of 500 A and a minimum conductor height of 32.25 ft. (9.8 m). The maximum field would decrease for increased conductor clearance. For the average conductor height of 38.4 ft. (11.7 m), the maximum field would be 14 mG. During Phases II the maximum field would be 93 mG and during Phase III, 97 mG.

Table 3.15-6 Physical and Electrical Characteristics of the Proposed North Steens Double-Circuit Transmission-Line. (See Figure 3.15-1 for drawing of tower)

Phase	I		II		III	
Circuit	West	East	West	East	West	East
Voltage[1], kV	121.7	–	121.7	241.5	241.5	241.5
Current, A Maximum/average	500/175	–	500/175	1000/350	261/91	1000/350
Electric phasing	A B C	–	A B C	C B A	A B C	C B A
Clearance, ft. Minimum/Average[2]	32.25/38.4	32.25/38.4	32.25/38.4	32.25/38.4	32.25/38.4	32.25/38.4
Tower configuration	Vertical Single-circuit	Vertical Double-circuit	Vertical Double-circuit	Vertical Single-circuit	Vertical Double-circuit	Vertical Double-circuit
Phase spacing, ft.[3]	16V	24H, 16 V	24H, 16 V	16V	24H, 16 V	24H, 16 V
Conductor diameter, in	1.545	1.545	1.545	1.545	1.545	1.545

[1] Maximum and average voltage assumed to be the same.

[2] Average voltage and average clearance used for corona calculations.

[3] H = horizontal spacing, feet; V = vertical spacing, feet

For maximum current and minimum clearance conditions during Phase I, the calculated magnetic fields at the edges of the 150-foot (45.7-m) ROW are 15 and 9 mG for the west and east sides of the ROW, respectively. For average current and conductor height during Phase I the fields at the edge of the ROW are 5 mG on the west side of the line and 3 mG on the east side. Under average conditions, the edge-of-ROW values during Phase II would be 2 and 7 mG, while during Phase III the values would be 4 and 8 mGs.

The magnetic fields from the proposed line would be below the ACGIH occupational limits, and well as below those of ICNIRP and IEEE for occupational and public exposures. The magnetic field at the edge of the ROW from the proposed line would be below the regulatory levels of states where such regulations exist.

SUMMARY

Electric and magnetic fields from the proposed transmission line have been characterized using well-known techniques accepted within the scientific and engineering community. The expected electric-field levels from the proposed line at minimum design clearance would be comparable to those from existing 115-kV and 230-kV lines in Oregon, and elsewhere. The expected magnetic-field levels from the proposed line would also be comparable to those from other 115-kV and 230-kV lines in Oregon, and elsewhere.

When the proposed line is operated at 115-kV, the peak electric field expected on the ROW would be 1.3 kV/m and the maximum value at the edge of the ROW would be about 0.3 kV/m. When operated at 230-kV, the maximum field values would be 2.1 kV/m on the ROW and 0.1 kV/m at the edge. The same maximum field values apply to road crossings for the two operating voltages.

For the single-circuit Phase I 115-kV operation the peak magnetic field on the ROW would be a maximum of 52 mG and an average value of 14 mG. At the edge of the ROW during Phase I, the largest fields would occur at the west edge with a maximum of 15 mG and an average value of 5 mG. For double-circuit operation with maximum current the peak fields on the ROW would be 93 mG for Phase II and 97 mG for Phase III. On average the peak magnetic field would be about one fourth the maximum value. During double-circuit operation the largest fields would occur at the east edge of the ROW, where the maximum would be 21 mG during Phase II and 25 mG during Phase III. Average values at the edge of the ROW during double-circuit operation would be about one third of the maximum values.

The electric fields from the proposed line would meet regulatory limits for public exposure in Oregon and all other states that have limits and would meet the regulatory limits or guidelines for peak fields established by national and international guideline setting organizations. The magnetic fields from the proposed line would be within the regulatory limits of the two states that have established them and within guidelines for public exposure established by ICNIRP and IEEE. The State of Oregon does not have limits for magnetic fields from transmission lines.

Short-term effects from transmission-line fields are well understood and can be mitigated. Nuisance shocks arising from electric-field induced currents and voltages could be perceivable on the ROW of the proposed line. Such occurrences are anticipated to be rare. It is common practice to ground permanent conducting objects during and after construction to mitigate against such occurrences.

TEMPORARY EFFECTS

EMF would be primarily be generated by operation of the proposed North Steens 230-kV transmission line; these effects are discussed under the Permanent Effects subheader above. Equipment used during construction of the proposed Project would not surpass general guidelines for EMF exposure that have been established for occupational and public exposure by national and international organizations (see the Affected Environment discussion for EMF above); therefore, no project design features or mitigation measures are proposed to reduce temporary effects.

Aviation and Military Operations

PERMANENT EFFECTS

The transmission line components that might become an aerial hazard include transmission towers 70 to 80 feet tall. Two towers at the Blitzen Valley crossing would be a maximum of 130 feet tall, which is necessary to span the valley while maintaining the appropriate ground clearance for the conductors. The conductors themselves might also become an aerial hazard. The conductors that would range from a maximum of 69 feet to a minimum of 22 feet above ground level, and typical spans of the transmission line would range from 600 to 1,000 feet between towers. The FAA Determinations of No Hazard to Air Navigation are not required for the transmission line because it would be less than 200 feet tall, the minimum height that triggers FAA approval.

MTRs VR316, VR319, VR1352, and IR304 and their authorized corridors intersect the transmission line alignment of Alternative B - West Route. With the exception of VR1352, all of these MTRs have authorized flight floors of 100 feet AGL. The floor for VR1352 is 200 feet AGL. With the exception of the Blitzen Valley crossing, the transmission line would be below these authorized flight floors and would pose no hazard to military aircraft. At the Blitzen Valley, the transmission towers and short sections of the conductors near the towers would encroach into VR316 and VR319 by a maximum of 30 feet, creating a location specific hazard to military aircraft utilizing those MTRs. At this location, it might be necessary for the military to raise their authorized flight floor to a safe level for a short distance above the transmission tower height. This might have an effect upon their ability to conduct effective low-level training exercises at this specific location within these MTRs.

Some civilian land management and local aircraft, such as fire aircraft, might occasionally fly at extremely low levels where the transmission line would become a hazard. This hazard would be limited because of the slower speeds and fewer numbers of these kinds of aircraft utilizing the area.

TEMPORARY EFFECTS

During construction, cranes used to raise the transmission towers and other high profile construction equipment might pose an additional but temporary hazard to low-level aircraft.

MITIGATION

In addition to the proposed design features (PDFs) and best management practices (BMPs) that were taken into account in the effects analysis in this section (see Section 2 and Appendix A.2), the following mitigation measures are recommended:

- Consultation by BLM and the Applicant with the DoD would ensure that the appropriate avoidance measures, such as raising authorized flight levels, are in place prior to construction of the transmission line.

- The Applicant should notify FAA, DoD, BLM Fire and Aviation, and other air space users and managers when construction of the transmission line has commenced so that these features can be incorporated into aerial hazard maps and warnings.

South Diamond Lane Route Option

FIRE HAZARDS

The potential fire hazards associated with the South Diamond Lane Route Option would be identical to those described for Alternatives B. The design features specified in Appendix A (A.1.9 and A.3.10) would be utilized, and the same mitigation measures described for Alternative B would be implemented to address permanent and temporary fire hazards associated with the South Diamond Lane Route Option.

HAZARDOUS MATERIALS

The potential hazardous materials effects associated with this route option would be identical to those described for Alternatives B. The same design features and mitigation measures described for Alternative B would be implemented under the South Diamond Lane Route Option.

ELECTRIC AND MAGNETIC FIELDS

For the purposes of assessing EMF effects, effects from the South Diamond Lane Route Option would be identical to Alternative B, since the transmission line design and operating characteristics would be the same for both.

AVIATION AND MILITARY OPERATIONS

PERMANENT EFFECTS

Aviation hazards associated with the South Diamond Lane Route Option would be slightly less than those described for Alternatives B because there would be no span of the Blitzen Valley and thus avoiding the use of taller transmission towers. The Blitzen Valley would still be crossed but in this area the valley is a broad floodplain that can be crossed using the same height of towers as the rest of the powerline. For this reason, the entire transmission line would be below authorized military flight floor levels.

MITIGATION

In addition to the proposed design features (PDFs) and best management practices (BMPs) that were taken into account in the effects analysis in this section (see Section 2 and Appendix A.2), the following mitigation measure is recommended:

- The Applicant should notify FAA, DoD, BLM Fire and Aviation, and other air space users and managers when construction of the transmission line has commenced so that these features can be incorporated into aerial hazard maps and warnings.

Hog Wallow Route Option

FIRE HAZARDS

The potential fire hazards associated with the Hog Wallow Route Option would be the same as described for Alternative B, as would be the proposed design features and mitigation measures.

HAZARDOUS MATERIALS

The potential hazardous materials effects for this route option would be the same as described for Alternative B, as would be the proposed design features and mitigation measures.

ELECTRIC AND MAGNETIC FIELDS

For the purposes of assessing EMF effects, effects from the Hog Wallow Route Option would be identical to Alternative B, since the transmission line design and operating characteristics would be the same for both.

AVIATION AND MILITARY OPERATIONS

The potential aviation hazards associated with the Hog Wallow Route Option would be the same as those described for Alternative B, as would be the proposed design features and mitigation measures.

115-kV Transmission Line Option

FIRE HAZARDS

The 115-kV Transmission Line Option would be a reduced capacity design configuration constructed along the same transmission line alignments described for Alternative B – West Route, the South Diamond Lane, and Hog Wallow Route Options. The only difference between the 115-kV Transmission Line Option and the others described above is the full build-out of this design option would have a single 115-kV circuit. The line location, pole heights, pole spacing, ROW widths, construction methods, interconnection points, and access requirements would be the same as for Alternative B and the route options described above. The only notable differences between this design option and the others would be this option would not involve a second round of construction to upgrade the line to 230 kV, nor would equipment upgrades be required at the interconnection station adjacent to the HEC line to accommodate the 230-kV upgrade. This option would have fewer temporary construction related fire hazards (such as sparks from construction equipment) compared to Alternative B and the other route options because the second round of construction would not be required. Ongoing operations and maintenance activities would be the same as described for Alternative B and the route options described above. The mitigation measures described for Alternative B would also apply to the 115-kV Transmission Line Option.

HAZARDOUS MATERIALS

The permanent and temporary effects of the 115-kV Transmission Line Option would be similar to those described for Alternative B and the two route options. However, this option would have lower overall temporary construction-related public health and safety effects associated with hazardous materials usage because only one round of construction would be required to install the single 115-kV circuit. Ongoing O&M activities would be the same as described for Alternative B and the two route options. The same mitigation measures described for Alternative B would apply to the 115-kV Transmission Line Option.

ELECTRIC AND MAGNETIC FIELDS

When the proposed line is operated at 115-kV, the peak electric field expected on the ROW would be 1.3 kV/m and the maximum value at the edge of the ROW would be about 0.3 kV/m. This is less than the maximum field values of 2.1 kV/m on the ROW and 0.1 kV/m at the edge which would be generated if the Project were built out to 230-kV. The same maximum field values apply to road crossings for the two operating voltages.

For the single-circuit Phase I 115-kV operation the peak magnetic field on the ROW would be a maximum of 52 mG and an average value of 14 mG. At the edge of the ROW during Phase I, the largest fields would occur at the west edge with a maximum of 15 mG and an average value of 5 mG. These values are less than would occur under development of the full 230 k-V, where the maximum current for peak fields on the ROW would be 93 mG for Phase II and 97 mG for Phase III. On average the peak magnetic field under double-circuit operation would be about one fourth the maximum value. During double-circuit operation the largest fields would occur at the east edge of the ROW, where the maximum would be 21 mG during Phase II and 25 mG during Phase III. Average values at the edge of the ROW during double-circuit operation would be about one third of the maximum values.

AVIATION AND MILITARY OPERATIONS

The potential aviation hazards associated with the 115-kV Transmission Line Option would be generally the same as those described for Alternative B and the South Diamond Lane and Hog Wallow Route Options. However, pilot visibility of the transmission line under this option might be reduced slightly because there would be only three conductors strung on the line, rather than the six conductors with the full 230-kV buildout.

3.15.3.4 Alternative C – North Route (Preferred Alternative)

Fire Hazards

PERMANENT EFFECTS

The potential fire hazards associated with Alternative C would be the same as described for Alternative B. The same design features would be utilized, and the same mitigation measures would be implemented to reduce potential fire hazards.

TEMPORARY EFFECTS

As described previously for Alternative B, construction activities could increase the risk of fire unless precautionary measures would be taken. The same design features described in Appendix A (A.1.9 and A.3.10) would be utilized to reduce fire risk.

FUTURE CONSTRUCTION PHASE – UPGRADE TO 230-KV

Future installation of the second 115-kV circuit would not require additional ROW, access roads, or new permanent features outside of areas already affected by installation of the initial 115-kV line. The effects from installation of the second circuit would be similar to those described above and would be associated primarily with the use of temporary laydown areas, pulling/tensioning sites, and the installation of temporary guard structures. Installation of the second 115-kV line would require equipment upgrades at the interconnection station adjacent to the HEC 115-kV line to accommodate the second circuit.

MITIGATION

The proposed design features (PDFs) that were taken into account in the effects analysis in this section would ensure that permanent and temporary effects to public health and safety related to fire hazards would be minimized. Therefore, no additional mitigation measures would be proposed.

HAZARDOUS MATERIALS

The Project features, effects, and mitigation for Alternative C would be the same as described for Alternative B.

ELECTRIC AND MAGNETIC FIELDS

For the purposes of assessing EMF effects, effects from Alternative C would be identical to Alternative B, since the transmission line design and operating characteristics would be the same for both.

AVIATION AND MILITARY OPERATIONS

PERMANENT EFFECTS

MTRs VR316, VR319, VR1352, and IR304 and their authorized corridors, along with the Saddle B MOA, intersect the transmission line alignment of Alternative C - North Route. With the exception of VR1352, all of these MTRs have authorized flight floors of 100 feet AGL. The floor for VR1352 is 200 feet AGL. The transmission line would be below these authorized flight floors, would pose no hazard to military aircraft, and would not affect the ability of the military to conduct low-level training within those areas.

Some civilian land management and local aircraft, such as fire and horse gathering aircraft, might occasionally fly at extremely low levels where the transmission line would become a hazard. This hazard would be limited because of the slower speeds and fewer numbers of these kinds of aircraft utilizing the area.

TEMPORARY EFFECTS

During construction, cranes used to raise the transmission towers and other high profile construction equipment might pose an additional but temporary hazard to low-level aircraft.

MITIGATION

In addition to the proposed design features (PDFs) and best management practices (BMPs) that were taken into account in the effects analysis in this section (see Section 2 and Appendix A.2), the following mitigation measure is recommended:

- The Applicant should notify FAA, DoD, BLM Fire and Aviation, and other air space users and managers when construction of the transmission line has commenced so that these features can be incorporated into aerial hazard maps and warnings.

115-kV Transmission Line Option

FIRE HAZARDS

The only difference between the 115-kV Transmission Line Option and Alternative C is the full build-out of this design option would have a single 115-kV circuit. The line location, pole heights, pole spacing, ROW widths, construction methods, interconnection points, and access requirements would be the same as for Alternative C. The only notable differences between this design option and Alternative C is this option would not involve a second round of construction to upgrade the line to 230-kV, nor would equipment upgrades be required at the interconnection station adjacent to the HEC 115-kV line near Crane to accommodate the upgrade to 230-kV. This option would have lower overall temporary construction related fire hazards, such as sparks from equipment, compared to Alternative C because the second round of construction would not be required. Ongoing operations and maintenance activities would be the same as described for Alternative C. The same design features intended to reduce fire hazards for Alternative C would also apply to the 115-kV Transmission Line Option.

HAZARDOUS MATERIALS

The permanent and temporary effects of the 115-kV Transmission Line Option would be similar to Alternative C. However, this option would have lower overall temporary construction related public health and safety effects from hazardous materials usage because only one round of construction would be required to install the single 115-kV circuit. Ongoing operations and maintenance activities would be the same as described for Alternative C and the same design features intended to reduce the potential for hazardous materials effects described for Alternative C would also apply to the 115-kV Transmission Line Option.

ELECTRIC AND MAGNETIC FIELDS

When the proposed line is operated at 115-kV, the peak electric field expected on the ROW would be 1.3 kV/m and the maximum value at the edge of the ROW would be about 0.3 kV/m. This is less than the maximum field values of 2.1 kV/m on the ROW and 0.1 kV/m at the edge which would be generated if the Project were built out to 230-kV. The same maximum field values apply to road crossings for the two operating voltages.

For the single-circuit Phase I 115-kV operation the peak magnetic field on the ROW would be a maximum of 52 mG and an average value of 14 mG. At the edge of the ROW during Phase I, the largest fields would occur at the west edge with a maximum of 15 mG and an average value of 5 mG. These values are less than would occur under development of the full 230 k-V, where the maximum current for peak fields on the ROW would be 93 mG for Phase II and 97 mG for Phase III. On average the peak magnetic field under double-circuit operation would be about one fourth the maximum value. During double-circuit operation the largest fields would occur at the east edge of the ROW, where the maximum would be 21 mG during Phase II and 25 mG during Phase III. Average values at the edge of the ROW during double-circuit operation would be about one third of the maximum values.

AVIATION AND MILITARY OPERATIONS

<u>The potential aviation hazards associated with the 115-kV Transmission Line Option would be generally the same as those described for Alternative C – North Route. However, pilot visibility of the transmission line under this option might be reduced slightly because there would be only three conductors strung on the line, rather than the six conductors with the full 230-kV buildout.</u>

3.15.3.5 Residual Effects after Mitigation

There would be no anticipated residual effects to public health and safety after mitigation measure have been implemented.

3.15.3.6 Summary Comparison of Alternatives

The effects to public health and safety from development of the Echanis Project, primary access road, and each alternative are summarized in Table 3.15-7. The table includes the effect to health and safety along the primary access road to the Echanis Project in addition to effects from each alternative.

Table 3.15-7 Summary of Effects to Public Health and Safety

			Alternative B			
Component	Alternative A – No Action	Echanis Wind Energy Project	West Route (Proposed Action)	S. Diamond Lane Route Option	Hog Wallow Route Option	Alternative C – North Route (Preferred Alternative)
Fire Hazards	Under No Action, the Echanis Project site would remain undeveloped and would continue to be used for livestock grazing. No new fire hazards would be introduced to the Project Area.	While unlikely, a potential fire risk from malfunction of the wind turbines and transformers exists. Risk of fire during construction could occur if sparks from equipment used during construction made contact with combustible material.	It is theoretically possible that an energized phase conductor could cause a fire if it were to fall to the ground and create an electrical arc that could ignite combustible material; however, this is a very unlikely event. Sparks from equipment used during operation and maintenance (O&M) of the transmission line, interconnection stations, and substation also pose a risk of fire. Permanent effects from operation of the transmission line, interconnection stations, and substation also include increased risk of fire due to inadequate clearance between vegetative fuel loads and Project facilities.	The same as Alternative B - West Route	The same as Alternative B - West Route	The same as Alternative B - West Route

EMF	No new sources of EMF would be developed or introduced into the Project Area.	No EMFs would be generated by the Echanis Project. EMFs associated with wind projects occur during the transmission of the energy produced by the turbines to the main electricity transmission grid for distribution.	EMFs would meet regulatory limits for public exposure in Oregon, as well as regulatory limits or guidelines for peak fields established by national and international guideline setting organizations. Magnetic fields from the proposed line would be within the regulatory limits of the two states that have established them, and within guidelines for public exposure established by ICNIRP and IEEE. No Project design features or mitigation measures are proposed.	The same as Alternative B - West Route	The same as Alternative B - West Route	The same as Alternative B - West Route
Hazardous Materials	No new sources of hazardous materials would be developed or introduced into the Project Area.	The potential exists for release of hazardous materials to the environment from improper use, storage, or disposal of hazardous materials. An accidental release could contaminate vegetation, soil, and water, which could result in indirect effects to human and wildlife populations. All major components of the wind turbines would undergo routine maintenance, which would involve the use of small amounts of hazardous materials, such as grease, lubricants, paint, corrosion control coatings, and glycol-based coolants.	The potential exists for release of toxic materials into the environment from improper use, storage, or disposal of these materials. Releases could contaminate vegetation, soil, and water, which could result in indirect effects to human and wildlife populations. Use of hazardous materials during Project construction, operation, and maintenance would pose potential health and safety hazards to construction and maintenance workers and nearby residents.	The same as Alternative B - West Route	The same as Alternative B - West Route	The same as Alternative B - West Route
Aviation and Military Operations	No new aviation hazards or effects to military air operations would occur.	Aerial hazards would be introduced into the Project Area, primarily from installation of wind turbines. Authorized DoD flight floors might require raising to avoid the wind turbines potentially affecting training capability within the affected MTRs. Turbines would also constitute a hazard to low-level land management and local civilian aircraft.	With the exception of the Blitzen Valley, the transmission line would be below authorized DoD flight floors. At the Blitzen Valley crossing, transmission towers would slightly encroach into MTRs, requiring avoidance by military aircraft. The transmission line would constitute a hazard to low-level land management and local civilian aircraft.	No transmission line components would encroach into MTRs. The transmission line would constitute a hazard to low-level land management and local civilian aircraft.	The same as Alternative B - West Route	No transmission line components would encroach into MTRs. The transmission line would constitute a hazard to low-level land management and local civilian aircraft.

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