3.14 GEOLOGIC HAZARDS

This section addresses potential impacts from geologic hazards on the Preferred Route, Proposed Route, and Route Alternatives during construction, operations, and decommissioning. The primary reason to define impacts from geologic hazards is to eliminate, minimize, or mitigate effects from these hazards during Project execution. This section analyzes the potential impacts from earthquakes, subsidence, landslides, and blasting in shallow bedrock on Project construction and operations. Impacts on minerals are discussed in Section 3.12 – Minerals, and impacts on soils are discussed in Section 3.15 – Soils.

The BLM's Preferred Routes for each segment of the Project are listed below. Where applicable, the preferred route identified by another federal agency or a county or state government is also noted.

- **Segment 1W:** The BLM's Preferred Route is the Proposed Route (Figure A-2). This route is also the State of Wyoming's preferred route.
- **Segment 2:** The BLM's Preferred Route is the Proposed Route (Figure A-3). This route is also the State of Wyoming's preferred route.
- **Segment 3:** The BLM's Preferred Route is the Proposed Route, including 3A (Figure A-4). This route is also the State of Wyoming's preferred route.
- **Segment 4:** The BLM's Preferred Route is the Proposed Route (Figures A-5 and A-6) except within the Caribou-Targhee NF. The portion of this route in Wyoming is also the State of Wyoming's preferred route. The Forest Service's preferred route is the Proposed Route within the NF incorporating Alternative 4G (Figure A-6).
- **Segment 5:** The BLM's Preferred Route is the Proposed Route incorporating Alternatives 5B and 5E, assuming that WECC reliability issues associated with 5E are resolved (Figure A-7). Power County's preferred route is the Proposed Route incorporating Alternatives 5C and 5E (Figure A-7).
- **Segment 6:** The BLM's Preferred Route is the proposal to upgrade the line voltage from 345 kV to 500 kV (Figure A-8).
- **Segment 7:** The BLM's Preferred Route is the Proposed Route incorporating Alternatives 7B, 7C, 7D, and 7G (Figure A-9). The Proposed Route in the East Hills and Alternative 7G will be microsited to avoid sage-grouse PPH. Power and Cassia Counties' preferred route is Alternative 7K (Figure A-9).
- **Segment 8:** The BLM's Preferred Route is the Proposed Route incorporating Alternative 8B (Figure A-10). This is also IDANG's preferred route.
- **Segment 9:** The BLM's Preferred Route is the Proposed Route incorporating Alternative 9E, which was revised to avoid PPH and the community of Murphy (Figure A-11). Owyhee County's preferred route is Alternative 9D (Figure A-11).
- **Segment 10:** The BLM's Preferred Route is the Proposed Route (Figure A-12).

3.14.1 Affected Environment

This section discusses those aspects of the environment that could be impacted by the Project. It starts with a discussion of the Analysis Area considered, identifies the issues that have driven the analysis, describes the method of analysis, and characterizes the existing conditions across the Project in Wyoming and Idaho.[1]

3.14.1.1 Analysis Area

Figure 3.14-1 is a generalized map showing the location of prominent physiographic features along the Project alignment. The Project would be located on land consisting of predominantly north-south trending mountain ranges separated by geographic and structural basins. The eastern portion of the Project (Segments 1 and 2) would be located within the Laramie Mountains and the Shirley Mountains, which consist of pre-Cambrian-age granite and younger sedimentary rocks. Farther west, the geology is dominated by major structural basins, including the Hanna Basin in Carbon County (Segment 2) and the Greater Green River Basin in Sweetwater County (Segments 3 and 4). Mountainous terrain is present along the Idaho-Wyoming border in Segments 4 and 5. Thrust faulting dominated the mountain-building processes in the east portion of the mountains, while block faulting was more common farther west into southeast Idaho. The mountain ranges consist of predominantly sedimentary or metamorphic rock. West of Borah Substation (Segments 6 through 10), the routes fall within the Snake River Plain, a broad structural valley, with extensive exposures of basalt, thinly covered with silty, mainly wind-blown soil. Some of the southern alternatives (Segments 7 and 9) remain within the basin and range mountain ranges similar to those in southeast Idaho, except with progressively more volcanism as one proceeds west. The nearest active volcanic field is the Wapi Lava Field, which erupted approximately 2,200 years ago. The Wapi Lava Field is within 650 feet of Segment 6, and approximately 8 miles northwest of Borah Substation. The Craters of the Moon Lava Field formed during eight eruptive periods with a recurrence interval averaging 2,000 years, and it has been more than 2,000 years since the last eruption. The Craters of the Moon Lava Field is approximately 29 miles from the Borah Substation and is within 4 miles of Segment 6. The Yellowstone volcano in northwest Wyoming is a caldera-type volcano, approximately 130 miles from the closest Route Alternative. It last erupted approximately 600,000 years ago but frequent hydrothermal activity and seismic events in this area suggest that the volcano could become active again. Neither is expected to affect the Project during its planned service life.

The Analysis Area for geologic hazards (landslides, subsidence, and shallow bedrock) was defined in a GIS file by buffering the centerlines of the Proposed Route and Route Alternatives 0.5 mile on either side and dissolving the buffers into a single polygon for each segment. This distance was used because it encompasses the potential geologic hazard area that could affect the stability of the transmission line relative to landslides, subsidence, and shallow bedrock, since each of those features is local in nature. The Analysis Area for earthquake hazard zones was based on the centerline

[1] The Project no longer has a route in Nevada.

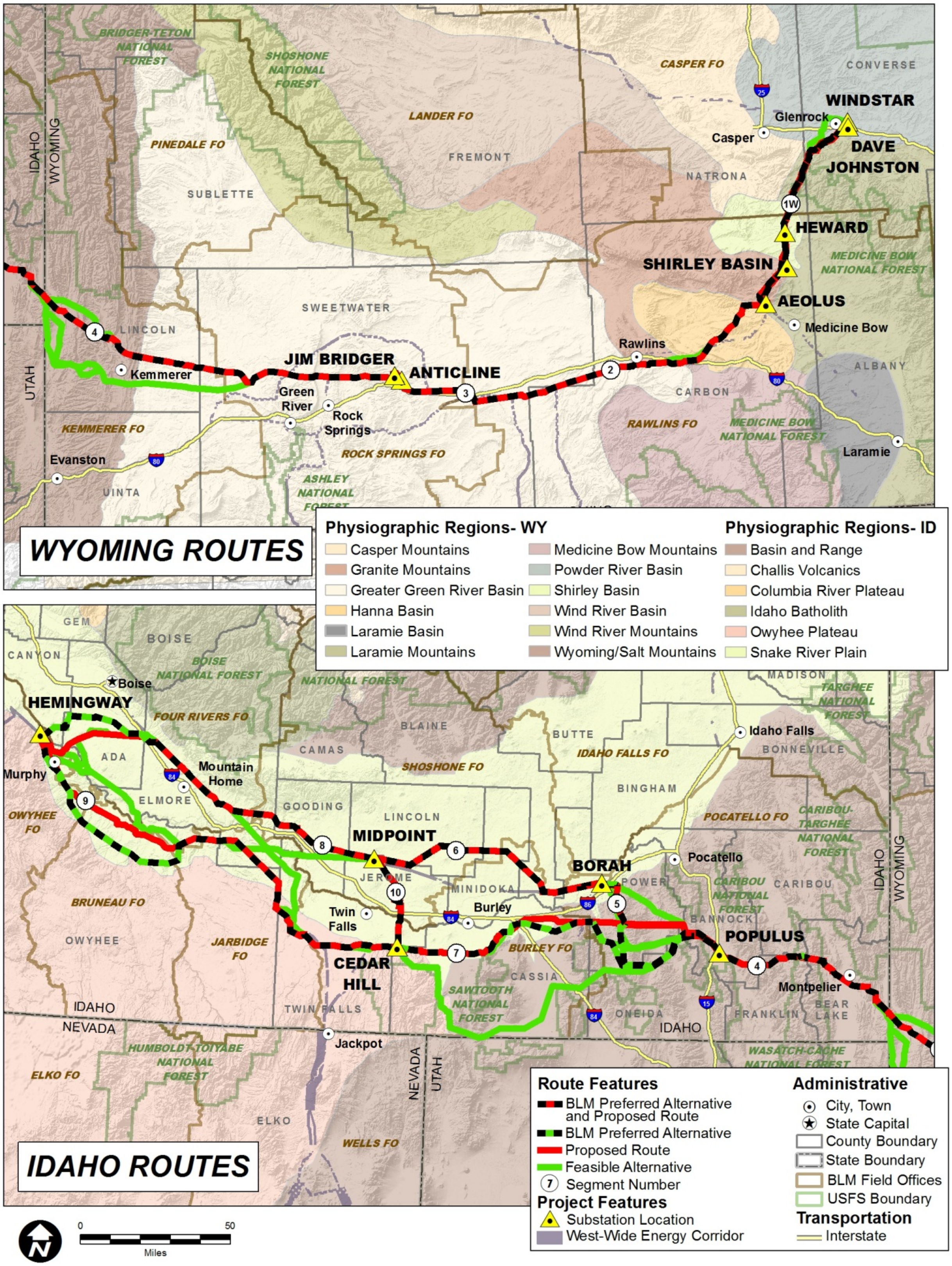

Figure 3.14-1. Physiographic Provinces

locations for the Proposed Route and Route Alternatives, whereas the Analysis Area for earthquakes was defined by a variable buffer distance around epicenters, or groups of epicenters, of historical earthquakes and extended out to 100 miles for the most severe earthquakes. The distance of 100 miles was chosen because at that distance, the effect on the proposed transmission line from earthquakes would be minimal from even the strongest recorded past earthquakes in the area.

3.14.1.2 Issues Related to Geologic Hazards

This review of geologic hazards addressed public comments received during scoping (Tetra Tech 2009) and comments on the Draft EIS regarding the potential for impacts to the transmission line from mine subsidence. A detailed analysis of subsidence is presented herein. The following geologic hazard issues were carried through for detailed analysis:

- a full inventory of potentially affected geological resources;
- the potential for earthquakes to damage the transmission line and associated structures;
- the effect subsidence from underground mining would have on the transmission line, and what the hazard to workers or infrastructure would be;
- the effect landslides would have on the transmission line (segments that cross medium or high landslide risk areas are identified);
- the effect construction blasting in shallow bedrock would have on unstable landforms (landslide or subsidence-prone areas or coal-mining areas containing methane), or on adjacent human-made structures not related to the transmission line.

3.14.1.3 Regulatory Framework

The 2012 International Building Code (IBC; ICC 2012) provides building standards for structures, including standards for structures located within seismically active areas. Local or state building codes may specify adherence to IBC standards. Management plans of the BLM and Forest Service also provide guidance relative to geologic hazards. The IBC will be used to design all structures considering seismic design criteria.

3.14.1.4 Methods

The environmental effects analyses completed for this assessment were conducted using readily available data and GIS files derived from preliminary centerline and component design for the Proposed Route and Route Alternatives including ROW, access roads, staging areas, and fly yards (see Section 3.1 for details on the development of these files). In all cases, after analysis of impacts was complete and where impacts were identified, Proponent-proposed measures to reduce impacts were reviewed for sufficiency. Where those measures were determined to be insufficient, additional measures were identified.

<u>Earthquakes</u>

Earthquake hazards were evaluated using two methods, including use of Office of Pipeline Safety (OPS) data, and by reviewing the location and intensity of historic earthquakes within the analysis area. The Federal Emergency Management Agency (FEMA) and the U.S. Department of Transportation, OPS National Disaster Study, National Pipeline Risk Index Technical Report (OPS Study) (FEMA and OPS 1996) was used to evaluate earthquake hazard zones. The OPS data provide earthquake hazard rankings for the United States, including those portions of Idaho and Wyoming near the proposed transmission lines. The OPS report utilized information from the USGS National Earthquake Hazards Reduction Program. The USGS compiled a large database of past earthquake magnitudes and locations. Based on those data, earthquake hazard zones were assigned to all parts of the country. Based on historical earthquake magnitudes and locations, geographic areas were assigned an earthquake hazard ranking, ranging from zero (no earthquake hazard) to 100 (highest earthquake hazard). For this analysis, a high earthquake hazard was assigned for areas with earthquake hazard rankings of 85 to 100. Locations with earthquake hazard rankings between 70 and 85 were considered as medium risk, and rankings less than 70 were considered low risk.

To identify existing earthquake conditions, the centerlines of the Proposed Route and Route Alternatives in each segment were overlaid on the OPS GIS data file and the mileage crossed for each earthquake hazard risk was determined and expressed as a percent for the segment. To disclose overall hazard risk for impacts analysis, the mileage crossed by the entire Proposed Route by segment and for those portions of each segment where alternatives were proposed was identified. Miles of earthquake hazard category were then compared for each segment by alternative.

The locations of historical earthquake epicenters were also reviewed relative to the transmission line routes. Wyoming earthquake data were obtained from the University of Wyoming's Wyoming Geographic Information Science Center (http://uwyo.edu/wygisc/info). Earthquake data for Idaho, Colorado, Nevada, Oregon, and Utah were obtained from the applicable state geologic survey departments.

The damage to structures caused by earthquakes is highly variable and based on many factors including, but not limited to, types of building materials and quality of construction, distance from epicenter, earthquake magnitude, and the susceptibility to ground shaking of underlying soil and rock at the site of the structure. Therefore, any relationship between structure damage and distance from earthquake epicenter is only an estimate. However, certain areas are subject to more earthquakes than others and the geographic distribution of earthquakes was considered.

Earthquake magnitude information obtained from University of Nevada, Reno (2008) estimated that earthquakes of Richter magnitude 6.0 to 6.9 may damage buildings for distances of up to 100 kilometers (62.5 miles). For this analysis, a 50-mile radius buffer was assigned to earthquakes within these magnitudes. The University of Nevada, Reno (2008) information stated that for earthquakes of magnitude less than 6, some structures could be damaged over small regions. For earthquakes of that magnitude, a buffer of 20 miles was assigned around each epicenter. University of Nevada, Reno (2008) described earthquakes of magnitude 7 or greater as having the potential for damage over larger areas. For these large earthquakes, a buffer of 100 miles was assigned. To identify the potential for structural damage, the centerlines of the

Proposed Route and Route Alternatives in each segment were overlaid on the consolidated buffers derived from each epicenter, or group of epicenters, and the mileage crossed for each set of buffers was summed for each segment and expressed as a percent. To disclose overall risk of structure damage for impacts analysis, the mileage crossed by the entire Proposed Route by segment and for those portions of each segment where alternatives were proposed was identified. Miles of structure damage category were then compared for each segment by alternative.

Landslides

The OPS Study was used to evaluate landslide hazard zones. The OPS data provide landslide hazard rankings for the United States, including those portions of Idaho and Wyoming near the proposed transmission lines. The OPS report utilized information from USGS and U.S. Natural Resources Conservation Service (NRCS) for locations of swelling clay, landslide incidence, landslide susceptibility, and land subsidence. Based on those four factors, landslide hazard rankings were assigned from zero to 100, where zero represents the lowest ground failure hazard and 100 represents the highest. Landslide hazard rankings of 85 to 100 were assumed to have high risk of landslides, rankings between 70 and 85 were considered to have medium risk, and areas less than 70 were assumed to have low risk. To identify existing landslide potential, the Analysis Area within each segment was overlaid on the OPS data to identify the percent of the segment within each landslide risk category. To evaluate the possible interactions between areas of high landslide potential and the Project, the mileage crossed by the entire Proposed Route by segment and for those portions of each segment where alternatives were proposed was identified. Miles of landslide hazard category were then compared for each segment by alternative.

Subsidence

The locations of underground mineral deposits were obtained from Wyoming Geological Survey (http://www.wsgs.uwyo.edu/GIS/DigitalData). WDEQ also provided the known locations of historic abandoned underground mine sites. It is well-documented that some areas overlying underground mines in southern Wyoming have experienced subsidence. As a conservative measure, it was assumed that any area with underground mineral deposits of coal, trona, or oil and gas and any area with abandoned underground mines had the potential for subsidence.

To identify existing subsidence potential, the Analysis Area within each segment was overlaid on the Wyoming geological survey and WDEQ data to identify the percent of the segment within identified subsidence-prone areas. To evaluate the possible interactions between subsidence-prone areas and the Project, the mileage crossed by the entire Proposed Route by segment and for those portions of each segment where alternatives were proposed was identified. Miles of subsidence-prone areas were then compared for each segment by alternative.

Blasting in Shallow Bedrock

The NRCS State Soil Geographic (STATSGO) database was used to evaluate depth to shallow bedrock (NRCS 1995). The database separates the depth to bedrock into categories, including depths of 1 to 4 feet, 4 to 8 feet, and 8 to 12 feet. No readily available data were found to evaluate depth to bedrock at depths greater than 12 feet. However, Table B-2 in Appendix B indicates that transmission structure foundations may be up to 32 feet deep for 500-kV towers (angle towers or dead-ends). In 2010, drilling began in some areas of Segments 1 through 4 to support geotechnical evaluations for transmission line structures. The drilling was conducted on public land and private land where landowner permission was obtained. As a conservative measure, it was assumed that all shallow bedrock that would need to be removed would require blasting.

To evaluate existing shallow bedrock areas, the Analysis Area within each segment was overlaid on the STATSGO database to identify the percent of the segment containing shallow bedrock. To evaluate the possible interactions between shallow bedrock, including the need for blasting, and the Project, the mileage crossed by the entire Proposed Route by segment and for those portions or each segment where alternatives were proposed was identified. Miles of route crossing shallow bedrock areas were then compared for each segment by alternative.

A comment was received that methane could accumulate in shallow voids in the subsurface, including monitoring wells. This methane, if present in a blasting area, could cause unintended explosions. The locations of current coal leases, presented in Section 3.12 – Minerals, were compared to the Proposed Route and Route Alternatives. Information from WDEQ, Abandoned Mine Lands Division, was also reviewed to assess the location of historic coal mines and those locations were compared to the Proposed Route and Route Alternatives. Similarly, blasting could cause subsidence in unstable areas.

To evaluate the risks of subsidence or contact with methane in shallow blasting areas, the Analysis Area within each segment was overlaid on the STATSGO database to identify the percent of the segment containing shallow bedrock, merged with subsidence areas, then merged again with coal-producing areas. To evaluate the possible interactions between blasting, subsidence, and methane potential, the route mileages for intersected areas (bedrock vs. subsidence, and bedrock vs. coal) were then compared for each segment by alternative.

Depth to Bedrock Confirmation from Geotechnical Boreholes

In 2010, drilling began in some areas to support geotechnical evaluations for transmission line structures. The drilling was conducted on public land and private land where landowner permission was obtained. The 2010 drilling program consisted of drilling 124 boreholes in Segments 1 through 4. Total depths drilled ranged from 15 feet to 66.5 feet. Drilling logs were reviewed to evaluate depth to bedrock. Shallow bedrock (less than 20 feet deep) was found in 11 of the boreholes. The locations of these boreholes were compared to the locations where STATSGO information indicated shallow bedrock. A comparison of depth to bedrock differences between the geotechnical boreholes and STATSGO data is provided in Section 3.14.1.5.

3.14.1.5 Existing Conditions

Geologic processes within the Project area, including earthquakes, landslides, and subsidence, could occur during the life of the Project. Existing conditions that could lead to geologic hazards affecting the transmission lines and associated facilities such as substations, access roads or communication facilities are described below. In addition, shallow depth to bedrock could require blasting. The resulting damage may result in adverse environmental effects.

Earthquakes

The Proposed Route and Route Alternatives across Wyoming and Idaho would be located in areas where earthquakes could occur. A summary of earthquakes that have occurred within the past 100 years, as well as an earthquake risk database, were reviewed in assessing the potential effects from earthquakes. Based on the data provided, earthquakes are most common in a north-south trending area along the Idaho-Wyoming border. Figure 3.14-2 shows the locations of earthquake epicenters, including Quaternary faults crossing the transmission lines, and corresponding buffer zones. The largest historical earthquakes have been in the Yellowstone area of northwest Wyoming, and in south and central Idaho. However, the frequency of earthquakes appears less in Idaho than in Wyoming. The data indicate that historical earthquakes have likely been felt in all of the segments.

Table 3.14-1 presents the percent of low, medium, and high earthquake risk within the Analysis Area by segment. Table 3.14-2 presents the Analysis Area within the buffers assumed for recent earthquake epicenters by segment. Parts of Segments 4, 5, 6, and 7 contain medium to high risks of earthquakes. Portions of Segments 5, 6, 7, 8, 9, and 10 have experienced an earthquake of greater than magnitude 7.

Table 3.14-1. OPS Earthquake Hazard Risk by Segment

Segment Number	Earthquake Zone Rank by Percent of Analysis Area		
	Low < 70	**Medium 70 to 84**	**High 85 to 100**
1	100	–	–
2	100	–	–
3	100	–	–
4	36	12	52
5	–	12	88
6	49	51	–
7	24	25	51
8	100	–	–
9	100	–	–
10	100	–	–

Table 3.14-2. Earthquake Magnitude Buffers by Segment[1/]

Segment Number	Earthquake Buffer Zone by Percent of Analysis Area		
	Magnitude 0.1 to 6	**Magnitude 6.0 to 6.9**	**Magnitude >7**
1	71	–	–
2	94	–	–
3	70	–	–
4	79	7	–
5	11	93	4
6	49	–	100
7	23	59	2
8	21	–	47
9	–	–	6
10	41	–	77

1/ Some areas are in more than one earthquake magnitude zone; therefore, total percentage can exceed 100.

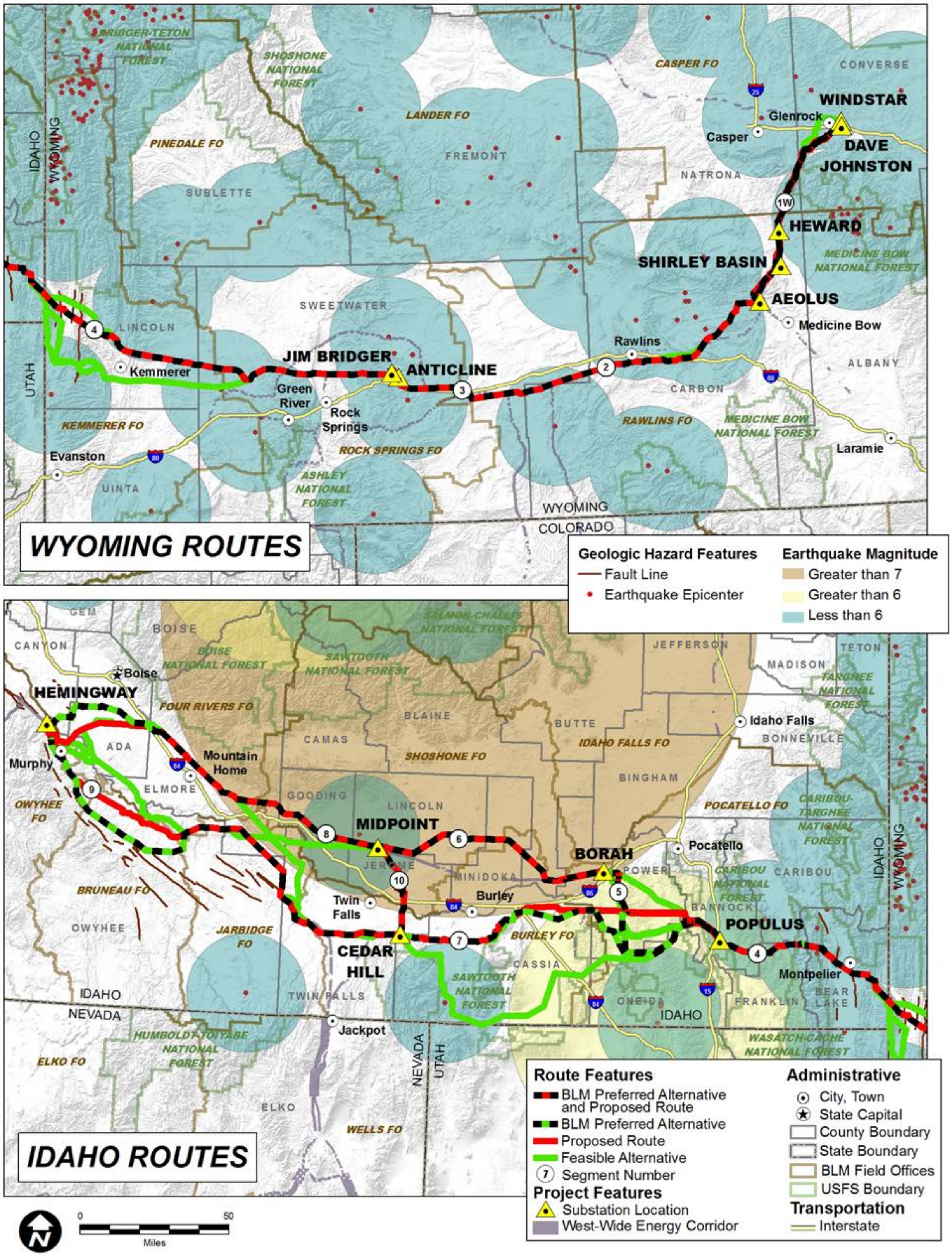

Figure 3.14-2. Earthquake Epicenters

Landslides

Landslides, including mudflows, mudslides, rock flows, rock slides, and debris flows could occur in mountainous portions of the Project area. Landslides are often triggered by other natural events, including earthquakes, or precipitation sufficient to cause earth movements. Certain geologic formations such as the Green River Formation are known to be more susceptible to landslides than others (Aase 2008). Table 3.14-3 presents the percent of low, medium, and high landslide risk within the Analysis Area by segment. The greatest landslide risks are in Segment 4, where 45 percent of the routes cross areas of medium to high landslide risks. Segment 3 contains medium landslide risk to 33 percent of the route (see Figure 3.14-3). Small portions (6 percent or less) of medium or high landslide risk are also present in Segments 1, 7, and 8.

Table 3.14-3. OPS Landslide Risk by Segment

Segment Number	Landslide Hazard Rankings by Percent of Analysis Area		
	0 to 69	**70 to 84**	**85 to 100**
1	94	–	6
2	100	–	–
3	67	33	<1
4	54	10	35
5	100	–	–
6	100	–	–
7	100	–	<1
8	96	4	–
9	100	–	–
10	100	–	–

Subsidence

Subsidence is the vertical sinking of earth, typically because of a natural or man-made void in underlying rock formations. Geologic areas with extensive limestone caves or large natural voids in basalt flows possess the potential for natural subsidence; however, there are no large areas of cavernous limestone or natural voids in the area crossed by the Proposed Route or Route Alternatives. Man-caused subsidence occurs in areas overlying extensive underground mine workings or in areas of aquifer drawdown or removal of other fluids, such as natural gas or crude oil. Underground trona and coal mines are particularly susceptible to subsidence because of their large extent. The subsidence potential analyzed in this assessment is associated with current and historic underground mine workings in southern Wyoming. Figure 3.12-1 shows the locations of trona, oil and gas, phosphate, coal, and geothermal leases in Wyoming.

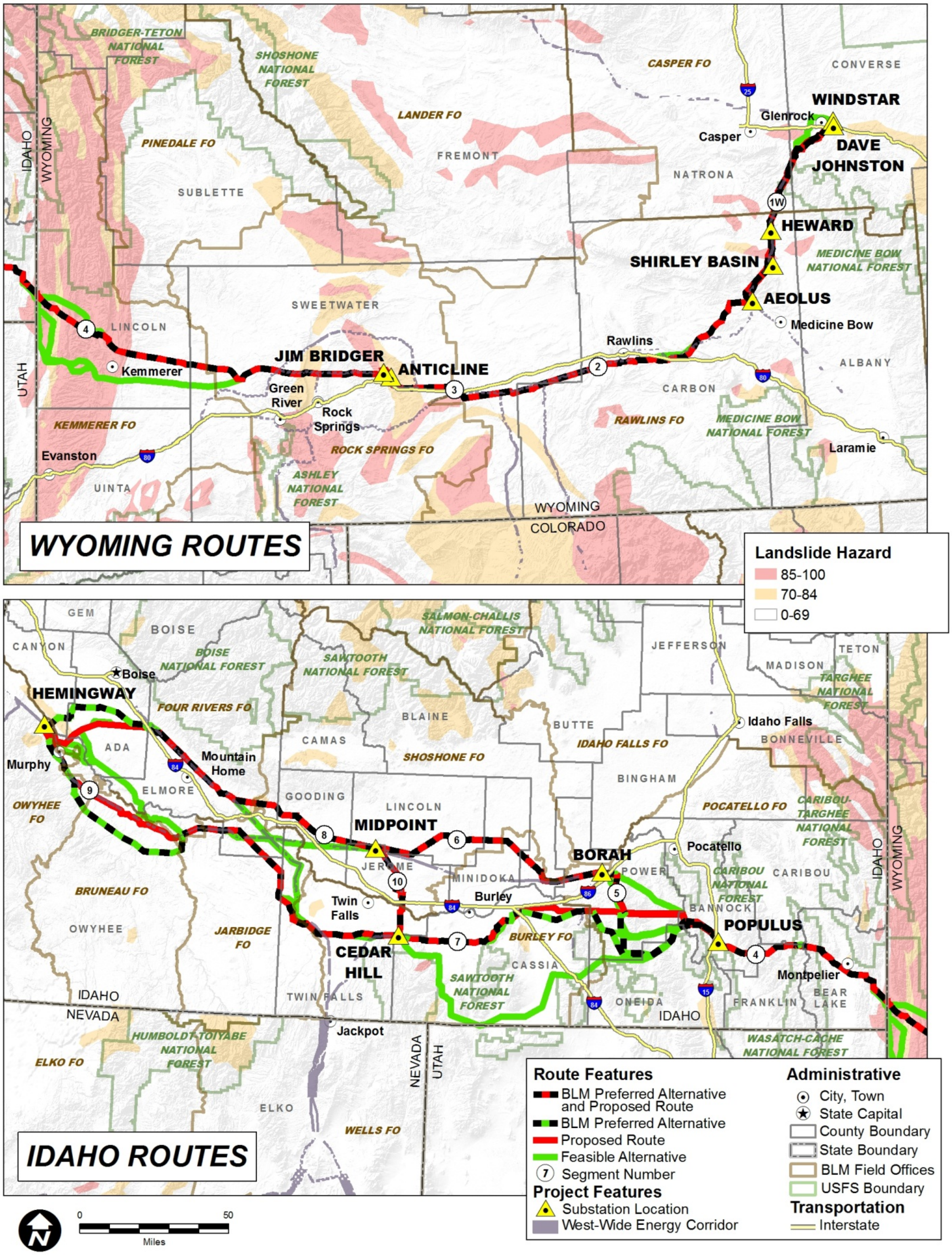

Figure 3.14-3. Landslide Zones

Table 3.14-4 presents the percent of the Analysis Area within each segment where subsidence could occur, based on the presence of mineral leases. Mineral extractions that could result in subsidence only occur in Segments 1 through 4. A total of 34 percent of the Analysis Area in these four segments is located in areas of possible subsidence.

Table 3.14-4. Potential Subsidence Areas by Segment

Segment Number	Mineral Lease Area as a Percent of Analysis Area				
	Coal	Oil and Gas	Trona	Abandoned Mines	Total Percent of Analysis Area
1	–	7	4	1	12
2	5	42	3	3	52
3	4	43	20	–	67
4	1	29	<1	2	32

Shallow Bedrock

Table 3.14-5 presents the percent of the extent of shallow bedrock within the Analysis Area by segment. The STATSGO data indicate that shallow bedrock is found in all segments of the Project except Segment 2. In 2010, a total of 124 boreholes were drilled in Segments 1 through 4. Total depths drilled ranged from 15 feet to 66.5 feet. The drilling data indicate that 11 borings contained bedrock at depths less than 20 feet including one in Segment 2 that intercepted bedrock at a depth of 15 feet. Therefore, it is assumed that shallow bedrock could be encountered in any of the segments. Additional drilling data will be used by project engineers to identify areas containing shallow bedrock that may require blasting. Due to the lack of depth-to-bedrock data deeper than 12 feet, the amount of shallow bedrock presented in Table 3.14-5 below and Table B-10 in Appendix B likely underestimates the amount of shallow bedrock that will be encountered during construction.

Table 3.14-5. Areas of Shallow Bedrock by Segment

Segment Number	Depth to Bedrock (feet) by Percent of Analysis Area			
	1 to 4	4 to 8	8 to 12	Total Percent of Analysis Area
1	7	<1	14	21
2	–	–	–	–
3	66	6	–	72
4	40	1	3	44
5	8	25	–	33
6	47	29	–	75
7	15	23	8	46
8	16	51	14	81
9	41	20	16	78
10	20	2	2	24

3.14.2 Direct and Indirect Effects

This section is organized to present effects from geologic hazards on construction, then operations, followed by decommissioning activities for the proposed Project. Route Alternatives are analyzed in detail below in Section 3.14.2.3.

EPMs are presented in detail within this section only if it is the first time they have been discussed in Chapter 3; all other measures are referenced or summarized. A comprehensive list of all EPMs and the land ownership to which they apply can be found in Table 2.7-1 of Chapter 2.

Plan Amendments

Proposed amendments to BLM RMPs and MFPs are summarized in Table 2.2-1 of Chapter 2, while BLM plan amendments associated with other routes are summarized in Table 2.2-2. BLM plan amendments are discussed in detail in Appendices F-1 and G-1. Proposed amendments to Forest Plans are summarized in Table 2.2-3 of Chapter 2 and discussed in detail in Appendices F-2 and G-2. Amendments are needed to permit the Project to cross various areas of BLM-managed lands and NFS lands. Effects described for areas requiring an amendment in order for the Project to be built would only occur if the amendment were approved. Amendments that alter land management designations could change future use of these areas. No amendments specific to geologic hazards are proposed for the Project and no direct impacts to geologic hazards resulting from approving the amendments beyond the impacts of the Project are anticipated.

3.14.2.1 No Action Alternative

Under the No Action Alternative, the BLM would not issue a ROW grant to the Proponents of Gateway West and the Project would not be constructed across federal lands. No land management plans would be amended to allow for the construction of this Project. Geologic hazards could not affect the Project because the Project would not be constructed. The demand for electricity, especially for renewable energy, would continue to grow in the Proponents' service territories. If the No Action Alternative is implemented, the demand for transmission services, as described in Section 1.3, Proponents' Objectives for the Project, would not be met with this Project and the area would have to turn to other proposals to meet the transmission demand. Under the No Action Alternative, geologic hazards could affect unrelated new transmission lines built to meet the increasing demand in place of this Project.

3.14.2.2 Effects Common to All Action Alternatives

Construction

Transmission lines and associated facilities could be negatively affected by geologic hazards, including earthquakes, landslides, subsidence, and blast vibrations in shallow bedrock. Earthquakes could occur in any segment of the Project. Project construction, operations, or decommissioning would have no effect on earthquake risks. However, ground shaking and displacement related to earthquakes may damage human-made structures, including transmission lines and substations. The risk interval from geologic hazards during construction is approximately 2 years.

All utilities governed by the National Electric Safety Code (NESC) are required to apply various weather-related structural loading cases while designing transmission lines. The Proponents apply all NESC required weather-related loading cases as well as some additional cases felt to be important to the integrity of the lines. A short note in NESC Section 250.A.4 indicates that by following the required loading cases, nothing further is required to resist earthquake loads. It states, “The structural capacity provided by meeting the loading and strength requirements of Sections 25 (Loadings for Grades B and C) and 26 (Strength Requirements) provides sufficient capability to resist earthquake ground motions.” For this reason, the Proponents do not plan any additional design efforts specific to earthquakes.

The Wyoming Department of Homeland Security in their Multi-Hazard Mitigation Plan (2011) indicates that significant mine subsidence problems have occurred in all of the southern Wyoming counties, including those containing Segments 1 through 4. They estimate that mine subsidence has resulted in approximately $85 million in damage. Therefore, the assessment assumed that areas containing trona and coal leases may be prone to mine subsidence. Subsidence is also known to occur over areas with extensive oil and gas extraction. The construction interval for subsidence effects would be approximately 2 years.

To minimize impacts due to subsidence, the following EPM would be implemented:

GEO-1 Review the final location of the preferred alternative with affected mine operators and lessees to ensure all measures are taken to protect against subsidence.

Natural events, such as earthquakes, or excessive rain or snow fall, can trigger landslides that could damage transmission lines and associated structures. The potential for landslides is slope dependent, with steep slopes containing greater landslide potential than shallow slopes. Construction activities can result in human-caused landslides in landslide-prone areas. Removal of soil at the base of an unstable slope can decrease slope stability and result in a landslide. Excavation and/or blasting in geological hazard areas at substations, transmission structure sites, or during road building could destabilize slopes, resulting in landslides, soil erosion, and stream sedimentation. Midslope road construction, concentration of drainage water on unstable ground, and removal of vegetation during construction can trigger landslides (CDC 2003).

To minimize failures due to landslides, the following EPM would be implemented:

GEO-2 A site-specific soil analysis shall be conducted prior to construction to verify any areas identified as unstable or marginally unstable on federal lands. A site-specific geotechnical analysis shall be conducted on federal lands prior to construction to locate areas where there is landslide risk. If such areas are identified, the Proponents will develop mitigation and submit a report to the appropriate land management agency.

Foundations for transmission line structures can be as deep as 32 feet below ground surface. Construction in areas of shallow bedrock may require blasting. The vibrations generated by blasting can also result in slope instability, damage to nearby structures, damage to water wells, and disturbance to wildlife. Ground shaking from blasting could result in subsidence or landslides in unstable areas. Voids within bedrock in coal-producing areas of Segments 1 through 4 could contain methane; the location of coal-producing areas is described in Section 3.12 – Minerals. Blasting in areas containing methane could result in dangerous explosions. Blasting may also impact undiscovered cultural or paleontological resources. Paleontological effects are discussed in Section 3.13 – Paleontological Resources.

Table 3.14-6 presents the percent of the Analysis Area by segment where blasting of shallow bedrock may increase the potential for landslides, subsidence, or contact with methane.

Table 3.14-6. Risks from Blasting by Segment

Segment Number	Risks from Blasting (by Hazard) by Percent of Analysis Area			
	Blasting / Landslides[1/]	Blasting / Subsidence	Blasting / Coal Mines	Total Percent Area of Blasting Hazards[2/]
1	–	<1	–	<1
2	–	–	–	–
3	20	32	2	43
4	30	20	1	34
5	–	–	–	–
6	–	–	–	–
7	–	–	–	–
8	1	–	–	1
9	–	–	–	–
10	–	–	–	–

1/ Represents medium to high landslide risks, as shown in Table 3.14-3.
2/ Some blasting area categories overlap. Therefore, total blasting hazard area can be less than the sum of the categories.

The Proponents would comply with all state and federal regulations regarding blasting. A Blasting Plan would be developed and used during construction. The Proponents have committed to implementing the following EPMs on all lands:

BLA-1 The Blasting Plan will identify blasting procedures including safety, use, storage, and transportation of explosives that will be employed where blasting is needed, and will specify the locations of needed blasting.

BLA-2 All blasting will be performed by registered licensed blasters who will be required to secure all necessary permits and comply with regulatory requirements in connection with the transportation, storage, and use of explosives, and blast vibration limits for nearby structures, utilities, wildlife, and fish (where blasting is conducted in waterbodies).

Operations

There is more risk from natural geologic hazards during operations than during construction of the Project because of the longer time interval for operations. The risk varies proportionally to the length of time of construction (2 years) versus the operational life of the Project (50 years). Ground shaking and displacement related to earthquakes may damage human-made structures, including transmission lines and substations, which could result in interruption of power and/or environmental consequences. Naturally occurring landslides could occur in areas of instability. However, the risks of Project-related landslides would be less than those during construction because Project areas disturbed during construction would be stabilized. The risk from subsidence would occur over a longer period during operations than during construction. The 50-year operations interval could also result in additional mining that could render more areas subject to subsidence risks. Blasting is not anticipated during the operations phase of the Project and therefore would have no effects during that phase.

Decommissioning

The decommissioning time interval for risks from natural geologic hazards (earthquakes, landslide, subsidence) is similar to the construction interval, about 2 years. Decommissioning would involve some ground disturbance, including vegetation removal, which could result in temporary increased risks for landslides on unstable slopes. No blasting is anticipated during Project decommissioning.

Summary

All phases of the Project would be subject to the effects of naturally occurring geologic hazards, such as earthquakes, landslides, and subsidence. The greatest risk from Project-caused geologic hazards would occur during construction. Construction activities could cause slope instability such as landslides and damage to structures. Blasting in areas of shallow bedrock could cause landslide or subsidence in unstable areas, damage to structures including water wells, and disturbance of wildlife. The Proponents would account for the risks of damage from earthquakes by designing and constructing transmission structures to withstand seismic forces and also wind/ice combination loads, which are considered more stringent than the loads induced due to ground motion.

The Proponents are committed to conducting all construction activities in accordance with the EPMs presented in Table 2.7-1 in Chapter 2. The EPMs include mitigation measures for traffic and transportation management; reclamation, revegetation, and weed management; stormwater pollution prevention; spill prevention; cultural and paleontological mitigation; and blasting.

3.14.2.3 Comparison of Alternatives by Segment

This section evaluates the Proposed Action and the differences between the Preferred Route, Proposed Route, and Route Alternatives for hazards associated with earthquakes, landslides, subsidence, and blasting of shallow bedrock.

Table 3.14-7 is a summary table showing where geological hazard effects are present along the Proposed Route and Route Alternatives. The effects by segment are presented in the following paragraph. Tables D.14-1 through D.14-7 in Appendix D show the presence of geologic hazard conditions for the Proposed Route as well as a comparison between Route Alternative and the comparison portion of the Proposed Route for miles crossed.

Table 3.14-7. Summary of Potential Geologic Hazards in Preferred/Proposed Routes and Alternatives

Segment Number	Route	Total Route Miles	Geologic Hazards				
			Earthquake Hazard[1/]	Earthquake Buffer[2/]	Landslide Hazard[3/]	Subsidence[4/]	Shallow Bedrock[4/]
1W(a)	Preferred/Proposed – Total Length	73.8	–	–	Yes	Yes	Yes
	Preferred/Proposed – Comparison Portion for Alt. 1W(a)-B	16.5	–	–	–	Yes	Yes
	Alternative 1W(a)-B	20.9	–	–	–	Yes	–
1W(c)	Preferred/Proposed – Total Length	73.6	–	–	Yes	Yes	Yes
2	Preferred/Proposed – Total Length	91.9	–	–	–	Yes	–
	Preferred/Proposed – Comparison Portion for Alt. 2A	16.8	–	–	–	Yes	–
	Alternative 2A	16.0	–	–	–	Yes	–
	Preferred/Proposed – Comparison Portion for Alt. 2B	12.5	–	–	–	Yes	–
	Alternative 2B	12.2	–	–	–	Yes	–
3	Segment 3 Preferred/Proposed – Total Length	45.9	–	–	Yes	Yes	Yes
	Segment 3A Preferred/Proposed – Total Length	5.1	–	–	Yes	Yes	Yes
4	Preferred/Proposed – Total Length	197.6	Yes	Yes	Yes	Yes	Yes
	Preferred/Proposed – Comparison Portion for Alts. 4B–F	85.2	Yes	–	Yes	Yes	Yes
	Alternative 4B	100.2	Yes	–	Yes	Yes	Yes
	Alternative 4C	101.6	Yes	–	Yes	Yes	Yes
	Alternative 4D	100.8	Yes	–	Yes	Yes	Yes
	Alternative 4E	102.2	Yes	–	Yes	Yes	Yes
	Alternative 4F	87.5	Yes	–	Yes	Yes	Yes
	Proposed – Length on the Caribou-Targhee NF	9.2	Yes	Yes	No	No	Yes
	Proposed – Comparison Portion for Alternative 4G	2.3	Yes	Yes	No	No	Yes
	Alternative 4G	2.6	Yes	Yes	No	No	Yes
5	Preferred – Total Length	73.3	Yes	Yes	–	–	Yes
	Proposed – Total Length	55.7	Yes	Yes	–	–	Yes
	Proposed – Comparison Portion for Alternatives 5A,B	22.3	Yes	Yes	–	–	Yes
	Alternative 5A	29.7	Yes	Yes	–	–	Yes
	Alternative 5B	40.4	Yes	Yes	–	–	Yes
	Proposed – Comparison Portion for Alternative 5C	32.9	Yes	Yes	–	–	Yes
	Alternative 5C	26.0	Yes	Yes	–	–	Yes
	Proposed – Comparison Portion for Alternative 5D	19.2	Yes	Yes	–	–	Yes
	Alternative 5D	17.0	Yes	Yes	–	–	Yes
	Proposed – Comparison Portion for Alternative 5E	5.8	Yes	Yes	–	–	Yes
	Alternative 5E	5.3	Yes	Yes	–	–	Yes

Table 3.14-7. Summary of Potential Geologic Hazards in Preferred/Proposed Routes and Alternatives (continued)

Segment Number	Route	Total Route Miles	Geologic Hazards				
			Earthquake Hazard[1/]	**Earthquake Buffer[2/]**	**Landslide Hazard[3/]**	**Subsidence[4/]**	**Shallow Bedrock[4/]**
6	Proposed – Total Length	0.5	Yes	Yes	–	–	Yes
7	Preferred – Total Length	130.2	Yes	Yes	--	--	Yes
	Proposed – Total Length	118.2	Yes	Yes	–	–	Yes
	Proposed – Comparison Portion for Alts. 7A, B	35.1	Yes	Yes	–	–	Yes
	Alternative 7A	37.7	Yes	Yes	–	–	Yes
	Alternative 7B	46.2	Yes	Yes	–	–	Yes
	Proposed – Comparison Portion for Alternative 7C	20.1	Yes	Yes	–	–	Yes
	Alternative 7C	20.3	Yes	Yes	–	–	Yes
	Proposed – Comparison Portion for Alternative 7D	6.2	Yes	–	–	–	Yes
	Alternative 7D	6.8	Yes	–	–	–	Yes
	Proposed – Comparison Portion for Alternative 7E	2.8	–	–	–	–	Yes
	Alternative 7E	4.5	–	–	–	–	Yes
	Proposed – Comparison Portion for Alternative 7F	10.5	–	–	–	–	Yes
	Alternative 7F	10.8	Yes	–	–	–	Yes
	Proposed – Comparison Portion for Alternative 7G	3.3	–	–	–	–	Yes
	Alternative 7G	3.4	–	–	–	–	Yes
	Proposed – Comparison Portion for Alternative 7K	118.2	Yes	Yes	–	–	Yes
	Alternative 7K	148.1	Yes	Yes	–	–	Yes
8	Preferred – Total Length	132.0	–	Yes	Yes	–	Yes
	Proposed – Total Length	131.5	–	Yes	Yes	–	Yes
	Proposed – Comparison Portion for Alternative 8A	51.9	–	Yes	Yes	–	Yes
	Alternative 8A	53.6	–	Yes	–	–	Yes
	Proposed – Comparison Portion for Alternative 8B	45.3	–	–	Yes	–	Yes
	Alternative 8B	45.8	–	–	Yes	–	Yes
	Proposed – Comparison Portion for Alternative 8C	6.5	–	–	–	–	Yes
	Alternative 8C	6.4	–	–	–	–	Yes
	Proposed – Comparison Portion for Alternative 8D	6.9	–	–	–	–	Yes
	Alternative 8D	8.1	–	–	–	–	Yes
	Proposed – Comparison Portion for Alternative 8E	7.0	–	–	Yes	–	Yes
	Alternative 8E	18.3	–	–	–	–	Yes

Table 3.14-7. Summary of Potential Geologic Hazards in Preferred/Proposed Routes and Alternatives (continued)

Segment Number	Route	Total Route Miles	Geologic Hazards				
			Earthquake Hazard1/	Earthquake Buffer2/	Landslide Hazard3/	Subsidence4/	Shallow Bedrock4/
9	Preferred – Total Length	171.4	–	–	–	–	Yes
	Proposed – Total Length	162.2	–	–	–	–	Yes
	Proposed – Comparison Portion for Alternative 9A	7.8	–	–	–	–	Yes
	Alternative 9A	7.7	–	–	–	–	Yes
	Proposed – Comparison Portion for Alternative 9B	49.1	–	–	–	–	Yes
	Alternative 9B	52.3	–	Yes	–	–	Yes
	Proposed – Comparison Portion for Alternative 9C	14.4	–	–	–	–	Yes
	Alternative 9C	14.4	–	–	–	–	Yes
	Proposed – Comparison Portion for Alts. 9D–H	57.2	–	–	–	–	Yes
	Alternative 9D	60.1	–	–	–	–	Yes
	Alternative 9F	63.3	–	–	–	–	Yes
	Alternative 9G	57.8	–	–	–	–	Yes
	Alternative 9H	61.0	–	–	–	–	Yes
	Proposed – Comparison Portion for Alt. 9E (revised)	61.4	–	–	–	–	Yes
	Alternative 9E	70.6	–	–	–	–	Yes
10	Preferred/Proposed – Total Length	34.4	–	Yes	–	–	Yes

1/ Based on OPS earthquake hazard data, a Yes is entered if medium or high earthquake risk is found in that alternative (see Section 3.14.1.5 and Table D.14-1).
2/ Based on historical earthquake epicenters, a Yes is indicated if the segment is within the buffer of any earthquake greater than magnitude 6.0 (see Section 3.14.1.5 and Table D.14-2).
3/ Based on OPS landslide hazard data, a Yes is entered if medium or high landslide risk is found in that alternative (see Section 3.14.1.5 and Table D.14-3).
4/ A Yes for subsidence or bedrock indicates that subsidence or bedrock less than 20 feet deep were identified in that alternative (see Section 3.14.1.5 and Tables D.14-4 and D.14-6).

Segment 1W

The preferred routes in Segment 1W are as follows:

Segment	Preferred Route	Agency
Segment 1W(a)	Proposed Route (Figure A-2)	BLM and State of Wyoming
Segment 1W(c)	Proposed Route (Figure A-2)	BLM and State of Wyoming

Segment 1W is composed of Segments 1W(a) and 1W(c), both of which consist of single-circuit 230-kV transmission lines. Generally, Segment 1W(a) would be a new 73.8-mile-long transmission line, and 1W(c) would involve reconstruction of a 73.6-mile-long portion of the existing Dave Johnston – Rock Springs 230-kV transmission line. However, in the area approximately 5 miles to the north and to the south of Ice Cave Mountain, the lines shift east to avoid the ice cave. In this area, 1W(a) would be the reconstruction of the existing line and 1W(c) would be the new line. Segment 1W(a) has one alternative, Alternative 1W(a)-B, which is located north and west of the town of Glenrock and was the Proponents' initial proposal. However, the Preferred/Proposed Route was revised following the Draft EIS public comment period in order to avoid the more populated area around Glenrock. Figure A-2 in Appendix A shows the location of the Segment 1W routes.

Earthquake hazards are low in this segment. The transmission line crosses the South Granite Mountain Fault in this segment, a west-northwest trending Class B fault that is potentially Quaternary in age. As stated in Section 3.14.2.2, NESC Section 250.A.4 indicates that by designing for the required weather-related loading cases, nothing further is required to resist earthquake loads. It states: "The structural capacity provided by meeting the loading and strength requirements of Sections 25 (Loadings for Grades B and C) and 26 (Strength Requirements) provides sufficient capability to resist earthquake ground motions." Approximately 4 percent of the Preferred/Proposed Route is located in a high landslide risk area; otherwise, landslide risks are low. Implementing EPM GEO-2 would assist in mitigating the construction effects to landslide-prone areas.

Low percentages of construction and operations disturbance areas are present in areas of potential subsidence. The construction acreage of Alternative 1W(a)-B contains over five times the subsidence potential area as the comparison portion of the Proposed Route. Nine Segment 1 exploratory boring logs were reviewed for the Draft EIS that contained shallow bedrock, eight of which contained shallow bedrock in areas not identified by STATSGO. This suggests that Table 3.14-5 may underestimate the areas of shallow bedrock for the Segment 1 Analysis Area. However, blasting would not occur in areas of subsidence. The comparison portion of Proposed Route 1W(a) contains a lower potential for geologic hazards than Alternative 1W(a)-B.

Segment 2

The preferred route in Segment 2 is as follows:

Preferred Route	Agency
Proposed Route (Figure A-3)	BLM and State of Wyoming

Segment 2 consists of one single-circuit 500-kV transmission line between the proposed Aeolus Substation and the location of the originally planned Creston Substation near

Wamsutter, Wyoming (a new substation at Creston is no longer needed due to changes in anticipated demand for oil and gas field electricity). The Preferred/Proposed Route has been revised to incorporate Alternative 2C, as analyzed in the Draft EIS. Segment 2 would be approximately 91.9 miles long. Alternative 2A is being considered by the BLM because this alternative route is within the WWE corridor. Alternative 2B was initially the Proponents' Proposed Route before they responded to local suggestions and relocated the Proposed Route farther to the south. Figure A-3 in Appendix A shows the location of the Segment 2 routes.

Segment 2 contains a moderate risk from geologic hazards, mainly from potential subsidence. This segment contains low earthquake and landslide risks. According to NRCS STATSGO soil data, Segment 2 is the only segment where shallow bedrock is not present. The east half of Segment 2 is located within a coal-producing area (see Section 3.12). The route overlies several miles of continuous historic underground coal mines near Hanna, Wyoming, on the east end of the route. According to the WDEQ (Parfitt 2010), underground workings in this area are extensive and not well-mapped. Some subsidence has already occurred in this area. This portion of the route should receive an engineering review relative to potential subsidence prior to construction. In addition, voids in bedrock near coal deposits could contain methane. Shallow bedrock is not reported in Segment 2, but if blasting is necessary, the Proponents should follow the Blasting Plan procedures BLA-1 and BLA-2 for blasting in areas of possible coal-related methane. Subsidence potential occurs in some of the construction and operations disturbance areas. As shown in Tables D.14-4 and D.14-5 in Appendix D, Alternative 2A has a larger area of subsidence in the operations and construction disturbance areas than the comparison portion of the Preferred/Proposed Route. Alternative 2B has a smaller area of subsidence in the construction and operations areas. EPM GEO-1 has been identified as a means of substantially reducing the potential for subsidence impact.

Segment 3

The preferred route in Segment 3 is as follows:

Preferred Route	Agency
Proposed Route, including 3A (Figure A-4)	BLM and State of Wyoming

A single-circuit 500-kV line would link the former location of the Creston Substation, approximately 2.1 miles south of Wamsutter, Wyoming, to the proposed Anticline Substation near the existing Jim Bridger Power Plant. Segment 3 would be approximately 45.9 miles long. This segment also includes a 5.1-mile segment of 345-kV line to connect to the existing Jim Bridger Power Plant Substation (Segment 3A). There are no alternatives proposed along Segment 3. Figure A-4 in Appendix A shows the location of the Segment 3 routes.

Segment 3 contains low risk from earthquakes. Approximately 33 percent of the route is located in areas containing medium landslide risk. To minimize failures due to landslides, a landslide mitigation plan will be prepared (GEO-2) that addresses measures to be taken in the Project design, construction, and operation.

Subsidence will be possible in operations and construction disturbance areas because 67 percent of the Analysis Area is underlain by mining leases, the largest percentage in any segment. Shallow bedrock possibly requiring blasting is present over 34 percent of the Preferred/Proposed Route. Blasting in areas of potential subsidence may cause subsidence. The west end of Segment 3, including the area of the Anticline Substation, is located within a coal-producing area (see Section 3.12). If blasting of shallow bedrock is necessary in this vicinity, the Proponents should follow the EPM procedures in Table 2.7-1 for blasting where methane may occur. The Proponents intend to prepare a site-specific Blasting Plan prior to construction that incorporates blasting procedures, use of qualified blasters, site control and protection measures, and compensation for repair of damage. GEO-1 has been identified as a means of substantially reducing the potential for subsidence impact.

Segment 4

The preferred routes in Segment 4 are as follows:

Preferred Route	Agency
Proposed Route (Figures A-5 and A-6) except within the Caribou-Targhee NF (see below)	BLM, State of Wyoming, and Lincoln County
Proposed Route within the NF incorporating Alternative 4G (Figure A-6)	Forest Service

Segment 4 would link the proposed Anticline Substation and the existing Populus Substation near Downey, Idaho with a single-circuit 500-kV line. Its proposed length is approximately 197.6 miles. The Segment 4 Preferred/Proposed Route was revised to follow Alternative 4A, as analyzed in the Draft EIS, based on public comments. This segment generally follows an existing transmission line corridor. Segment 4 has five Route Alternatives in the middle portion of its route; however the first 52 miles to the east and the last 61 miles to the west (in Idaho) do not have any route alternatives. The middle section of the Preferred/Proposed Route, for which alternatives are presented, is approximately 85.2 miles long, and its alternatives vary from approximately 87.5 to 102.2 miles long. Alternatives 4B through 4E were proposed by the BLM Kemmerer FO (with input from various cooperating agencies), with the intent to avoid impacts to cultural resources to the extent practical. Alternative 4F was proposed by the Proponents to avoid impacts to cultural resources while still remaining north of the existing Bridger Lines. Alternative 4G was proposed by the Forest Service in order to avoid unstable soils identified along the Proposed Route during the 2012 soil assessment (located within Sections 1 and 2, Township 12 South, Range 41 East). Figures A-5 and A-6 in Appendix A show the location of the Segment 4 routes in Wyoming and Idaho, respectively.

Segment 4 and all of its alternatives stand out as containing the greatest potential geologic hazards of all segments. None of the Segment 4 alternatives offer a way of avoiding the multiple hazards present. Large portions of Segment 4 contain medium to high risk of earthquakes and Segment 4 routes cross several north/south-trending Quaternary faults, including the Rock Creek Fault, Eastern and Western Bear Valley Faults, and the Sublette Flat Fault. Project structures would need to be engineered to account for differential movement across active faults. Historical earthquakes have been predominantly less than magnitude 6.0 within the Segment 4 Analysis Area.

Segment 4 also contains the highest risk from landslides. This segment and all the alternatives contain large areas of medium to high landslide risk. In the mid-1980s, a landslide failure near Viva Naughton Reservoir in southwest Wyoming (near Route Alternative 4F) necessitated the re-alignment of the existing Bridger to Borah 345-kV transmission lines. Figure 3.14-4 presents a detailed view of landslide-prone areas near Viva Naughton Reservoir. The current preliminary engineered layout shown in the figure is one option to microsite transmission line structures to avoid landslide-prone areas in this area. The layout is slightly outside the one-mile buffer for the Proposed Route, and also extends slightly out of the corridor established by the Wyoming Governor's EO. To minimize failures due to landslides, actions described in GEO-2 will be taken in the Project design, construction, and operations phases.

Using the STATSGO database information, approximately 37 percent of the Preferred/Proposed Route is located on shallow bedrock. Results of the 2010 log review in Segment 4 indicated that five borings advanced in areas assumed to contain shallow bedrock did not encounter any, and one boring contained shallow bedrock in an area not anticipated by STATSGO. Therefore, shallow bedrock should be expected in Segment 4, but the bedrock percentages reported here are approximate. Much of the shallow bedrock is located within areas of medium to high landslide risk or in areas of potential subsidence. Blasting in these areas may cause landslides or subsidence. Trona mining companies in this segment indicated that subsidence has occurred near some of the previously mined areas, and they recommended avoidance of trona mining areas to avoid construction on subsidence-prone areas, as well as to avoid interference with mining operations (Hodgson 2008). The Proponents used active mining areas as a constraint when siting alternatives for the transmission line. Segment 4 includes three coal-producing locations (see Section 3.12 – Minerals). Blasting in these areas should occur using the EPM procedures BLA-1 and BLA-2 for blasting in areas of possible methane. The Proponents intend to prepare a site-specific Blasting Plan prior to construction that incorporates blasting procedures, use of qualified blasters, site control and protection measures and compensation for repair of damage. GEO-1 has been identified as a means of substantially reducing the potential for subsidence impact.

In summary, the Preferred/Proposed Route and all Route Alternatives contain the same landslide risk zones. Therefore, the risks are proportional to the segment lengths. As shown in Table 3.14-7, Alternative 4F is shorter than the comparison portion of the Proposed Route and Alternatives 4B, 4C, 4D, and 4E are longer. The Preferred/Proposed Route is the shortest of all and would have the lowest risk from landslides. It also has the least exposure to subsidence risk compared to all the alternatives except Alternative 4F.

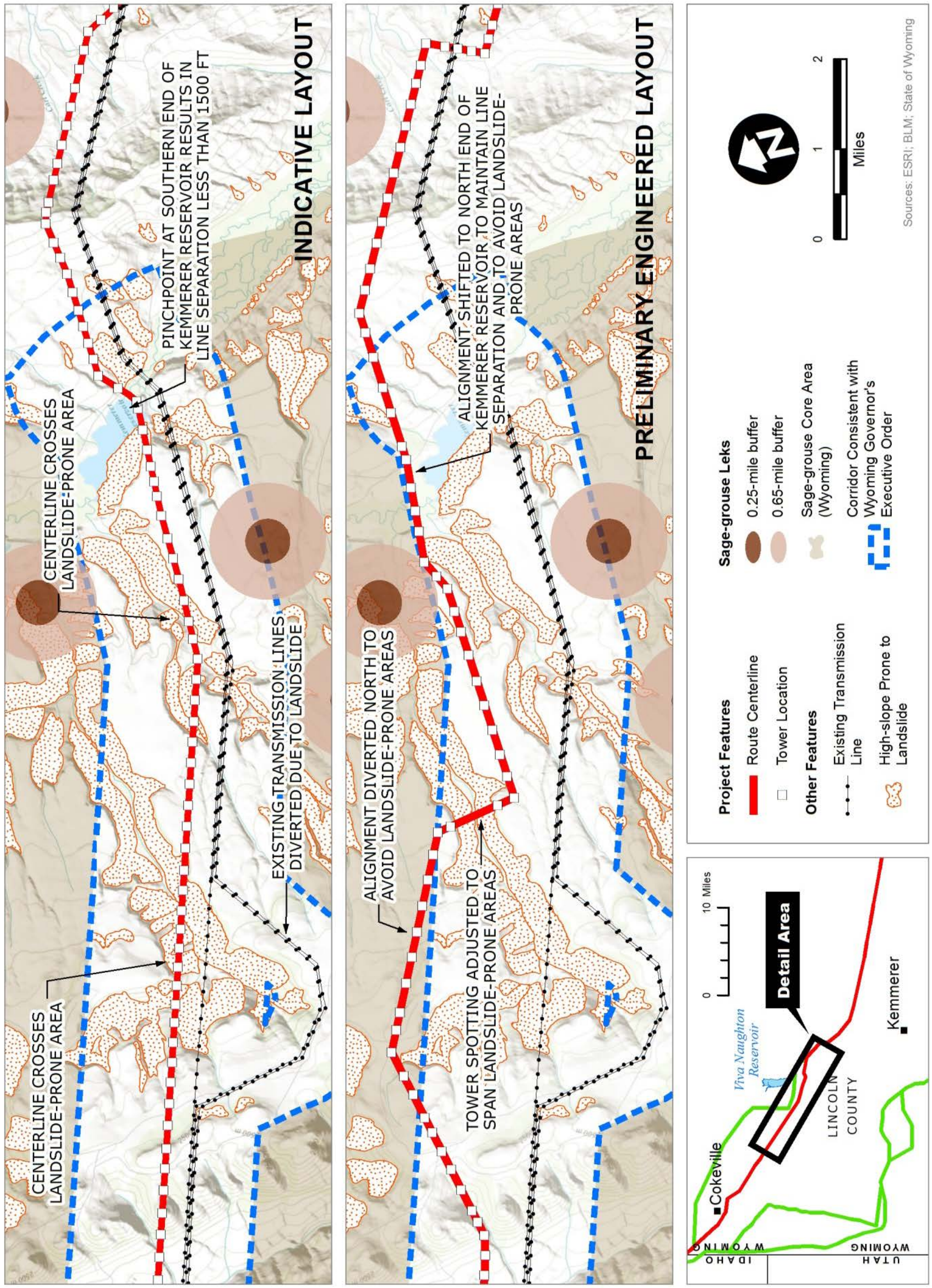

Figure 3.14-4. Micrositing to Avoid Landslide-Prone Areas along the Segment 4 Proposed Route near Viva Naughton Reservoir

Caribou-Targhee National Forest Geologic Hazards

The Proposed Route would cross 9.1 miles on the Caribou-Targhee NF. Alternative 4G is also completely contained on the Caribou-Targhee NF. At a length of 2.6 miles, Alternative 4G is 0.3 mile longer than the comparison portion of the Proposed Route. A summary of geologic hazards for the Caribou-Targhee NF portion of Segment 4 is presented in Table 3.14-7. Both the Caribou-Targhee NF portion of the Proposed Route and Alternative 4G contain similar earthquake hazards, as well as shallow bedrock that may require blasting. The Caribou-Targhee NF proposed Alternative 4G due to steep slopes up to 60 percent along a portion of the Proposed Route. Blasting on the steep slopes of the Proposed Route may result in increased blasting-initiated slope instabilities. For this reason, Alternative 4G may be preferable from a geologic hazards perspective.

Segment 5

The preferred routes in Segment 5 are as follows:

Preferred Route	Agency
Proposed Route incorporating Alternatives 5B and 5E[1/] (Figure A-7)	BLM
Proposed Route incorporating Alternatives 5C and 5E (Figure A-7)	Power County

1/ Assumes that Western Electricity Coordinating Council reliability issues associated with 5E are resolved.

Segment 5 would link the Populus and Borah Substations with a single-circuit 500-kV line that would be approximately 55.7 miles long. There are five Route Alternatives to portions of the Proposed Route in Segment 5. Alternatives 5A and 5B were proposed by the BLM to avoid crossing the Deep Creek Mountains. Alternative 5C, which crosses the Fort Hall Indian Reservation, was proposed as the preferred route by Power County; however, the Fort Hall Business Council has voted not to permit the Project across the Reservation. Alternative 5D was originally the Proponents' Proposed Route. Alternative 5E was proposed by Power County as an alternative approach to the Borah Substation. The BLM has identified a Preferred Route that includes portions of the Proposed Route with Alternatives 5B and 5E (with the assumption that reliability issues associated with 5E can be resolved). The Segment 5 Preferred Route is 73.3 miles long, compared to 55.7 miles for the Proposed Route. Figure A-7 in Appendix A shows the location of the Segment 5 routes.

Earthquake risks in Segment 5 are medium to high. Portions of Segments 5 through 10 are located within the 100-mile buffer of historic earthquakes with magnitudes greater than 7.0. Landslide risks are low in this segment. About 29 percent of the Proposed Route is located in shallow bedrock, none of which is located in an area of subsidence or landslides. Therefore, the risk of initiating landslides or subsidence from blasting should be minimal. Subsidence was not identified in Segments 5 through 10 because underground mining has generally not occurred within the Project area in these segments.

The Proponents intend to prepare a site-specific Blasting Plan in accordance with the EPMs summarized in Table 2.7-1 prior to construction that incorporates blasting procedures, use of qualified blasters, site control and protection measures, and compensation for repair of damage.

In summary, earthquake risks are the only important risk from geologic hazards in Segment 5. Since the earthquake risk includes the entire segment, the risks are proportional to the lengths. Alternatives 5C and 5D are shorter than the comparison portion of the Proposed Route and therefore have less risk. Alternatives 5A and 5B are longer, with Alternative 5B being the longest and resulting in the greatest exposure to earthquake-related risks. The Preferred Route includes Alternative 5B, and therefore the earthquake risks to the Preferred Route are greater than those for the Proposed Route.

Segment 6

The BLM's Preferred Route in Segment 6 is as follows:

Preferred Route	Agency
The proposal to upgrade the line voltage from 345-kV to 500-kV (Figure A-8)	BLM

Segment 6 is an existing transmission line linking the Borah and Midpoint Substations; it is now operated at 345 kV but would be changed to operate at 500 kV. This segment has no Route Alternatives. Existing support structures would be used and impacts would be limited to within approximately 0.25 mile from each substation to allow for moving the entry point into the substation to the new 500-kV bay. Changes at the Borah and Midpoint Substations would allow Segment 6 to be operated at 500 kV. Figure A-8 in Appendix A shows the Preferred/Proposed Route for Segment 6.

There would be only 0.5 mile of new disturbance associated with Segment 6. There would be low risks from landslides and no potential for subsidence. Earthquake risks are low to medium for the newly disturbed portion of Segment 6.

Segment 7

The preferred routes in Segment 7 are as follows:

Preferred Route	Agency
Proposed Route incorporating Alternatives 7B, 7C, 7D, and 7G (Figure A-9). The Proposed Route in the East Hills and Alternative 7G will be microsited to avoid Preliminary Priority Sage-grouse Habitat (PPH).	BLM
Alternative 7K (Figure A-9)	Power and Cassia Counties

Segment 7 would link the Populus Substation and the proposed Cedar Hill Substation with a single-circuit 500-kV line that would be approximately 118.2 miles long. Several alternatives to the Proposed Route are being considered. Route Alternatives 7A and 7B have been proposed by the BLM to avoid crossing the Deep Creek Mountains. Alternatives 7C, 7D, 7E, 7F, and 7G were proposed by local landowners to avoid private agricultural lands. Alternative 7K (also called the Goose Creek Alternative) was identified during the public comment period as a shorter alternative to the Proposed Route than either 7I or 7J (refer to Chapter 2 of the Draft EIS for a description of these routes). The alignment for Alternative 7K was developed in cooperation with Cassia County. Alternatives 7H, 7I, and 7J, which were analyzed in the Draft EIS, are no longer under consideration. The BLM has identified a Preferred Route that includes portions of the Proposed Route with Alternatives 7B, 7C, 7D, and 7G. The Segment 7

Preferred Route is 130.2 miles long, compared to 118.2 miles for the Proposed Route. Figure A-9 in Appendix A shows the location of the Segment 7 routes.

Earthquake risks in the Segment 7 Analysis Area are variable with an approximately even mix of low, medium, and high risk. Landslide risks are low. About 40 percent of the Proposed Route contains shallow bedrock.

The Proponents intend to prepare a site-specific Blasting Plan in accordance with the EPMs in Table 2.7-1 prior to construction that incorporates blasting procedures, use of qualified blasters, site control and protection measures, and compensation for repair of damage.

In summary, earthquake risks are the only important risk from geologic hazards for Segment 7. The Proposed Route is the shortest route and therefore would have the lowest exposure to geologic hazard risks. Because the Preferred Route is 12 miles longer than the Proposed Route, the risks from geologic hazards are greater in the Preferred Route than in the Proposed Route.

Segment 8

The preferred route in Segment 8 is as follows:

Preferred Route	Agency
Proposed Route incorporating Alternative 8B (Figure A-10)	BLM and IDANG

Segment 8 would link the Midpoint and Hemingway Substations. This 131.5-mile single-circuit 500-kV transmission line would stay north of the Snake River generally parallel to an existing 500-kV transmission line, before ending at the Hemingway Substation. There are five Route Alternatives to the Proposed Route. Alternative 8A follows the WWE corridor but crosses the Snake River and I-84 twice (while the Proposed Route would stay north of this area). Alternatives 8B and 8C were originally proposed by the Proponents as parts of the Proposed Route but were later dropped from the Proposed Route to avoid planned developments near the cities of Kuna and Mayfield, respectively. Alternative 8D would rebuild a portion of an existing 500-kV transmission line to move it away from the National Guard Maneuver Area. Alternative 8D would be constructed within the ROW currently occupied by the existing line. Alternative 8E was proposed by the BLM in order to avoid crossing the Halverson Bar non-motorized portion of a National Register Historic District (see the discussion of 8E under Segment 9). The BLM has identified a Preferred Route that includes portions of the Proposed Route with Alternative 8B and generally avoids the SRBOP. The Segment 8 Preferred Route is 132.0 miles long, compared to 131.5 miles for the Proposed Route. Figure A-10 in Appendix A shows the location of the Segment 8 routes.

The earthquake and landslide risks in Segment 8 are generally low except that the eastern half of the Proposed Route does fall at the edge of the buffer for a high risk earthquake zone. Shallow bedrock is present, but except for about 2 miles in Alternative 8B, any necessary blasting would not occur in landslide-prone areas.

The Proponents intend to prepare a site-specific Blasting Plan in accordance with the EPMs in Table 2.7-1 prior to construction that incorporates blasting procedures, use of qualified blasters, site control and protection measures, and compensation for repair of damage.

In summary, the Segment 8 Proposed Route and Route Alternatives possess similar risks from geologic hazards and the risks are relatively low. The geologic hazard risks to the Proposed Route are slightly greater than the risks to the Proposed Route. This is because the Preferred Route is 0.5 mile longer, and it incorporates Alternative 8B, which contains a 2-mile interval where blasting may be necessary in landslide-prone areas.

Segment 9

The preferred routes in Segment 9 are as follows:

Preferred Route	Agency
Proposed Route incorporating Alternative 9E, which was revised to avoid PPH and Murphy (Figure A-11)	BLM
Alternative 9D (Figure A-11)	Owyhee County

Segment 9 would link the Cedar Hill and Hemingway Substations with a 162.2-mile single-circuit 500-kV transmission line which skirts the Jarbidge and Owyhee Military Operating Areas to the north, then follows the WWE corridor just north of the Saylor Creek Air Force Range, passing through Owyhee County before entering the Hemingway Substation. There are eight Route Alternatives proposed. Alternative 9A was the Proponents' Proposed Route until that route was revised to avoid the Hollister area. Alternative 9B is being considered by the BLM because it follows the WWE corridor and parallels existing utility corridors. Alternative 9C was the Proponents' Proposed Route until that route was revised to avoid the Castleford area. Alternatives 9D through 9G were proposed by the Owyhee County Task Force in order to reduce impacts to private land. Alternatives 9F and 9H were proposed to avoid crossing the non-motorized area south of C.J. Strike Reservoir and as an alternate route if Alternative 8E is selected. The BLM has selected a Preferred Route that includes portions of the Proposed Route with Alternative 9E. Figure A-11 in Appendix A shows the location of the Segment 9 routes. A portion of Alternative 9D/F uses the same path as Alternative 8E in Segment 8; therefore, 8E and 9D/F could not both be selected. Alternative 9E has been revised to avoid sage-grouse PPH and to incorporate a recommended route change submitted by Owyhee County that avoids a planned subdivision near Murphy. The Segment 9 Preferred Route is 171.4 miles long, compared to 162.2 miles for the Proposed Route.

Segment 9 contains low risks from earthquakes and landslides. Shallow bedrock is present, but because landslide risk is low, blasting would probably not cause landslides.

The Proponents intend to prepare a site-specific Blasting Plan in accordance with the EPMs in Table 2.7-1 prior to construction that incorporates blasting procedures, use of qualified blasters, site control and protection measures, and compensation for repair of damage.

In summary, the Segment 9 Proposed Route and all Route Alternatives have low exposure to risks from geologic hazards. The geologic risks in both the Preferred Route and the Proposed Route are low. The geologic hazard risks may be slightly higher in the Preferred Route because it is 9.2 miles longer than the Proposed Route.

Segment 10

The BLM's Preferred Route in Segment 10 is as follows:

Preferred Route	Agency
Proposed Route (Figure A-12)	BLM

Segment 10 would link the Cedar Hill and Midpoint Substations with a 34.4-mile single-circuit 500-kV line. Segment 10 would follow a WWE corridor for most of the route. The Preferred/Proposed Route would also be adjacent to the existing 345-kV line most of this length and has been sited to follow the same alignment of the planned SWIP. Either the SWIP or Gateway West would be built, but not both. There are no Route Alternatives proposed along this segment. Figure A-12 in Appendix A shows the location of the Preferred/Proposed Route in Segment 10.

Segment 10 also contains low risks from earthquakes and landslides except that the northern three quarters of the Segment are within the edge of the buffer for a high risk earthquake zone. Blasting of shallow bedrock would not be likely to cause slope instabilities.

The Proponents intend to prepare a site-specific Blasting Plan in accordance with the EPMs in Table 2.7-1 prior to construction that incorporates blasting procedures, use of qualified blasters, site control and protection measures, and compensation for repair of damage.