Grand Coulee's Third Powerplant 500-kilovolt Transmission Line Replacement Project

Preliminary Environmental Assessment

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

DOE/EA-1679

Grand Coulee's Third Powerplant 500-kV Line Replacement Project

Summary and Synthesis

Agency Proposing Action. U.S. Bureau of Reclamation is the lead NEPA agency. The Bonneville Power Administration is assisting Reclamation through project design, environmental review and construction, if the Proposed Action is taken.

Action. Reclamation is proposing to replace the six, 500-kV transmission lines of the Third Powerplant (TPP) at Grand Coulee Dam. The transmission lines are presently installed within the dam and a two-chambered tunnel that leads to a Spreader Yard about a mile away.

Purpose and Need. The TPP's six generators and transmission lines are critical to the regional power supply. Three of the six circuits installed within the dam and tunnel are near failure and need to be replaced. In addition, the entire installation within the dam and tunnel, designed more than 30 years ago, does not meet present–day safety and reliability standards. The interior installation needs to be either completely redesigned and rebuilt or replaced with overhead lines.

Original Proposal and Public Comments. Reclamation presented an initial plan to the public in 2009 proposing overhead lines and towers generally using the same path as existing backup lines and towers. Several members of the local community were concerned that the proposed towers would block the popular laser light show shown at the dam, eliminate the public tour, and remove space on the Visitor's Center grounds needed for the annual Festival of America; an event that draws thousands of visitors each Independence Day, and that is important to the local economy. Other public concerns included electric and magnetic fields (EMF), loss of value for properties within sight of the lines and towers.

Revised Proposal. Reclamation responded to public comments with a revised Proposed Action (Preferred Alternative) that would span the Visitor's Center, rather than placing towers on the lower Visitor's Center grounds. Proposed lines would cross over the Columbia River below the dam and continue over the Visitor's Center and State Route 155, where they would meet three, 300-foot tall towers. Lines would continue up an undeveloped hillside to a second set of three towers to reach the Spreader Yard. While the revised Proposed Action addresses most concerns regarding tower placement, the project is not without adverse effects, including some that could be mitigated and some that would be unavoidable, as summarized below.

Specific Adverse Impacts Identified and Mitigation. (1) Due to electrical connections behind the TPP required for overhead transmission lines, the pedestrian tour bridge would be removed and the viewing balcony used for the TPP public tour would be closed. A replacement tour would provide similar viewing opportunities. (2) Visual changes from the proposed lines may adversely affect historic values of the TPP and Visitor's Center. Mitigation may be provided through a Memorandum of Agreement (MOA). (3) Removing existing towers from the Visitor's Center grounds would help offset some of the visual impacts, including changes to historic character (4) Proposed lines could still interfere with a portion of the laser show, but this could be mitigated by a laser show replacement using more advanced equipment. (5) Erosion and storm water on steep slopes could be managed by design-level plans, (6) impacts on bald and golden eagle and other migratory birds could be managed and reduced through monitoring and adaptive management conducted under an Avian Protection Plan.

Unavoidable Adverse Impacts. (1) While a revised public tour would be provided, removal of the tour bridge and closure of this portion of the tour cannot be avoided. (2) Visual changes would also be unavoidable. Lines and towers would become part of the Grand Coulee Dam viewscape. Visitor response to lines and towers is expected to be mixed, but overall neutral in terms of experience and enjoyment. Visual changes are not likely to change visitor numbers, (3) Some loss in bald eagle wintering and osprey foraging habitat may be unavoidable. (4) Some avian mortality from striking lines may be unavoidable.

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Chapter 1
Need and Purpose for Action

1.1 Background

The Federal Columbia River Power System (FCRPS) is a unique collaboration among three U.S. government agencies: the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (Corps), and the Bureau of Reclamation (Reclamation). Collectively, these agencies maximize the use of the Columbia River by generating power, protecting fish and wildlife, controlling floods, providing irrigation and navigation, and sustaining cultural resources. The 31 federally-owned multipurpose dams on the Columbia River and its tributaries that comprise the FCRPS provide about 60 percent of the region's hydroelectric generating capacity and have a have a maximum capacity of 22,500 megawatts. BPA owns and operates more than 15,000 miles of high-voltage transmission lines that extend from the FCRPS throughout the Pacific Northwest.

Grand Coulee Dam is located on the mainstem Columbia River approximately 90 miles west of Spokane, Washington, and is the largest concrete structure in the United States. Construction of the original dam began in 1933 and was completed in 1942. The Grand Coulee Dam complex layout can be seen in Figure 1-1. Facilities associated with the Grand Coulee Dam complex include three powerplants (the left powerplant, the right powerplant, and the third powerplant), a pump-generating plant, and three switchyards (also referred to as the spreader yards). Franklin D. Roosevelt Lake behind the dam is 151 miles long with over 5,000,000 acre feet of active storage. Water is pumped for irrigation in the Columbia Basin to irrigate approximately 670,000 acres with an ultimate potential of 1.1 million acres.

The focus of this environmental assessment is the transmission lines associated with the third powerplant (TPP) and the 500-kilovolt (kV) spreader yard. Grand Coulee's third powerplant generates an approximate maximum output of 4,200 megawatts or roughly 18 percent of the FCRPS maximum output. Grand Coulee Dam is central to the Reclamation's Columbia Basin Project, one of the largest irrigation and hydroelectric projects in the world.

The third powerplant, the largest powerplant at the Grand Coulee Dam complex, was built at the peak of the U.S. environmental movement in the mid-1970s. Reclamation placed high value on the aesthetics of the project; and this attention to detail was shown in the design of the TPP as well as with the tubular steel towers near the spreader yard that deliver this power onto the Federal Columbia River Transmission System (FCRTS). Consistent with that aesthetic vision, Reclamation engineers designed a completely enclosed transmission line system, which involved putting the six TPP 525-kV transmission lines (which transmit power generated from the six turbine generators located within the TPP) underground through a chambered tunnel. The TPP transmission lines make their way up the hillside west of the dam, where the transmission lines then emerge from the tunnel to connect to overhead 500-kV towers and continue to a spreader yard where they connect to the FCRTS delivering power to Spokane, Hanford, Ellensburg, and Chief Joseph Dam. The end result was a completely transformed Grand Coulee Dam complex area, with no visible towers, transmission lines, or spreader yards near the dam. Additionally, a

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Figure 1-1. Grand Coulee Dam complex and its associated facilities.

new Visitor Center and associated park was constructed with grounds that have striking views of the complex (*See* Figure 1-1).

Presently, the six oil-filled TPP transmission lines have been operated near or above their continuous current rating for over 30 years. Operating under these conditions has made it apparent that these high voltage transmission lines are becoming degraded and constitute an unacceptable risk for loss of generation for Reclamation.

This chapter provides an overview of the proposed project, explains why Reclamation needs to take action, details the partnership with BPA to engineer and design the project, and provides the purpose that Reclamation is trying to achieve to meet this need. This chapter also identifies the cooperating agencies that are participating in the preparation of this Environmental Assessment (EA), and describes the public involvement that has occurred which resulted in the identification of significant issues related to the proposed project.

1.2 Need for Action

The National Environmental Policy Act (NEPA) requires federal agencies to explain the "purpose and need" of proposed actions.[1] Over time, standard practice and NEPA case law has established that the ***purposes*** of a proposed action reflect goals, while the ***needs*** reflect specific problems to be resolved and/or objectives needed to be accomplished in order to reach goals. "Purpose and need" statements for federal actions determine the "reasonable range of alternatives" the agency should consider.

The transmission lines enclosed within the dam and tunnel system need to be replaced with overhead transmission lines because (a) the enclosed system is damaged and poses an immediate and unacceptable risk and (b) with the inherent and intractable limitations of Grand Coulee Dam's internal galleries, any system enclosed within the dam and tunnel poses unavoidable and unacceptable risks to the regional energy supply and human health and safety.

Reclamation has proposed to replace the underground high-voltage transmission lines at Grand Coulee Dam with a standard overhead system spanning transmission lines across the Columbia River over the Visitor's Center grounds, across State Route 155 (SR 155), and then uphill 700 vertical feet and over a distance of about one-half mile to reach BPA's regional power grid. The proposed line replacement project is one of several repairs and overhauls that have been identified for the TPP in order to increase generating capacity and reliability. These generator units have been in service since the mid-1970s and have been heavily used over the years. Their condition has deteriorated to the point that a complete overhaul was necessary to ensure these generators would continue to operate reliably. Work has already begun on the generators, turbines, shafts, and auxiliary equipment with the overall goal of ensuring another 30 years of dependable service. Planners have had to orchestrate the overhaul schedule so that the TPP can keep generating power during the overhaul process. After completion of the environmental review for the TPP overhaul activities regarding the turbine generators described above, Reclamation also found a need for replacing and upgrading the TPP's enclosed transmission lines by 2013 since they would no longer be able to handle the increased power output of the overhauled turbine generators. This need lead to the proposed activities described below.

[1] http://ceq.hss.doe.gov/nepa/regs/ceq/1502.htm#1502.13

The proposed changes include converting the underground transmission lines to an overhead system of lines in order to address both reliability and safety concerns. The lines proposed to be replaced actually consist of eighteen oil-filled lines. Each of the six turbine generator within the TPP (G-19 through G-21) actually have one circuit (equal to three transmission lines) that emanate from them and this is how power produced from these generators is cycled through the transmission lines system. These eighteen oil-filled lines, therefore, connect the TPP with BPA's transmission towers, located approximately one mile to the west. Inside the dam structure, the lines are attached to the sides of tunnel galleries (walkways) that were built into the dam as part of the original design of the 1930's. Limitations inherent to this design required that the high-voltage lines be fitted tightly next to each other, so that an intense incident such as a fire, earthquake or electrical fault within the enclosed area could likely lead to multiple line failures. It was just such an event that occurred in the tunnel in which the oil-filled lines associated with TPP's generators G-22, G-23, and G-24 which forced those units off-line in 1981. It took four months to install temporary overhead lines during which time the all six generators within the TPP were out of service. It took another four years before long-term replacement transmission lines were replaced within the tunnel. Besides the physical damage, the fire also damaged Reclamation's confidence in the relatively bold internal installation of high-voltage lines from one of the largest hydroelectric plants in the world. Of Reclamation's five major power generating dams, including Hoover and Glen Canyon, internal transmission lines have only been installed and used at Grand Coulee Dam.

Reclamation needs to take action to ensure that the highest reliability and safety rating is available for connections between the Grand Coulee Dam's third powerplant and the FCRTS. Since these transmission lines are nearing the end of their useful life, and therefore present an increasing risk of failure during operation, replacing these underground transmission lines with overhead lines will solve several problems:

- Overhead transmission lines could be inspected and maintained more safely than oil-filled cables.
- The new overhead lines could be of adequate size to allow for up-rating of TPP generators.
- Replacement by use of an overhead route would not require long periods without generation in order to safely remove old lines and install new lines in the old route.
- Impact to the Pacific Northwest (in terms of lost generation while oil-filled cables were being replaced) could approach $177 million; and,
- Replacing the existing lines with overhead transmission lines would remove the potential of one line failure causing the loss of 2,100MW or more of generation. (USBR 2010)

1.3 Purposes

The Need for Action represents the initiating purpose and need for the project. Reclamation must also factor a wide range of other agency plans, policies, regulations, and programs into decisions regarding the Proposed Action, and these too are considered purposes and needs. In satisfying the underlying need for action, BPA would like to achieve the following five purposes:

1. Reliably transmit electricity from the TPP to BPA's regional transmission grid as required by law.
2. Provide a safe environment for workers, residents, businesses and visitors.
3. Identify and meet required technical specifications.
4. Achieve project goals with environmentally sound solutions.
5. Achieve project goals with financially sound solutions.

The NEPA administrative record includes a summary table comparing how each alternative meets these purposes and their associated needs. Reclamation will be systematically evaluating and considering these purposes and associated needs as part of the decision-making process regarding the Proposed Action, Action Alternatives, and a No Action Alternative.

1.4 Cooperating Agencies

Reclamation is the lead agency under NEPA and has not formally designated any other federal agency as a "cooperating agency." However, BPA is assisting Reclamation with the design, environmental review, and possible construction of the Project, should a decision be made to build the project. The U.S. Fish and Wildlife Service have been consulted regarding the Bald and Golden Eagle Protection Act of 1940 to ensure that the Proposed Action does not disturb a bald or golden eagles. Lastly, the Confederated Tribes of the Colville Reservation and the Washington State Department of Archaeology and Historic Preservation will provide input through on-going consultations with Reclamation and through review and comment of the EA (this document).

1.5 Public Involvement and Significant Issues

NEPA requires the opportunity for public involvement and comment during the preparation of an EA. The initial phase of public involvement is the "scoping" phase, during which the lead agency requests public input on the scope of the proposal being presented, the range of alternatives, the potential environmental impacts, and any possible mitigation measures. The lead agency notifies the public of the proposal through various media (e.g., sending letters, publication notices, and internet postings). This allows the public to comment on the proposal during the scoping period through public meetings in which scoping comments are accepted. This section summarizes the public involvement and agency coordination activities that have been conducted to date for this EA.

Scoping Letter. On July 6, 2009, BPA mailed out a letter to people potentially interested in the proposed Project that explained Reclamation's proposal, BPA's involvement on behalf of Reclamation, the Environmental Assessment process (including scoping), and information regarding how the public could participate in and comment on the proposal. A comment form was also included so that the public could mail in their comments to BPA. Additionally, a Project website was created and posted under BPA's main website so that information related to updates on the proposal and information regarding the EA process could be easily accessed. An additional letter was mailed out on July 15, 2009.

BPA Environmental Assessment Determination (DOE/EA-1679). On July 9, 2009, BPA issued a memorandum announcing its involvement to the Department of Energy. This memorandum, provided information to the Department regarding the BPA environmental project lead's contact information and the geographical location of the proposed Project.

Agency Scoping Meeting. Prior to the first public information and EA scoping meeting, Reclamation and BPA participated in joint teleconference calls regarding the expectations and involvment of both agencies. On July 16, 2009, representatives from both Reclamation and BPA met to discuss the scope of this proposal.

First Public Information and EA Scoping Meeting. On July 16, 2009, BPA hosted an afternoon scoping meeting on Reclamation's behalf at the Coulee Dam Town Hall, in the city of Coulee Dam, Washington. The meeting was an "open house" format in which the public was able to browse through poster presentations that described the proposal and in which the public was also able to interact with representatives from both agencies. Members of the public asked questions and were given the opportunity to provide both oral and written scoping comments on the EA.

Second Public Information and EA Scoping Meeting. On August 11, 2009, BPA hosted an afternoon scoping meeting on Reclamation's behalf at the Coulee Dam Town Hall, in the city of Coulee Dam, Washington. Similar to the July 16 meeting, the meeting was an "open house" format in which the public was able to browse through poster presentations that described the proposal and in which the public was also able to interact with representatives from both agencies. Members of the public asked questions and were given the opportunity to provide both oral and written scoping comments on the EA.

Mailing List. Reclamation and BPA developed and maintain a mailing list of parties interested in the proposal and the EA. All public notices and announcements concerning the proposed Project are mailed to all parties on the mailing list.

EA Scoping Report. Following closure of the public scoping comment period on September 14, 2009, BPA reviewed all of the comments received from the public, tribes, public agencies, interest groups, and other parties and developed the scope of issues to be evaluated in the EA. An EA Scoping Report as prepared by BPA and made publicly available on October 27, 2009.

EA scoping comments were received both at the EA scoping meetings and through written submittals. A total of 21 people attended both scoping meetings. By the close of the comment period, a total of 19 comment letters and/or oral comments were received by BPA. The EA scoping report, which is incorporated by reference, provides additional information on the EA scoping comments that were received.

1.6 Issues to be Resolved

1.6.1 Key Issue 1 – Laser Light Show

Would proposed towers and/or conductors (lines) interfere with or otherwise detract from the public's enjoyment of the popular laser light show at Grand Coulee Dam?

⇒ *Addressed in Section 3.9, Laser Light Show*

1.6.2 Key Issue 2 – Public Tour

Would proposed conductors interfere with public tours of the TPP, either directly through displacement or safety risks or indirectly by making visitors uncomfortable?

⇒ *Addressed in Section 3.6, Land Use*

1.6.3 Key Issue 3 – Public Safety

Would the proposed towers and/or conductors pose a risk to human safety at the Visitor's Center, adjacent roads and businesses or otherwise harm residences or businesses, including the Columbia River Inn?

⇒ *Addressed in Section 3.14 Public Health and Safety*

1.6.4 Key Issue 4 – Visual Changes

Would visual changes from the Proposed Action impact views or cause visitors to avoid Grand Coulee Dam?

⇒ *Addressed in Section 3.8 Visual Quality*

1.6.5 Key Issue 5 – Visitor's Center Grounds

Would towers interfere with Visitor's Center use, including community and Chamber of Commerce sponsored events?

⇒ *Addressed in Section 3.6 Land Use*

1.6.6 Key Issue 6 – Tourism and Economy

Would alternatives harm the local or regional economy, including visitation, production, real estate values, and jobs or spending?

⇒ *Addressed in Section 3.13 Socioeconomics and Environmental Justice*

1.7 Organization of this EA

Chapter 2. Proposed Action and Alternatives. This chapter describes the Proposed Action and Alternatives, the No Action Alternative, and alternatives to elements of the Proposed Project that were evaluated.

Chapter 3. Affected Environments, Environmental Consequences, and Mitigation Measures. This chapter describes the existing environment without implementation of the Proposed Action. This chapter also includes analyses of the environmental effects of replacing the existing underground transmission lines (removal) and construction of the new transmission lines (overhead) and determines whether there is potential for environmental impacts to occur. If impacts could occur, they are evaluated to determine if they can be avoided or minimized. Mitigation measures to lessen or eliminate impacts are also listed.

Chapter 4. Consultation, Review, and Permit Requirements. This chapter describes the permits and approvals that must be obtained for the removal of the existing underground lines and the construction of the new overhead lines should the Project move forward.

Chapter 5. References

Chapter 6. Acronyms and Abbreviations

Appendices. Appendix A, Electrical Effects from the Proposed Grand Coulee's Third Powerplant 500-kV Line Replacement Project. The report describes and quantifies the electrical effects of the proposed Grand Coulee's Third Powerplant 500-kV Line Replacement Project.

Chapter 2
Proposed Action and Alternatives

This chapter describes the Proposed Action Alternatives, the No Action Alternative, and alternatives considered but eliminated from detailed study. It also presents a comparison of the alternatives with each other and relative to the project purposes.

2.1 Proposed Action

2.1.1 Overview

BPA has been asked by Reclamation to design and construct six new 500-kV transmission lines at Grand Coulee Dam. These proposed new overhead lines would replace six existing underground lines, which are actually an assemblage of 18 aging, oil-filled lines that exist between Grand Coulee's TPP and the 500-kV spreader yard, both of which are owned and operated and maintained by Reclamation. As described in Chapter 1, each of the six turbine generators within the TPP (G-19 through G-21) actually have one circuit that originates from them, which is then translated to18 transmission lines that originate from the TPP (one circuit is equal to three transmission lines; therefore, three transmission lines exist per turbine generator and there are six turbine generators within the TPP). Figure 2-1 provides basic information on describing components of transmission lines and transmission towers. The proposed new overhead transmission lines would transfer power that is generated at the TPP, across the Columbia River, over the visitor center area, and then proceed uphill where they will connect to existing lines that transfer power from this area into the Regional power grid or FCRTS.

2.1.2 Proposed Action Alternatives

In response to public concerns raised during the public scoping process, Reclamation asked BPA's design team to explore alternative tower placement and conductor routing, with an emphasis on increasing the separation between private lands and proposed transmission corridors. Alternatives considered by the design team included exploring alternative tower locations, including those suggested by the public.

Once preliminary alternatives were identified, they were reviewed against the purposes identified as part of the scope of the EA. In brief, the process screened out alternatives that would be unreliable, unsafe, technically infeasible, and/or environmentally or financially unsound. As a result of this development and screening, Reclamation identified five alternatives to consider in the EA, one of which is the new Preferred Alternative. Four of the Proposed Action alternatives include an overhead configuration, and one includes an underground configuration (see Alternatives section). All overhead alternatives include removal of the TPP Tour Visitor's Bridge. Also, as part of a Value Engineering report prepared by Reclamation (USBR 2010), Reclamation identified five additional proposals to include as part of the Proposed Action:

- Add removal of the 18 existing underground cables to the work to be contracted now rather than later.
- Sell the existing steel structures (essentially extract material value by re-use or disposal).

- Reuse the Spreading Yard take off structure.
- Remove the Visitor's Bridge used for public tours of the TPP. This is being proposed for all overhead alternatives described below in order to make way for conductors and attachments to the Forebay Dam and to provide adequate separation from visitors.
- Rebuild the enclosed installation, including modifications to the gallery in the dam.

Reclamation will not select an alternative until after it issues a preliminary EA for public review and has received and responded to comments. The EA will determine whether Reclamation can reach a Finding of No Significant Impact (FONSI) or if they will need to prepare an Environmental Impact Statement (EIS). If Reclamation proceeds with a FONSI, final selection of a specific course of action will be identified in either a final EA/FONSI (Finding of No Significant Impact) or ROD (Record of Decision) following the preparation of an EIS (environmental impacts statement).

2.2 Overhead Alternatives

2.2.1 Alternative 1

Alternative 1 is the originally proposal plan, which was retained for evaluation and comparison, in order to determine if the additional alternatives developed actually address the concerns that were raised by the public. Alternative 1 proposes to follow the same right-of-way in which the temporary overhead lines currently occupy. This alternative would also require the removal of the Visitor's Bridge that is used in tours of the TPP. Figure 2-2 lists this and all other alternatives for comparison.

2.2.2 Alternative 2 (Preferred Alternative)

The Preferred Alternative, or Alternative 2, involves an extended span. This span would be from the transmission lines that emanate from the six turbine generator transformers at the TPP, up to the face of the Forebay dam, across the Columbia River, and up towards the hillside immediate west of the Visitor Center. The Preferred Alternative would not include towers on the Visitor Center grounds as originally proposed plan. This alternative would also increase separation between transmission lines and private property and would result in three less towers being built (six instead of nine). However, the Preferred Alternative would require that these new towers would need to be taller towers, and would cost more than the original proposal (*See* Figure 2-4). This alternative would also require the removal of the Visitor's Bridge that is used in tours of the TPP.

2.2.3 Alternative 3

Alternative 3 is similar to the originally proposed plan of Alternative 1. However, this alternative proposes that towers receiving that overhead transmission lines that will be spanning from the TPP be situated near (below) the Visitor Center grounds rather than on the grounds themselves. New towers would need to be built for this option (and located below the Visitor Center ground), and the two existing two backup towers would be removed to provide more area for public use of Visitor Center grounds. This alternative would also require the removal of the Visitor's Bridge that is used in tours of the TPP.

2.2.4 Alternative 4

Alternative 4 is similar to the originally proposed plan of Alternative 1. However, this alternative proposes to shift new tower structures slightly south within Visitor Center grounds. This alternative would also require the removal of the Visitor's Bridge that is used in tours of the TPP.

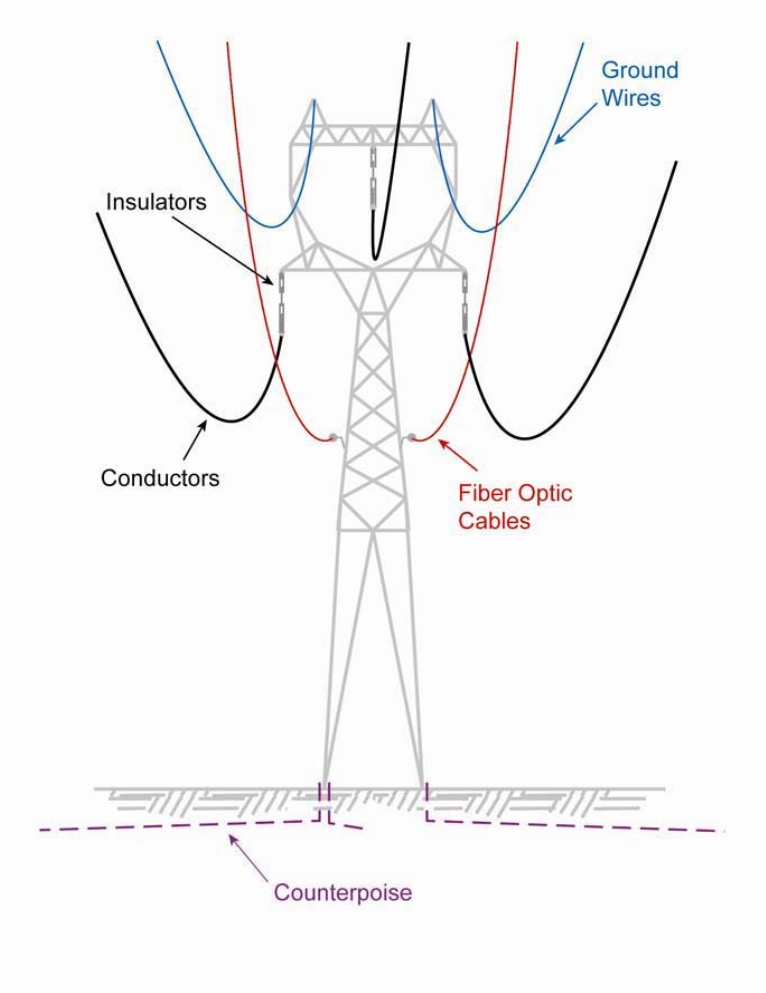

Figure 2-1. Components of a typical transmission tower and its associated transmission line. ***Please note that this example depicts a single-circuit line, which is composed of three transmission lines (also referred to as conductors) per turbine generator from which the energy produced is being transmitted.***

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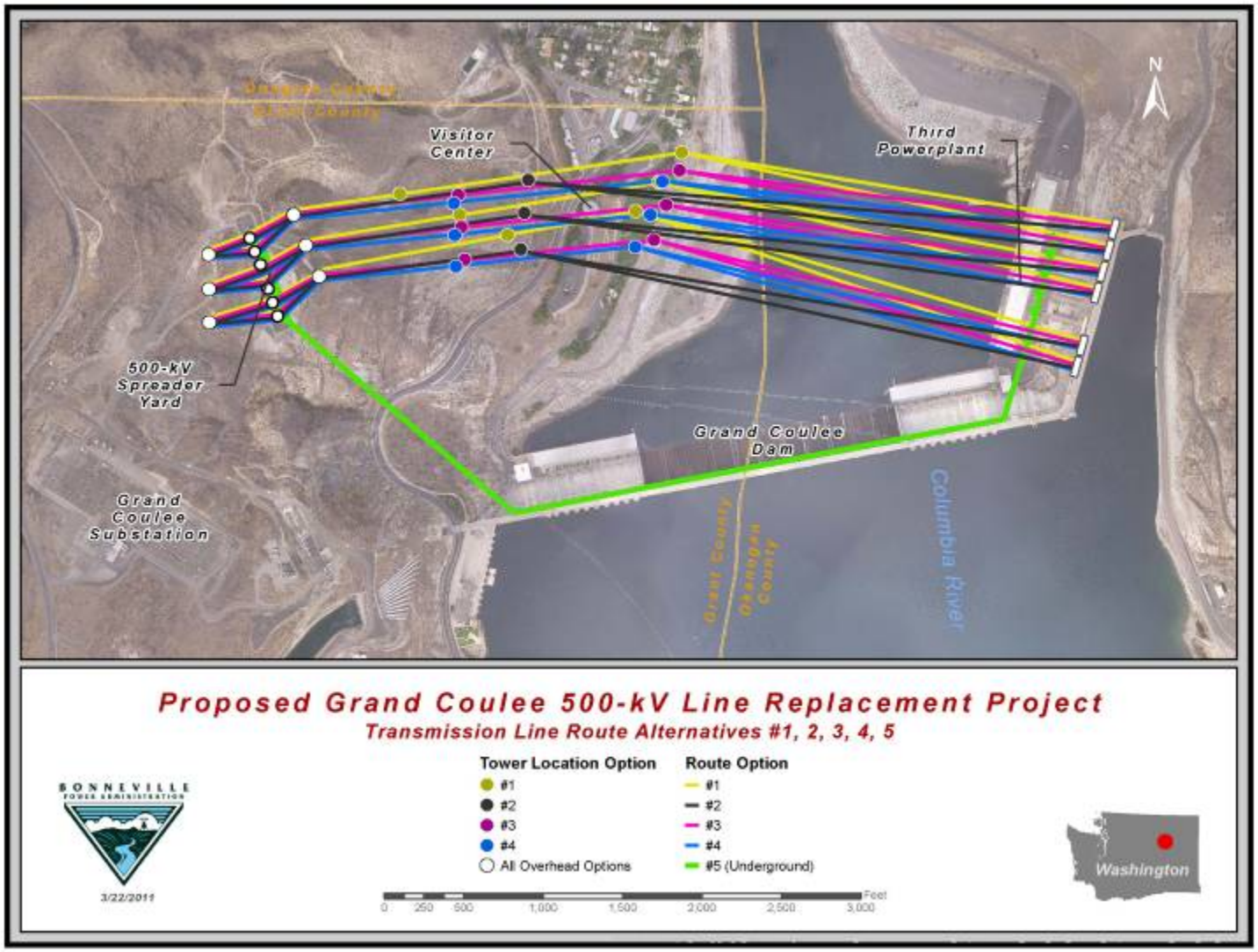

Figure 2-2. Alternatives 1 through 5 of the Proposed Action.

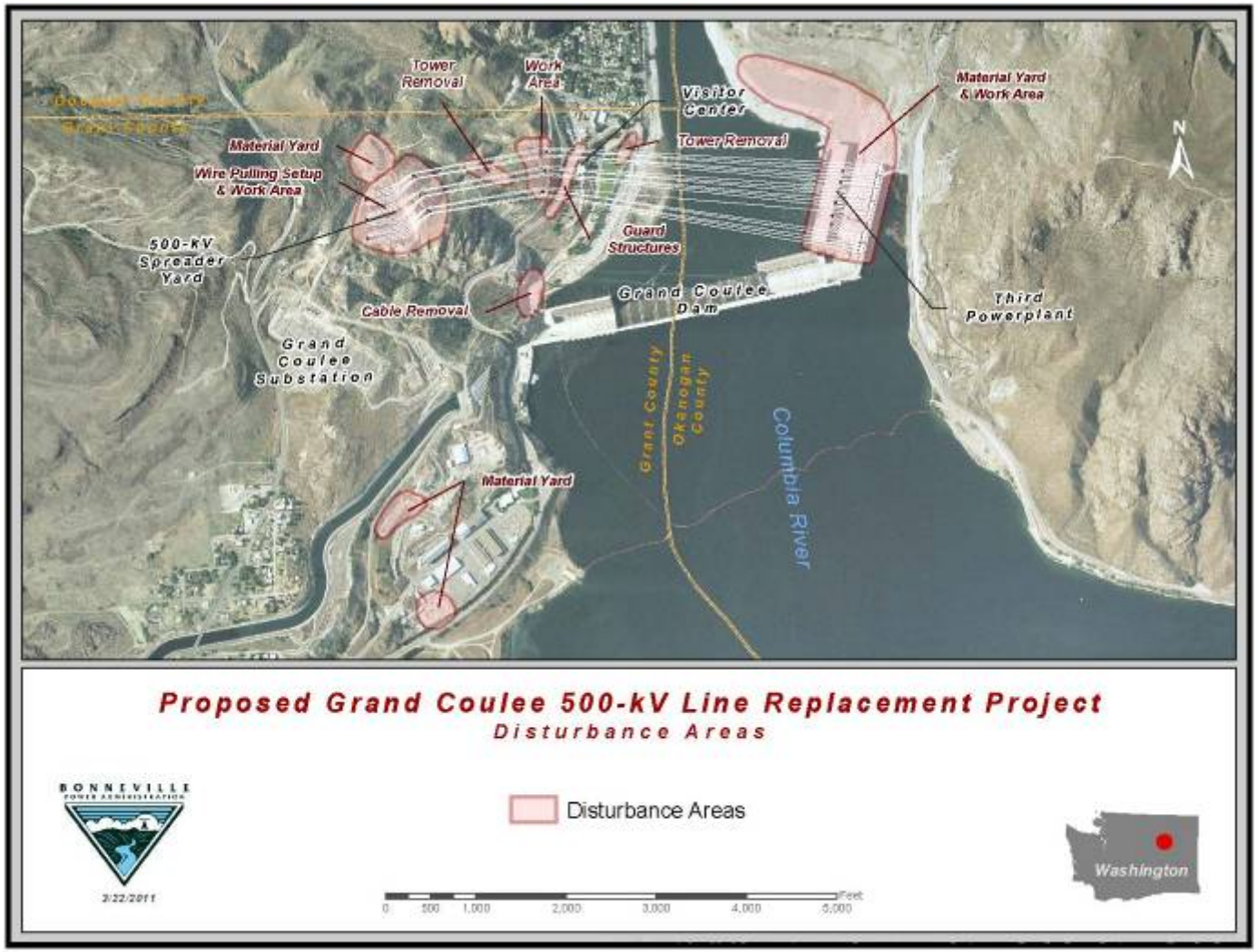

Figure 2-3. Areas of ground disturbance associated with all proposed Overhead Alternatives.

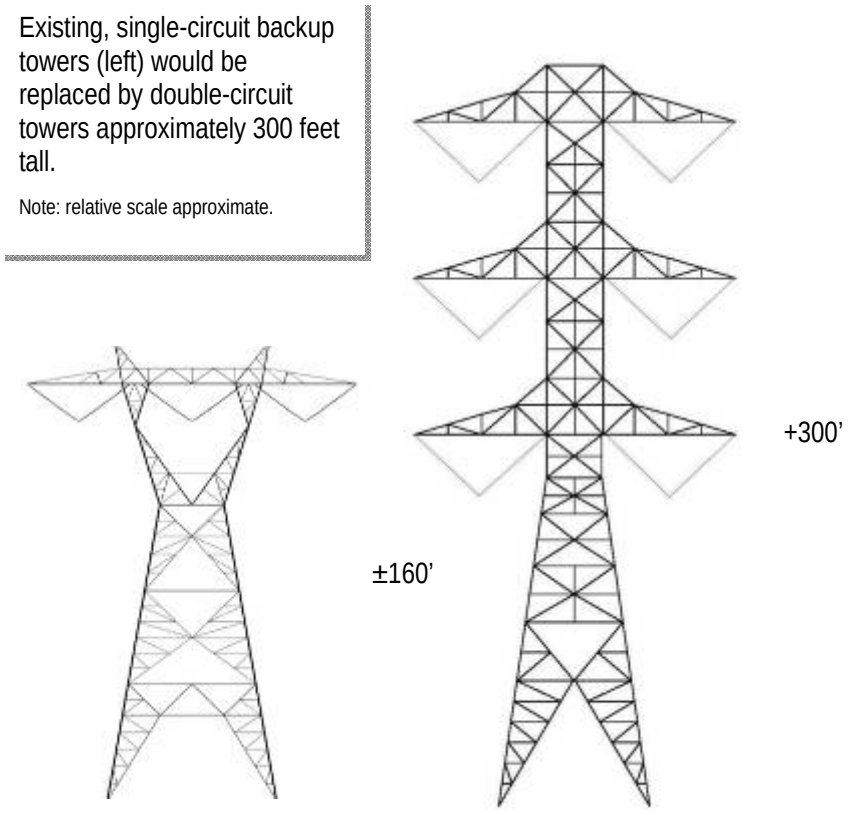

Figure 2-4. Comparison of existing towers and proposed towers needed for the Preferred Alternative, Alternative 2.

2.3 Underground Alternative

2.3.1 Alternative 5 (Rebuild Alternative)

Alternative 5 proposes to rebuild the underground transmission lines within the tunnel system within the dam as suggested by public comments received during the public scoping process. In response to these comments, Reclamation will consider a rebuild alternative. Under this alternative, Reclamation would have BPA remove the existing lines and rebuild new internal transmission lines using best available technology. The rebuild would require installation of additional safety features, including fire-rated barriers (fire doors), additional access points, separation compartments, automatic sprinklers, and smoke ventilation systems. Retaining the backup lines under a rebuild scenario would remain an option to provide a backup in the case of multiple line failures, a risk inherent to installing transmission lines within the dam, even with new cables.

2.4 No Action Alternative

Under the No Action alternative, Reclamation would continue to operate Grand Coulee Dam without any improvements to existing transmission lines that transfer power from the TPP. Reclamation considers this alternative to be unacceptable for the primary long-term reliability of power delivery from Grand Coulee Dam. Secondarily, operating limits of the existing transmission lines would make it impossible to also act on proposals to increase power production within the TPP. Populations that reside within the Pacific Northwest would continue to live with elevated risk of cascading power outages which would follow failure of the existing transmission lines. This alternative is being included for analysis in the EA in order to evaluate the effects of the Preferred Alternative relative to current conditions.

2.5 Alternatives Considered But Eliminated From Detailed Study

As part of the scoping conducted for the EA, the public suggested two alternatives that Reclamation considered but eliminated from detailed study. The following sections present the suggested alternatives and reasons why they were dismissed from further consideration in the EA.

2.5.1 Behind the Dam

The first alternative involves stringing new overhead transmission lines from the TPP, behind the south side of the dam, and across the river. This alternative presents several serious technical challenges and environmental impacts. Technical challenges would include somehow stringing the new transmission lines from the transformers behind the TPP and then up and over the Forebay dam. This would also likely require attaching towers or poles onto the dam. Another set of very tall towers would need to be near the shore south of the main dam, close to the ramp used for overhauling the Keller Ferry. Then, lines would need to cross more than a mile over the river to another set of towers; where little-to-no land is available on which to construct them (the area includes a boat launch, SR 155, a Lake Roosevelt viewing area, and existing Reclamation

facilities). From there, the lines would need to cross 230-kV transmission lines from the Right and Left Powerplants in order to reach the 500-kV spreader yard. Environmental impacts would occur as a result of the required attachment structures visually changing the dam and the line disrupting views from the Lake Roosevelt National Recreation Area and many existing and planned residences along State Route 174, southeast of the dam. Due to these technical and environmental challenges, this suggested alternative was not carried through for further consideration in the EA.

2.5.2 Downriver

The second alternative was proposed as having the transmission lines being routed down an existing right-of-way approximately ½-mile downriver from the current location. However, this right-of-way is a lower-voltage BPA transmission line that provides Elmer City and tribal areas toward Nespelem with power. This route could not be accessed from the TPP without having to cross non-Federal lands in which new transmission right-of-way easements would be required. This "downriver" route would require more than 12 additional transmission towers and fifty additional miles of transmission line when compared to the Preferred Alternative route. In addition to this major technical challenge, environmental impacts would include encroachment on private lands, visual impacts on the Town of Coulee Dam, and habitat loss for bald eagles. Therefore, this alternative was considered but eliminated from further consideration in the EA.

2.6 Comparison of Alternatives

Table 2.1 compares the alternatives described above to the purpose and need for the Proposed Action relative to the biological environment, the physical environment, and the human environment. Under the Preferred Alternative (Proposed Action) and/or the Other Overhead Alternatives, the Proposed Project would be approved after the issuance of a Final EA/FONSI and Record of Decision, the project would be constructed, and the new lines would be built as previously described for these alternatives. Under the Rebuild Alternative, the Proposed Project would be approved after the issuance of a Final EA/FONSI and Record of Decision, the project would be constructed, and the new lines would be rebuilt within the Grand Coulee Dam. Under the No Action alternative, Reclamation would continue to operate Grand Coulee Dam without any improvements to existing transmission lines that transfer power from the TPP.

Table 2-1. Comparison of Alternatives

Environmental Category	Preferred Alternative	Other Overhead Options	Rebuild	No Action
Vegetation	No plant species protected under the Endangered Species Act are likely present. Vegetation would be temporarily disturbed at tower construction and removal sites. Native shrub-steppe habitat would be disturbed during construction of the upper towers. Total impact area would be less than two acres.	The three additional towers (nine total, compared to six with the Proposed Action) located at mid-slope would likely result in more impact on native shrub-steppe habitat and other vegetation. Lower line clearances may also increase the likelihood of future tree pruning on the Visitor Center grounds.	Rebuild would not involve tower construction or removal. Access roads to existing towers may be reopened during construction, since the backup transmission lines would likely be used to maintain power transmission.	No effect
Fish and Wildlife	Additional overhead transmission lines would reduce foraging habitat quality and quantity and increase the risk of injury or mortality for birds that forage below the dam, including wintering bald eagles and nesting osprey. Line markers could reduce risks of avian collisions. Ground disturbance to remove existing towers and install new towers would occur at tower footings and access roads. Bull trout is the only species listed under the Endangered Species Act that may be present in the project vicinity and adverse effects are unlikely.	All overhead options involve the same number, width and span of conductor cables, with no discernable difference in avian habitat impacts or risks of avian collisions. Overhead options other than the preferred would require three additional towers, resulting in greater ground disturbance.	Some ground habitat may be disturbed should access roads to backup towers be reopened during construction. Existing backup lines would continue to interfere with bald eagle and osprey habitat and pose risks of avian collisions.	Existing backup lines would continue to interfere with bald eagle and osprey habitat and pose risks of avian collisions.

Environmental Category	Preferred Alternative	Other Overhead Options	Rebuild	No Action
Geology and Soils	Due to fine-grained soils on steep slopes, some erosion would be unavoidable at tower construction sites and along access roads, particularly where any cuts into hillsides are required.	Additional towers at mid-slope would increase likelihood of erosion.	Soils would likely be disturbed as part of required upgrades to the system, including exits and fire systems within the tunnel. Restoring backup towers and lines for use during construction would involve work within steep slopes and associated erosion.	No effect
Water and Wetlands	No wetlands or streams would be disturbed. The Columbia River would be spanned. Fine-grained soils and slopes present at tower foundations and access roads increase stormwater erosion potential both during and after construction.	Additional towers at mid-slope would increase likelihood of stormwater-related erosion.	No effect	No effect
Land and Shoreline Use	Impacts on the Visitor's Center and adjacent lands, including the Columbia River Inn, would be limited to visual changes. The bridge and viewing balcony portions of the public tour would be eliminated. Lines may interfere with the laser show in the projection zone above the Third Powerplant. Because the laser show equipment is due for replacement, impacts may be avoided with a revised show.	Other overhead alternatives would require towers to be placed in front of the lower Visitor's Center Grounds, resulting in towers being farther from the Columbia River Inn but closer to shoreline residences, elimination of the laser show as currently configured, complicating the ability to create a replacement show, and reduced public open space at the Visitor Center. As with Proposed Action, the bridge and viewing balcony portions of the public tour would be eliminated.	Under the rebuild alternative, backup towers and lines would likely be retained indefinitely to offset increase risks of failure inherent to the rebuild alternative and would remain visible from the Columbia River Inn and elsewhere and continue to take up space on the Visitor Center grounds	Backup towers would and lines would remain.

Environmental Category	Preferred Alternative	Other Overhead Options	Rebuild	No Action
Recreation	Proposed line replacement would have no effect on off-site recreational use, experiences or opportunities at the Lake Roosevelt NRA, Banks Lake, Steamboat Rock State Park, private campgrounds and resorts, or other recreational land uses located outside of the immediate project area below Grand Coulee Dam.	As with the Proposed Action, none of the alternatives would have direct, indirect, or cumulative effects on recreation.	No effect	No effect
Visual and Aesthetics	Proposed towers and lines would be clearly visible from the Visitor's Center and public tour and from nearby parks, motels, and residential areas. The three ±300 foot-tall towers to be built above SR 155 would be clearly visible from SR 155, the Visitor Center, and the pool and parking areas of the Columbia River Inn. Removing existing backup towers from the lower Visitor's Center grounds would help to offset some of the visual impacts.	All other overhead options include towers located in front of the Visitor Center, resulting in greater visual impacts to the Visitor Center. Towers would not be as visible from the Columbia River Inn but would be visible from shoreline residences.	Existing backup towers would remain on the Visitor Center grounds.	Existing backup towers would remain on the Visitor Center grounds.

Environmental Category	Preferred Alternative	Other Overhead Options	Rebuild	No Action
Historic Properties	The visual presence of proposed lines and towers and removal of the historic tour bridge and viewing balcony portion of the public tour would alter the historic character of Grand Coulee Dam, which is eligible for listing on the National Register of Historic Places. Mitigation may be provided through a Memorandum of Agreement between Reclamation, the Washington State Department of Archaeology and Historic Preservation and the Colville Confederated Tribes.	All other overhead options include towers located in front of the Visitor Center, resulting in much greater changes to the historic character of Grand Coulee Dam and Visitor Center.	Existing backup towers would remain on the Visitor Center grounds.	Existing backup towers would remain on the Visitor Center grounds.
Indian Trust Assets and Indian Sacred Sites	The Proposed Action would have no effect on Indian Trust Assets (ITAs) or Indian Sacred Sites.	No effect	No effect	No effect
Public Health and Safety	Maximum EMF would remain within standard safety levels would represent only a marginal increase in the existing levels.	No discernable differences from the Proposed Action.	Existing backup lines would likely be reenergized during construction of the rebuild alternative, resulting in increased levels of EMF at the Visitor Center.	No effect
Air Quality	Some dust and exhaust emissions would be expected to drift offsite during construction. Ozone may be generated by proposed lines, but levels would be well within EPA air quality standards.	Same as Proposed Action.	No effect	No effect

Environmental Category	Preferred Alternative	Other Overhead Options	Rebuild	No Action
Traffic and Transportation	Trucks delivering tower sections, conductors, heavy equipment and other project materials could delay vehicles by slow speeds and stops required to make turns. Removal of towers from the lower grounds could block vehicle access to the lower grounds for up to two days. Traffic on SR 155 would need to be stopped as conductors are installed (work may involve helicopters).	Construction of towers on the Visitor Center grounds would result in more traffic-related disturbances.	Construction traffic would be lower, since no towers would be constructed. Some temporary traffic disruption may occur should backup lines be reenergized during installation of replacement lines within the dam.	No effect

Chapter 3
Affected Environments, Environmental Consequences, and Mitigation Measures

3.1 Introduction

This chapter evaluates the expected impacts of the Action Alternatives and the No Action Alternative on natural, cultural, and social resources to determine the potential for significant environmental effects from each alternative. For each resource, the chapter describes the affected environment, the potential environmental impacts, and proposed mitigation.

Resource specialists used the best available data from a variety of sources to describe the Affected Environment of the project area. They used currently accepted methods and protocols to determine and describe the expected impacts of the Proposed Action and the No Action Alternatives on affected resources. The resource specialists also developed Best Management Practices (BMPs) and mitigation measures to avoid and minimize impacts where possible and to compensate for some unavoidable impacts.

Both direct and indirect impacts were evaluated. Direct impacts are those that would occur within or next to the right-of-way (ROW) during a construction activity and would have an immediate effect on the environmental resource being evaluated. For example, removal of vegetation used for foraging or refuge during project construction would constitute a direct impact on wildlife. Generally, direct impacts would be confined to the existing ROW, except in those areas where access road improvements are planned outside the ROW. Indirect impacts are those that would occur after a construction activity or in an area adjacent to construction activities or outside the ROW. For example, the introduction of noxious weeds following the removal of vegetation that results in lower quality habitat for wildlife would be an indirect impact. If the affected environment for a specific natural or other resource extends beyond the general limits of the existing ROW, it is noted under the specific resource.

The impact analysis lists proposed mitigation that could reduce or compensate for impacts and discusses cumulative effects of the proposal when combined with impacts from past, present, or foreseeable future projects in the area. Impact discussions assume that the proposed mitigation measures are fully implemented. If no cumulative impacts are expected then none are listed.

The impacts of the No Action Alternative are discussed in the final part of each resource section.

3.2 Vegetation

3.2.1 Affected Environment

North facing slopes in the project area contain native big sagebrush/Idaho fescue community, a community listed on the Grant County list of "Known High-Quality Ecosystems of Washington" maintained by the Washington Natural Heritage Information System (2008). While not protected by any state or federal laws, maintaining existing native shrub-steppe habitat is regarded as important to maintaining the state's biodiversity. The Washington Biodiversity Council (2007) has identified shrub-steppe habitat as one of the four ecosystems to be the focus of conservation efforts in the state. The other three include: marine, estuarine, and near-shore; riparian and freshwater aquatic; and old-growth forest. For evaluation, the biological setting has been divided into three zones (*See* Figure 3-1):

- **Zone 1 - Aquatic/Shoreline**: the waters and shorelines of the Columbia River immediately downstream from Grand Coulee Dam;
- **Zone 2 - Developed**: landscaped and partially paved areas of the Visitor's Center grounds and adjacent SR 155;
- **Zone 3 - Upland**: range lands on the slopes above SR 155 leading to the 500-kV spreading yard near the top of the hill. Shrub lands include healthy native plant communities on north facing slopes and cheatgrass dominated ground cover on south facing slopes.

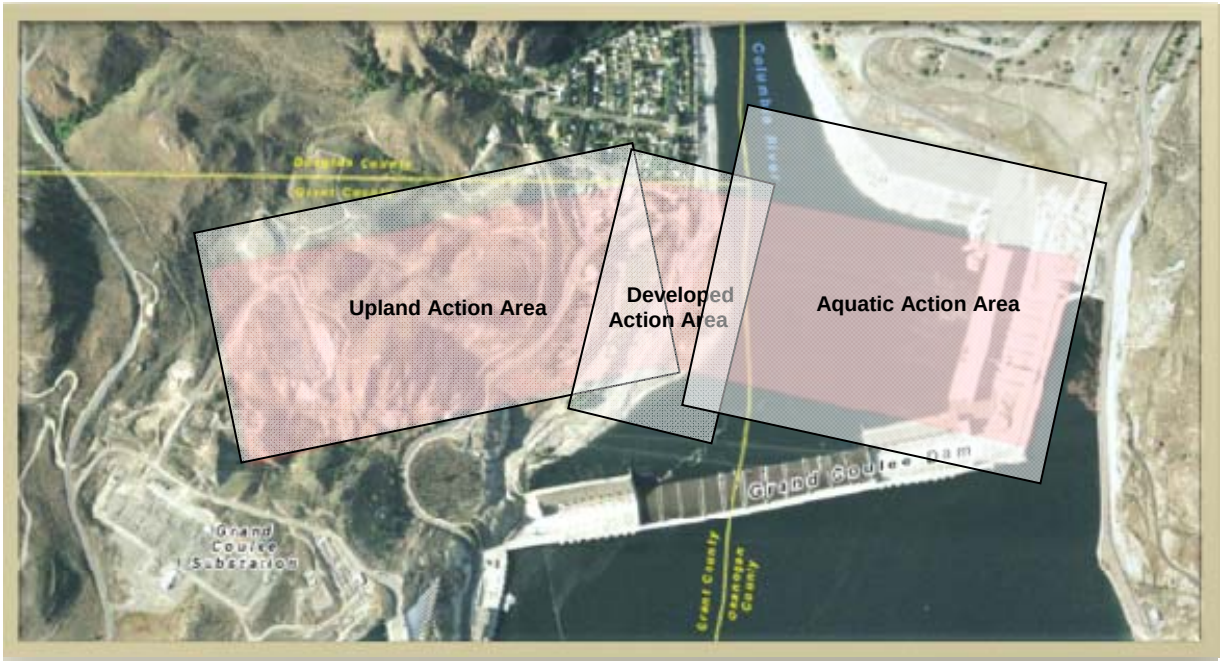

Figure 3-1. The Direct Action Areas related to the Proposed Action.

3.2.1.1 Vegetation and Land Cover Types

Zone 1 Aquatic/Shoreline: Sparse Vegetation

The proposed overhead transmission lines would span an approximately 25-acre floodplain terrace (normally dry but annually flooded). As shown in Figure 3-2, vegetation is limited to sparse (<5% cover) patches of shrub-sized willow and other small shrubs are taking hold. Substrate is primarily fist- sized and smaller granitic rock. Riprap armors the short bank of about 12 feet elevation gain leading to a chain link fence and the Visitor's Center lower grounds. Weedy vegetation is present along the fence line (e.g. rabbitbrush and cheatgrass).

Zone 2 Developed: Terraced Lawn with Shrub and Tree Plantings

The Visitor's Center grounds contain two graded terraces separated by approximately 40 feet elevation as seen in Figure 3-3. The upper lot is mostly paved, though approximately 30-foot tall conifers are located in the lot and along the property line that abuts SR 155. The lower level includes a 4-acre mowed lawn interspersed with landscaped shrubs and trees. The lawn area is used for the annual "Festival of America" events. Between the upper and lower lots is a slope vegetated almost entirely in invasive cheatgrass in the north but in more native vegetation at the southern end.

Zone 3 Upland: Five Cover Types

From a distance, the hillsides above the Visitor's Center appear to be fairly uniform sagebrush and grassland. However, field surveys conducted by Point Consulting and Hart Crowser in June 2010 identified five distinct cover types: big sagebrush/Idaho fescue, big sagebrush/rabbitbrush/cheatgrass, thickets of hawthorn, mock orange and service berry, un-vegetated solids found along unpaved roads, and ruderal vegetation (vegetation that is first to colonize disturbed lands).

Figure 3-2. Example of typical Aquatic/Shoreline Zones at Grand Coulee Dam.

Figure 3-3. Example of Terraced Lawn with Shrub and Tree Plantings within the Developed Action Areas at the Grand Coulee Dam.

Cover Type 1. Big sagebrush/ Idaho fescue Shrub-Steppe. North-facing slopes support well-established big sagebrush interspersed with bitterbrush and some rabbit brush. Some of the big sage and bitterbrush plants are more than six feet tall, indicating good growing conditions and relatively long time since the area was cleared by fire and/or grazing. The ground layer is dominated by Idaho fescue; a bunchgrass which grows in clumps. Cheatgrass is present but is patchy and is not dominant.

Being near the northern extent of shrub-steppe habitats in Washington, this area experiences relatively high precipitation when compared to the majority of the range that extends throughout the Columbia Plateau, as evidenced by well-developed shrub, forb and grass layers and occasional shrubs such as mock orange and service berry found in isolated spots along the hillsides. Interspersed among the fescue are a wide range of forbs including yarrow, lupine, balsam root, and butter and eggs. Prickly pear cactus was also observed at one location within this community type.

This stand also contains patches of intact cryptogamic crust (also called a "microbiotic" crust), which is a layer of algae, mosses, or lichens. The cryptogamic crust contributes to sustaining shrub-steppe ecosystems and, therefore, is also an indicator of the overall health and functioning of the stand, including contributing to the state's biodiversity (Link et al. 2005).

Cover Type 2. Big sagebrush/ Rabbit brush cheatgrass. South-facing slopes differ distinctly from north-facing slopes, with lower densities of big sagebrush and essentially little-to-no native ground cover. In this lower quality shrub-steppe, cheatgrass is the dominant ground cover. South-facing slopes also contain more severe erosion and their associated un-vegetated soils cover type.

Cover Type 3. "Gully" Thickets. The north and south oriented hillsides meet in "dry gullies," which contain no defined bed or bank of a stream channel but rather are fully vegetated. Shrubs

and small trees grow at the head (upslope) of these gullies, including hawthorn, serviceberry, and mock orange as seen in Figure 3-4.

Figure 3-4. Example of a Gully Thicket in Project Area (Cover Type 3)

Cover Type 4. Un-vegetated Erosion Areas. Access roads and the existing towers were constructed in the 1980s. Access to the existing two towers is via a road traveling from the ottom of the slope up, cutting across a south facing slope for approximately 1,700 linear feet and then crosses over to the north facing slope, bending back approximately 1,000 feet to reach the two tower locations.

While big sage and other vegetation has re-colonized the roadbed and bank in many places, other places support sparse or no vegetation, including several areas where the road cut has continued to edge its way up slope. Using an estimated disturbance width of 12 feet, the total un-vegetated area covers approximately 0.6 acres. Other un-vegetated areas are present at granite outcrops located south of proposed lines.

Cover Type 5. Ruderal Vegetation. "Ruderal" vegetation refers to vegetation growing in highly disturbed areas such as grows along roadsides and in abandoned property. This term fits a disturbed area located on City of Coulee Dam lands near the bottom of a draw that occupies roughly 2 acres. A road leads to a berm of soil and what appeared to be yard waste. The area contains dozens of concrete slabs approximately 3 feet square, yard waste, woodpiles, and some trash. Most debris is in the lower portion of the draw, but upper portions support a mix of grasses and weeds, including a dense stand of tansy mustard - a common invasive weed - along the flat portion of the draw.

Vegetation at existing tower sites also includes disturbance indicated by smaller shrub sizes, overall low native plant density and the presence of invasive species. One notable exception was the top, southern tower that was built on a north facing slope and that contains relatively healthy big sagebrush-fescue vegetation.

Table 3-1. Plants of the Big Sagebrush Fescue Communities

Shrubs
bitterbrush (*Purshia tridentata*)
common sagebrush (*Artemisia tridentata*)
mock orange (*Philadephus lewisii*)
serviceberry/saskatoon (*Amelanchier alnifolia*)
rabbit brush (*Chrysothamnus nauseosus*)
Grasses
cheatgrass (*Bromus tectorum*)
Idaho fescue (*Festuca idahoensis*)
bluebunch wheatgrass (*Pseudoroegneria spicata*)
basin wildrye (*Elymus glaucus*)
Forbs and Succulents
yarrow (*Achillea millefolium*)
golden aster (*Chrysopis villosa*)
silky lupine (*Lupinus sericeus*)
sage (*Salvia dorii*)
balsam root (*Balsamorhiza sagittata*)
Mariposa lily (*Calochortus macrocarpus*)
Douglas' buckwheat (*Eriogonum douglasii*)
pink fairies (*Clarkia pulchella*)
fleabane (*Erigeron filifolius*)
white-leaved globe mallow (*Sphaeralcea munroana*)
butter and eggs (*Linaria vulgaris*)
prickly pear (*Opuntia fragilis*)

3.2.1.2 Noxious Weeds

Noxious weeds are legally designated by the State of Washington. The Federal Noxious Weed Act of 1974 (7 U.S.C. §§ 2801-2814, January 3, 1975, as amended 1988 and 1994) provides for the control and management of non-indigenous plants. Noxious weeds are non-native plants that have been designated as undesirable plants by law because they are invasive and can degrade and

lower the economic value of the lands on which they occur. They degrade farmland and threaten the integrity of native plant communities by displacing native species and decreasing species diversity.

Identification and management of noxious weeds is broken down to a regional level. The proposed project area is located within Region 6 which encompasses Kittitas, Grant, Chelan and Douglas counties and south of Highway 2, and portions of Yakima and Adams counties. Within Region 6, 65 species of weeds have been designated as noxious. Under Washington law, the land owner or manager is primarily responsible for controlling noxious weeds.

No designated noxious weeds were identified during field surveys, though a formal noxious weed inventory was not conducted.

3.2.1.3 Special-Status Species

Special-status plant species are those species that have been identified for protection under federal or state laws. Only one special-status plant species, the Ute ladies'-tresses (*Spiranthes diluvialis*).

Ute ladies'-tresses, *Spiranthes diluvialis,* is a federally threatened plant known to occur within "moist meadows" along Columbia River reservoirs (Fertig et al 2005). In Okanogan County, the species is known to occur from Wannacut Lake on a "periodically flooded, moist meadow on alkaline flat bordering the lake" at 1830 feet.

In Chelan County, known populations occur near the shores of Rocky Reach (below Chief Joseph Dam), with known populations at:

- Gallagher Flats (WA-002), which is described as "a seasonally flooded, moist meadow on gravel bar bordering reservoir;
- Rocky Reach (river mile 505.5, WA-003), where they occur in a moist meadow bordering small pond and at a partially wooded riparian community above high water line on reservoir bank; and,
- Howard Flats (WA-004), where they occur on a seasonally flooded moist meadow near the shore of the reservoir.

Based on this evidence, Ute ladies'-tresses is likely absent from the flooded terrace area. The general condition of "gravel bar" may be there, but the shoreline has been completely modified as part of bank stabilizing efforts below the dam, making threatened populations unlikely. Also, no "moist meadow" habitat is present. The rocky shoreline contains no soil layer or associated emergent vegetation associated with "moist meadow" habitat. No disturbance is proposed within this shoreline area, so verification would not be required.

One federal candidate species, the northern wormwood (*Artemisia campesstris ssp. borealis var. wormskioldii*) was reviewed for habitat associations and known range. Known populations of this candidate species are located more than 40 miles downriver from the Proposed Action, therefore it is unlikely that it would be present within the action area (*See* Table 3-3).

Other Special-Status Species and Communities

The WDFW identifies shrub-steppe as a "priority habitat," and the big sagebrush/Idaho fescue community -- present on north facing slopes in the project area -- is listed on the Grant County

list of "Known High-Quality or Rare Plant Communities and Wetland Ecosystems of Washington" maintained by the Washington Natural Heritage Information System (2008).

3.2.2 Environmental Consequences – Preferred Alternative

3.2.2.1 Vegetation and Land Cover Types

Zone 1 - Aquatic/Shoreline: Sparse Vegetation. No direct impacts would occur on existing sparse vegetation along the shorelines and rip-rap banks of the river. Vegetation could be affected later in time (an indirect impact) should any shoreline trees grow within 50 feet of overhead lines over the approximately 450-foot corridor width (at the point crossing the floodplain and shoreline). Lines would span at approximately 115 feet above the floodplain terrace present along the shoreline area, so it would likely be many years before any tree would require topping or removal (assuming any were to grow to that height at all).

Zone 2 - Developed: Terraced Lawn with Shrub and Tree Plantings. Removing existing backup towers would disturb lawn and possibly some landscaped shrubs, but otherwise, no vegetation would be removed. The area would be restored to open lawn.

Zone 3 - Upland: Shrub and Grassland Slopes. The intact and disturbed shrub-steppe communities (Cover Types 1 and 2) would be directly impacted by accessing and removing existing towers; installing new towers; access roads to new towers; and equipment staging areas. Vegetation would be temporarily removed at the tower footprints during tower removal, but the greatest potential impacts on vegetation would be from repairing the existing access roads to allow deconstruction crews to access the two towers at mid-slope. Approximately 3,000 linear feet of road would need to be repaired to access the two towers. This repair could exacerbate existing erosion and associated un-vegetated areas.

Six towers would be constructed within the shrub and grassland slopes. Vegetation would be permanently removed for tower footings. Temporary construction impacts within intact shrub-steppe cover type would include an avoidable lag time between disturbance and recover of up to ten years.

At the bottom of the hill, two of the tower sites are located in disturbed sagebrush/cheatgrass cover type and one is located within the ruderal cover type. The center and southern towers (Line 2 and Line 3) as proposed would require cutting into steep banks, which could trigger long-term erosion and associated un-vegetated ground.

At the top of the hill, two of the towers would be constructed at existing tower locations and one within a new location. The northern-most tower location is within disturbed habitat, while the southern tower is located on a north facing slope and native grasses have recovered nicely under the tower. Less than one acre of native shrub steppe would be removed during construction at this tower location. The third tower location contains mixed disturbed and Idaho fescue habitats. Once the native shrub steppe cover is removed, vegetation might have difficulty reestablishing should soils on steep slopes start to erode. The north facing orientation of the central tower (Line 2- Tower 2, and existing southern tower) would better support re-vegetation than would the more exposed northern tower (Line 1-Tower 2).

Access Roads to New Towers and Equipment Staging. Both the lower and upper tower sites have relatively good existing access so little existing vegetation would be removed for access

roads. One exception may be the middle and southern towers at the top of the hill (Line 2-Tower 2 and Line 3-Tower 2), where sagebrush fescue habitat may be disturbed for access to the towers.

Equipment Staging Areas. No specific area has been identified for staging; however, for the lower towers, the disturbed "ruderal" area presents a logical option, presenting a flat area already highly disturbed and containing no intact shrub steppe plant communities.

3.2.2.2 Noxious Weeds

The spread of noxious weeds and other invasive species from transmission lines are generally a concern with extended new corridors within crop lands, where weeds growing within the corridor could spread to adjacent fields (BPA 2000). The Proposed Action would not cross cropland and, at less than a mile in length and a total of six proposed towers, is very short as far as transmission projects go (e.g., BPA's McNary-John Day line, currently under construction, runs 75 miles). Still, weeds are relevant with any land disturbing activities, particularly in areas next to or within relatively intact native shrub-steppe communities and parks/residential areas.

Because most areas that would be disturbed already support many invasive species, concerns for this project would be that construction may expand existing distribution of invasive plants on the hillsides above the Visitor's Center.

3.2.2.3 Special-Status Species

No threatened or endangered plant species or designated critical habitat is present within areas proposed for tower removal or construction. The presence of Ute ladies'-tresses could be unlikely but possible in the flooded terrace area. No disturbance is proposed within this shoreline area, so even if this species were present, the project would have no adverse effects.

3.2.2.4 Indirect Impacts

Vegetation could be affected later in time (an indirect impact) should any trees grow within 50 feet of overhead lines over the approximately 450 foot corridor width (at the point crossing the floodplain and shoreline). Lines would span at least 100 feet above the ground in most places, and few trees are present, and no existing trees appear to be sufficiently tall to require pruning. It would likely be many years before any tree would require topping or removal (assuming any were to grow to that height at all).

Weeds, should they become established on areas disturbed by project construction, could spread to adjacent lands or further.

3.2.3 Mitigation Measures

3.2.3.1 Construction Fencing

In conjunction with options to protect soils, impacts to native plant communities can be minimized by installing temporary construction fences around tower sites, particularly Towers 2-2 and 3-2, located at the top of the slope near the 500-kV Spreader Yard. Fencing and perhaps incentives to avoid incidental disturbance to vegetation (or disincentives for causing unnecessary impacts) could be incorporated into construction bid and contract documents. Also, integrating

any vegetation management included in final designs with soils mitigation planning would serve to better protect both vegetation and soils.

3.2.3.2 Reseeding Disturbed Areas

In order to reduce the spread of weeds, reseeding of disturbed areas will be performed with desirable vegetation which will also assist in controlling erosion.

3.2.4 Unavoidable Impacts Remaining After Mitigation

Vegetation would be permanently removed for tower footings. Temporary construction impacts within intact shrub-steppe cover type would include an unavoidable lag time between disturbance and recovery for up to ten years.

All alternatives would cross landscaped trees located north and south of the Visitor's Center. With approximately 150-feet of vertical clearance, the preferred alternative would not be expected to impact these trees now, but they could be impacted in the future (e.g., topping or removal) to maintain safe clearance.

Even with the best of plans and efforts, weeds would likely invade portions of areas disturbed. This impact would be of greater concern in areas where native species currently prevail over invasive species, specifically the southern and central tower locations at the top of the hill (Towers 2-2 and 3-2).

3.2.5 Cumulative Impacts

Construction of the existing towers and access roads – particularly the two mid-slope towers – removed native shrub-steppe habitat that in places never recovered. Road cuts include erosion and bare areas that support weeds or no vegetation at all. These past impacts lessen the direct impact of the preferred alternative, since much of the work would be conducted within these disturbed areas. These past disturbances viewed collectively with proposed disturbances would result in a direct effect of less than five percent reduction in available north-facing slopes that support shrub-steppe communities.

Mitigation measures to reduce impacts on vegetation from the preferred alternative could result in a net gain in native plant distribution in the area, should erosion and other disturbance areas caused by past construction area be addressed as part of removal of the mid-slope towers.

3.2.6 Environmental Consequences – Alternatives

3.2.6.1 Overhead Alternatives

For vegetation disturbance, the Preferred Alternative is also the environmentally preferred alternative because under the other overhead alternatives considered (Alternatives 1, 3 and 4):

- Three additional towers would be required, and these would be placed at mid-slope, within intact and previously impacted shrub-steppe habitat; and
- Lower vertical clearance would be required over the Visitor's Center.

The three additional towers located at mid-slope would likely result in more, rather than less impact on shrub-steppe habitat. Lower clearances may eventually result in trees pruning

3.2.6.2 Rebuild Alternative

The Rebuild Alternative would not require towers to be constructed nor existing towers to be removed. Access roads to existing towers may be reopened during construction, since the backup transmission lines would likely be used maintain power transmission. This alternative would involve mostly disturbed habitats along the roadway, including areas that had eroded due to the previous construction, and areas needed to provide additional tunnel access points.

3.2.6.3 No Action Alternative

Under the No Action Alternative, no direct impacts on vegetation would occur immediately. A fire or other major incident within one of the tunnels containing the current transmission lines could require ground disturbing actions in response to any potential emergency situations. Over time, roads to existing towers may need to be repaired for access, which would result in similar impacts as those described for the preferred alternative.

3.3 Fish and Wildlife

3.3.1 Affected Environment

3.3.1.1 River and Floodplain Habitat

This area includes the approximate 2,670-foot span between the TPP to, and including, the level shoreline area (technically called the floodplain terrace).

Shorelines have been modified through bank stabilization conducted as part of Grand Coulee Dam operations and include the "north storage yard," which is proposed for storage buildings as part of the TPP Overhaul project.

This area includes waters and shorelines of the "afterbay" area immediately downstream from Grand Coulee Dam and the TPP (from which proposed lines would span across the river).

The waters between Grand Coulee and Chief Joseph dams are known as Rufus Woods Lake. Native species include bull trout, westslope cutthroat and redband trout (Confederated Tribes of the Colville Reservation 2000 and 2006). Native fisheries are now mostly limited to tributary streams, while the main body of the river (now a reservoir) supports mostly non-native fisheries, including walleye, hatchery-stock rainbow trout, and landlocked sockeye salmon (kokanee). Several commercial fish rearing operations on the lake raise trout and sometimes fish escape from the pens or are intentionally released into the lake to supplement the existing fish available to fisherman. These commercially-raised fish can weigh over 20 pounds. Fish are known to travel through the turbines at Grand Coulee Dam from Lake Roosevelt. Eagles and other birds feed on fish disoriented by going through generator turbines, and such fish likely serve as a major food source for wintering bald eagle and nesting osprey that occupy the area.

The river and floodplain area supports two notable wildlife uses: bald eagle winter habitat and osprey nesting. These two species are discussed in more detail under *Other Special-Status Species and Habitats* below.

Other species known or likely to use the river and floodplain include gulls, ravens, turkey vulture, great blue herons, and occasionally waterfowl, including mallard, coot and Canada geese.

Developed

This area includes the highly modified areas of the shoreline, landscaped and partially paved areas of the Visitor's Center grounds and areas adjacent State Route 155 (approximately 40 acres). Reclamation's wildlife objective for this area is more focused on damage control from wildlife. Yellow bellied marmots and other burrowing mammals have long created problems by burrowing within the landscaped grounds (L. Brougher pers. com.). An osprey nest site is also located in this area: a stick nest is located in the northern backup tower located on the lower Visitor's Center grounds. This area contains no streams.

Upland slopes

The hills above the Visitor's Center leading to the Spreading Yard are where both sets of towers would be built and all six lines would cross over an area measuring approximately 50 acres.

These slopes support native big sagebrush/fescue cover types on north-facing slopes and primarily non-native cheatgrass and weak shrub cover on south-facing slopes.

Three wildlife habitat features present on the upland slope stand out: 1) native plant communities and thickets provide cover, food and nesting habitat for a variety of wildlife; 2) deep, fine soils support burrowing mammals; and 3) low level of human disturbance provides "secure" habitat.

Collectively, these features are likely used by a wide range of birds and mammals. During field surveys conducted in June 2010, an adult and three young great horned owls were seen at mid-slope. While 2010 was a record wet spring (which increases plant growth and associated small mammal communities), three healthy fledging owlets is an indication of productive wildlife habitat.

The upland slopes contain no fish habitat. Intermittent drainage channels are vegetated with upland plants and are expected to only carry storm water during extreme rain events. A storm water outlet and holding area was identified on the uphill side of the abandoned railroad grade at the toe of the slope and north of the proposed tower locations.

Indirect Action Area

The "indirect action area" considered included (a) a disturbance radius of 0.5 miles for effects of construction noise and activity (b) downstream waters for effects on water quality or quantity impacts.

3.3.1.2 Endangered Species Act: Listed Species and Critical Habitats

The USFWS maintains online lists of ESA species and critical habitats by county (USFWS 2010).

The project begins in Okanogan County at the TPP, and then crosses the Columbia River into Grant County, where lines would meet the proposed transmission towers leading across the developed and upland action areas. Two other counties are close. Douglas County begins a few hundred feet north of proposed towers; and Lincoln County is located on the south side of Lake Roosevelt, behind (and upstream of) the dam.

Due to the location of the project, a list was compiled using USFWS lists for all four counties. In addition, BPA data from the Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) Program was reviewed for known location of listed wildlife and/or possible habitats.

Tables 3-2 and 3-3 present the initial species list and screening factors evaluated. The following describes subsequent screening of species and habitats to determine which may be present within the action area and which can be dismissed as absent or likely absent from the project area.

Species and Critical Habitat Found to be Absent

Due to the broad area encompassed by the four-county area, several species and habitats can be dismissed as absent based on habitat conditions alone. In particular, several wide-ranging forest carnivores found on the Okanogan County (Okanogan Ecoregion) do not travel through the non-forested Columbia Basin Ecoregion or near areas of concentrated human activity, and are therefore dismissed from further consideration in the impact analysis. These species include:

- Canada lynx (*Lynx Canadensis*)—Threatened
- Grizzly bear (*Ursus arctos horribilis*)—Threatened
- Northern spotted owl (*Strix occidentalis caurina*)—Threatened
- Critical habitat for Canada lynx
- Critical habitat for Northern spotted owl
- Fisher (*Martes pennanti*)—Candidate

In 1938, Grand Coulee Dam blocked anadromous fish from habitat upstream of river mile 597 (Confederated Tribes of the Colville Reservation 2000). In 1961, the Chief Joseph Dam blocked anadromous fish from the remaining habitat upstream of River Mile 545. Therefore, no salmon or other species under the jurisdiction of the NOAA Fisheries are present within the waters that would be spanned and only indirect (downstream) effects are considered further.

Species Evaluation for the Aquatic Action Area

Bull trout (*Salvelinus confluentus*) is federally threatened. Adults may use the mainstream Columbia, though tributaries contain the main populations (WDFW 2000). The waters below Grand Coulee Dam are outside of the recovery planning zone for the species. Watersheds targeted for recovery are located more than 20 miles downstream from the action area.

Species Evaluation for the Developed Action Area

The developed area contains no habitats or species listed under ESA. Based on known and suspected distributions reported in published literature and/or recovery plans, bull trout is the only listed species that may occur within the "action area." The Proposed Action would span the "afterbay" area of Grand Coulee Dam, with no inwater work and no direct impact pathways to fish or fish habitat. Indirect pathways of water quality (e.g. project-generated water pollution) and shading from the lines or towers were considered but determined to be unlikely to affect fish.

Species Evaluation for the Upland Action Area

The upland hills are outside of the known and mapped ranges of listed species of the Columbia Basin Ecoregion, including those known to occur in Douglas and/or Grant Counties. Pygmy rabbit (*Brachylagus idahoensis*) is a federally endangered species closely associated with shrub-steppe habitat, but with no known natural populations in Washington and only a few populations reintroduced under a WDFW program (Sayler et al 2006, WDFW 2007). No reintroduction areas are located within ten miles of the action area and, therefore, this species is likely absent from the project area.

Federal Candidate Species

Three federal candidate species were reviewed for habitat associations and known range and found unlikely to be present within the action area. These species are listed below:

Greater sage grouse (*Centrocercus urophasianus*) is a federal candidate and state endangered species. The WDFW designates habitat on the shrub-steppe plateaus located above and north of the upland action area as sage grouse habitat (using WDFW data included in BPA's GIS

database). The following excerpt from the Washington Sage Grouse Recovery Plan summarizes the habitat and distribution of this candidate species (Stinson et al. 2004):

> "*The sage-grouse has been declining in Washington and many parts of its range in North America. The reduction in sage-grouse numbers and distribution in Washington is primarily attributed to loss of habitat through conversion to cropland and degradation of habitat by historic overgrazing and the invasion by cheatgrass and noxious weeds. Sage-grouse occur on about 8% of their historical range in the state. The population is estimated to have declined 62% from 1970 to 2003. Local extirpations have been noted as recently as the 1980's. The statewide breeding population of sage-grouse in Washington in 2003 was estimated to be 1,011 birds. This estimate is based on lek counts of males, and probably is an underestimate.* (*A lek is a gathering of males, of certain animal species, for the purposes of competitive mating displays*).
>
> "*A breeding population of about 624 sage-grouse is located in Douglas and Grant Counties where a large amount of agricultural lands are enrolled in the Conservation Reserve Program (CRP) and shrub-steppe remnants exist where rocky soil and rugged terrain have precluded agricultural conversion. The other population of about 387 birds is located in Kittitas and Yakima counties in contiguous shrub-steppe that has been maintained on the Yakima Training Center (YTC), a U.S. Army training facility. Neither of the 2 isolated grouse populations is large enough for long-term viability. A recent investigation indicated reduced genetic diversity in both the YTC and Douglas-Grant populations. The polygamous mating system and fluctuations of sage-grouse populations over time reduce the effective population size and increase the number of grouse needed for a population to be viable.*"

Washington ground squirrel (*Spermophilus washingtoni*) (state endangered, federal candidate). A WDFW study published in 2007 provides the most recent published information on the distribution and habitat of Washington ground squirrel (WDFW 2007). Based on that study, it is found within colonies, the closest of which being located in Foster Coulee west of Banks Lake, approximately 13 miles southwest of the action area (WDFW 2007).

The WDFW report summarized Washington ground squirrel habitat requirements as follows:

> "*Washington ground squirrels are most common in shrub-steppe habitats over silty loam soils, particularly Warden and Sagehill soils. Vegetation preferences of the species are not fully understood, but other* Spermophilus *are usually food-limited, requiring high quality vegetation and seeds. Recent research on Washington ground squirrels indicates high use of bluegrass* (Poa *spp.*) *in mid-season followed by a late season diet of forbs (vegetative matter and seeds) and grass seed.*"

Soils within the upland action area are primarily sands and silts, rather than the loam soils. However, the deep sands and silts that are present could conceivably support burrows. So, without confirmation through surveys, the data support a conclusion that Washington ground squirrels are possibly, but unlikely, present within the action area.

Yellow-billed cuckoo (*Coccyzus americanus*) no longer breeds in Washington State (Washington Nature Mapping Program 2010).

Table 3-2. Federal Candidate Species

Common Name	Scientific Name	State Status	Grant	Okanogan	Douglas	Ferry	Findings
Greater sage grouse	*Centrocercus urophasianus*	Threatened	X		X		**Likely Absent.** Within historic range, but project is outside of present range, which begins west of the project area and continues west and south. Conceivable that individuals could occur in shrub-steppe habitats on slopes proposed for new transmission lines.
Washington ground squirrel	*Spermophilus washingtoni*	Candidate	X				**Likely Absent**
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate		X			**Likely Absent.** Breeding extirpated from Washington. Most suitable habitat in four-county area evaluated may be in riparian habitat along Okanogan River.
Northern wormwood (plant)	*Artemisia campestris ssp. borealis var. wormskioldii*	Candidate	X				***Likely absent.*** Known populations located more than 40 miles downriver from the proposed action.

Source: Stinson et al. 2004 Washington State Recovery Plan for the Greater Sage-Grouse; Finger et al. 2007 Washington Ground Squirrel Surveys in Adams, Douglas, and Grant Counties, Washington, 2004; Washington Nature Mapping Program 2010; WDFW 1997.

Table 3-3. Threatened and Endangered Species and Designated Critical Habitats Evaluated

Common Name	Scientific Name	Status	Grant	Okanogan	Douglas	Ferry	Findings
Bull trout	*Salvelinus confluentus*	Threatened	X	X		X	**Assumed Present**. Adults may be present in Rufus Woods Lake (waters that would be crossed by proposed lines), but project "action area" is outside of the recovery planning area zone.
Pygmy rabbit	*Brachylagus idahoensis*	Endangered	X		X		**Likely Absent**. Shrub-steppe species known to exist only in reintroduced populations, none of which are within 25 miles of the action area.
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened	X	X		X	**Likely Absent**. Requires moist habitats. Occurs in floodplain on Rufus Woods Lake near Chief Joseph Dam.
Canada lynx	*Lynx canadensis*	Threatened		X		X	**Absent**. Wide-ranging forest carnivore absent from project area.
Grizzly bear	*Ursus arctos horribilis*	Threatened		X		X	**Absent**. Wide-ranging forest carnivore. Absent from project area.
Northern spotted owl	*Strix occidentalis caurina*	Threatened		X			**Absent**. Occurs in forested habitats. Absent from project area.
Critical habitat: Canada lynx		Designated Critical Habitat		X			**Absent**. Wide-ranging forest carnivore. Absent from project area.
Critical habitat: Northern spotted owl		Designated Critical Habitat		X			**Absent**. None present in project area (includes only forest habitat, which is absent).

Source: Fertig et al. 2005

3.3.1.3 Other Special-Status Species and Habitats

Deer and Elk Winter Range

The WDFW has mapped the hills above the Visitor's Center as Roosevelt elk winter range and the area just to the north (including Crown Point State Park) as mule deer winter range (*See* Figure 3-5).

Winter range deer and elk habitat both share similar qualities. These qualities include a combination of food sources available, security from threats, and protection from the cold. Winter range is believed to be most important during severe and prolonged winter weather, where they become islands of survival. Major winter kills can affect populations for many years, so that the amount of winter habitat available becomes one of the key limiting factors for populations (Johnson 1998).

The upland portion of the project area – where towers would be constructed – contains many features reported to be good indicators of deer and elk winter habitat, including: little human disturbance, good hiding cover and forage plants on north-facing slopes (thickets, sagebrush, bitterbrush), "thermal habitat" provided by sunshine on south-facing slopes and protection from the wind, and clear lines of sight of possible predator approach avenues from below.

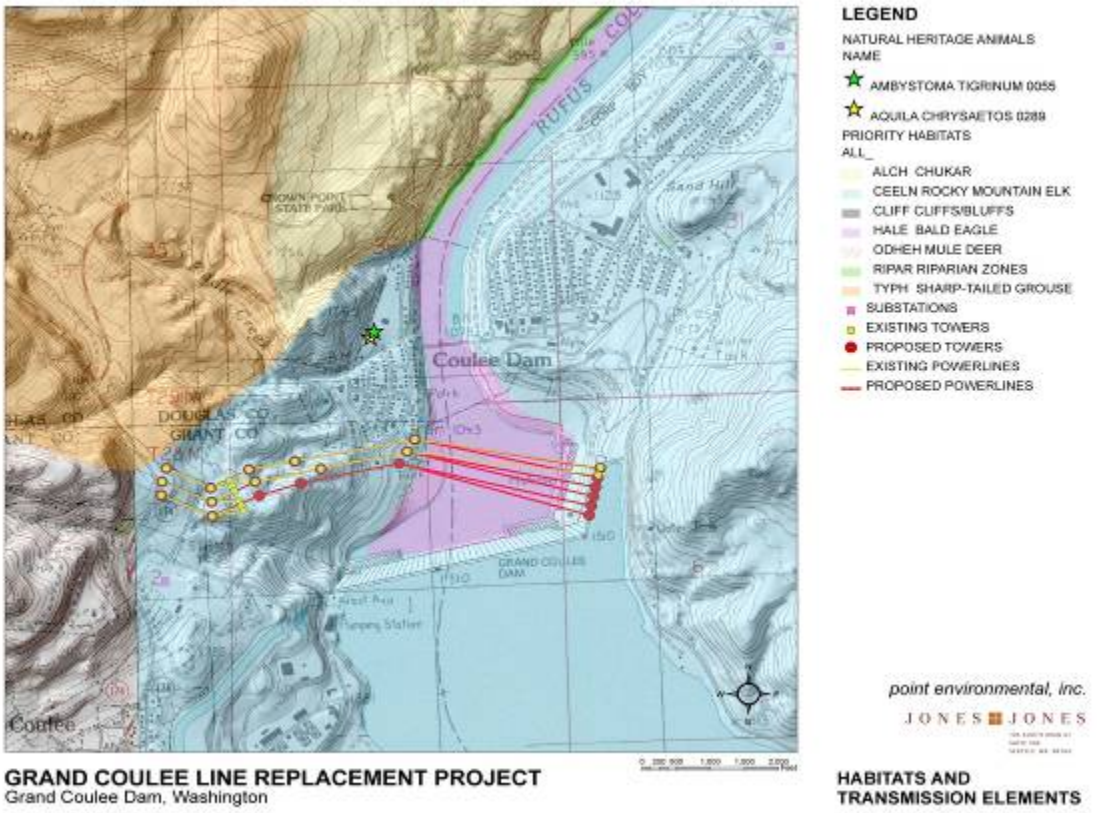

Figure 3-5. Habitats for Deer, Elk, and other Sensitive Species in the Affected Area.

Bald Eagle Winter Foraging

Bald eagle studies performed in the 1980s at Grand Coulee Dam determined four foraging regions that were utilized below the dam, and reported bald eagle use, as seen in Figure 3-6, as follows:

- **Region A** included areas between the 500-kV backup lines and SR 155 Bridge. This region was fished 25 percent of the time and produced 26% of the fish caught.
- **Region B** was identified as the area along the shoreline perpendicular to the backup lines. This area was fished 20 percent of the time, but produced 40% of fish caught.
- **Region C** was identified as the "afterbay" area below the left powerplant. This area was fished 10 percent of the time, providing 14% of the fish caught.
- **Region D** was identified as the area between the 500-kV backup lines and the right powerplant. It was fished 37 percent of the time but produced only 20% of the fish caught.

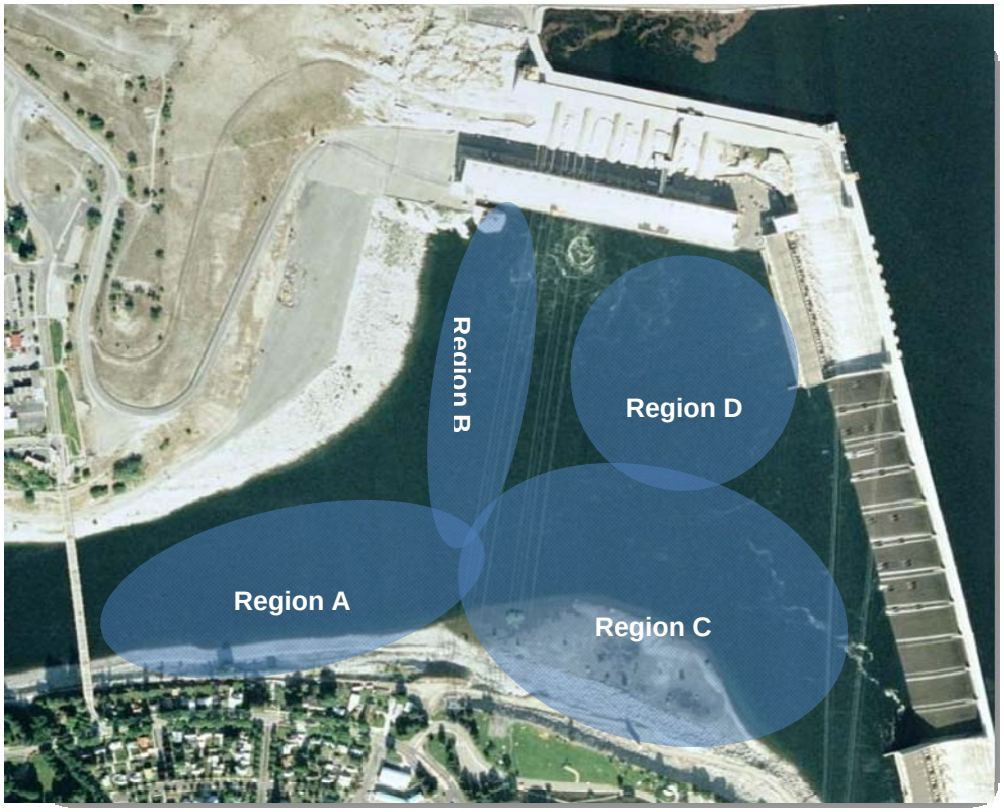

Figure 3-6. Bald Eagle use areas identified during a study performed in 1985.

These earlier bald eagle surveys also noted the following:

> "*As winter freeze-up in the Grand Coulee area eliminates the availability of their food supply, eagles are forced to concentrate in areas of remaining open water. During periods of severe cold, when major portions of FDR Reservoir freeze over, the Grand Coulee Dam afterbay and reaches of the Columbia River downstream from the afterbay provide essential open water for foraging bald eagles wintering in this area (USFWS 1985).*"

The area immediately below Grand Coulee Dam is part of a much larger foraging area used by hundreds of bald eagles that winter in the Banks Lake/Lake Roosevelt area (National Park Service 1998). Northrup Canyon, located about seven miles south of Grand Coulee Dam, is the primary communal winter roost for bald eagles in the area.

Bald eagle winter ecology is fairly well understood and is generally predictable (Stalmaster 1987). Bald eagle use of the shorelines immediately below Grand Coulee Dam likely includes resident individuals that may establish seasonal foraging territories and transient and nomadic eagles that may come and go as part of much larger territories or migratory movements. The area below the dam is believed to be used more heavily by bald eagles during prolonged periods of extreme cold – as Banks and Roosevelt Lakes freeze over – because it remains one of the last areas of open water (USFWS 1985).

Fish are the most likely food source for wintering eagles at Grand Coulee Dam (USFWS 1985). Large numbers of kokanee and trout are known to travel from Lake Roosevelt to Rufus Woods Lake below the dam (Confederated Tribes of the Colville Reservation 2000), and dead or injured fish coming out of the TPP could provide a food source for wintering eagles (Wood 1979).

Other possible food sources include winter killed deer and elk and road killed animals. The nearby presence of deer and elk winter range means that some carcasses may be available during certain years, particularly harsh winters and/or toward the end of the winter season, when overwinter mortality is highest (Stalmaster 1987).

The WDFW has mapped the area below Grand Coulee Dam as bald eagle habitat, and bald eagles regularly occur below the dam during winter months as seen in Figure 3-7. Reclamation has erected perch poles along the shores below the dam specifically for bald eagle use and the poles are regularly used during the winter months (Brougher pers. comm. 2010).

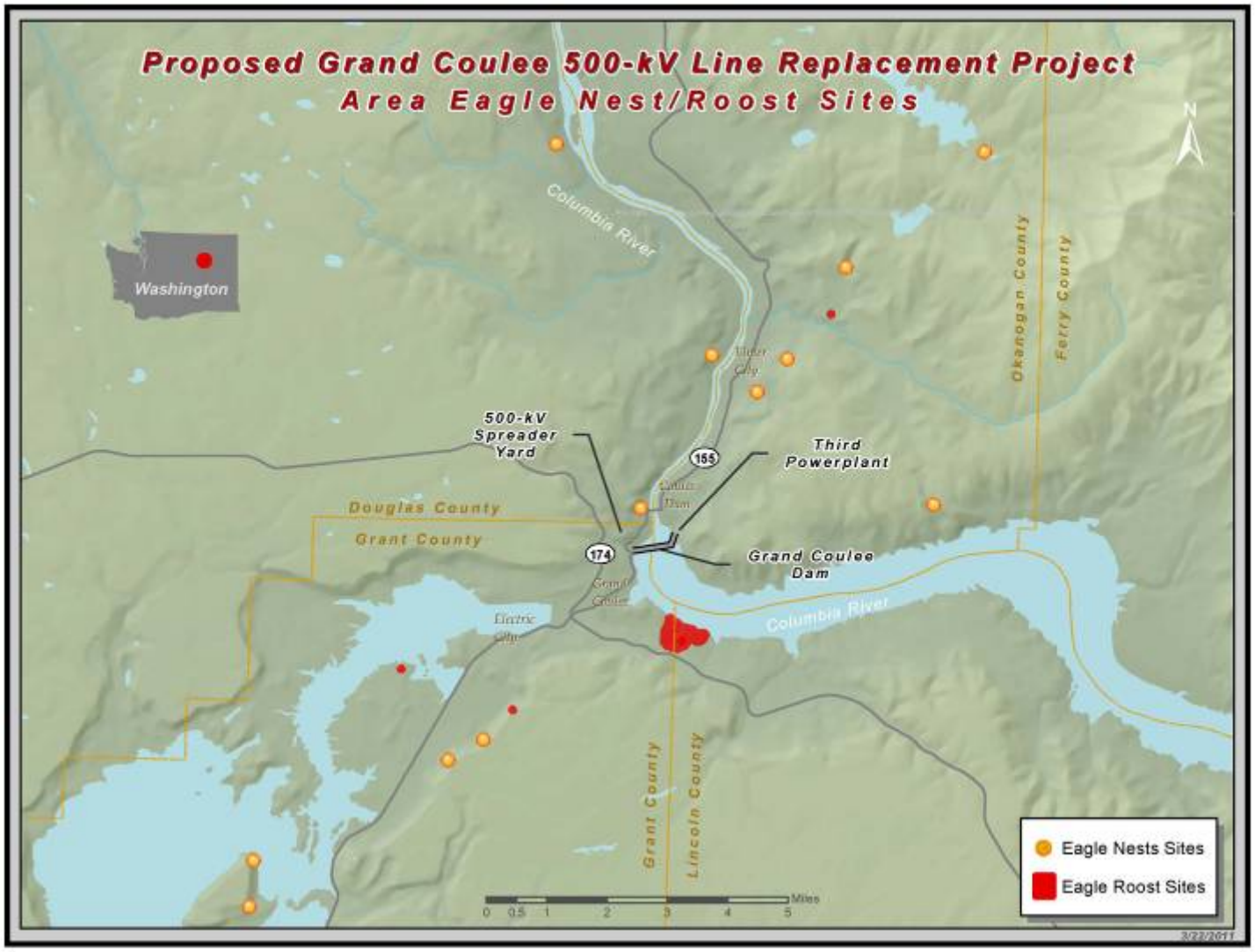

Figure 3-7. Bald and Golden Eagle Nests Sites within a 5-mile radius of the Grand Coulee Dam.

Osprey Nesting

Two osprey nest sites are located below the dam and within the area proposed for overhead lines. One is located on local utility pole just north of the TPP and the other is located on one of the backup towers on the Visitor's Center grounds. It is not known if these represent two nesting pairs or a single pair with alternate nest sites. Rarely, one male will tend to two nearby nests, each occupied by a female (Poole 1989). Since the nests are so close, they are most likely to be alternate nests for a single breeding territory. This could be confirmed during the following nesting season. Osprey nesting in Washington typically occurs between April 1 and September 30. Egg incubation takes 5-7 weeks and young take 7 to 8 weeks to fledge the nest.

Sharp-Tailed Grouse

Sharp-tailed grouse may be present in the general area, but the proposed project would occur outside of the areas mapped as occupied range. Big sage/fescue habitats on north facing slopes are potentially suitable foraging and cover habitat.

Golden Eagle and other Raptors

Golden eagles are known to nest near Steamboat State Park on Banks Lake (USBR 2010) and adults and dispersing juveniles are expected to occur within the upland areas of the Proposed Action. However, no nesting habitat is present.

Red tailed hawk and northern harriers are also likely to be present in the general vicinity with both nesting and foraging habitat present. Great horned owls are confirmed present and nesting at the mid-slope area near the existing towers.

3.3.2 Environmental Consequences – Preferred Alternative

3.3.2.1 River and Floodplain Habitat

Based on the analysis above, the following specific adverse impacts have been identified:

Construction Disturbance

Construction noise and physical disturbance would temporarily impact wildlife. Impacts would be most likely to occur during sensitive periods, such as nesting or wintering. The primary concern for construction disturbance would be for nesting osprey and wintering deer and bald eagles. For osprey, the nest site located on the north tower on the Visitor's Center grounds would be removed. This would need to be done at a time when there is no activity at the nest to avoid violation of the Migratory Bird Treaty Act and Washington State wildlife laws (*See* Mitigation Measures below). For bald eagle wintering habitats, any construction conducted from November through February of any given winter could disturb foraging and resting eagles. For wintering deer and elk, the impact that would be of most concern is severe and prolonged winter weather (especially deep snow). Such winter conditions would not coincide with any proposed construction activities as these conditions would make construction unlikely to occur.

Impacts on General Fish and Wildlife Species and Habitats

Lines spanning over the aquatic zone could interfere with or reduce aerial habitat used by birds and bats that forage or travel over the river (collisions with lines are addressed separately below). The width in which the proposed 500-kV transmission lines would span is typically 450-feet for all lines being proposed. This makes for a total over-water area of roughly 70 acres where the proposed transmission lines would be crossing the river. The area impacted would include the area immediately below the TPP, where fish killed from going through the turbines (called "entrainment" mortality) provide food for opportunistic foraging birds, such as gulls, cormorants, bald eagles, osprey, Turkey vultures, great blue herons and ravens. Birds that forage in flight (gulls, osprey) would be more affected than birds that forage from shorelines (herons) or in water (cormorant).

Other than removal of one of the two osprey nests, no impacts to wildlife would be expected from tower removal or from temporary transmission lines spanning over the Visitor's Center grounds and SR 155. Habitat that would be removed at tower locations and where existing towers would be removed would result in less than two acres. Impacts would occur at the scale of individuals and would not be sufficient to create effects at the population level. Direct habitat disturbance would alter small mammal, insect, and other communities. Effects would be limited to the site of action and habitat values would be expected to recover to previous habitat values over time.

3.3.2.2 Endangered Species Act: Listed Species and Critical Habitats

Bull trout is the only listed species likely present in the project area. Use is likely limited to transient (wandering) adults in the waters to be crossed by the proposed six 500-kV transmission lines. The only possible impact pathway identified would occur during the brief construction period, when lines would be strung from the TPP and across the afterbay. This work could include helicopters flying over water, but will not include any in-water work. The adverse effect would be limited to possibly startling and/or causing individual bull trout within the aquatic action area to hide or flee. Other possible impact pathways considered but dismissed included lubricants or cleaners used on the lines that might enter the water. However, lines are not washed (so no solvents/cleaners will be involved) and no lubricants, other than possible residues from manufacturing, would be present.

3.3.2.3 Special-Status Species and Habitats

Disturbance of native shrub-steppe habitat would result in temporary impacts of less than 2 acres and permanent impacts of less than 1 acre. Overall impacts would be limited to the site of action and individuals and would not likely adversely impact overall populations or ranges.

3.3.2.4 Avian Collisions with Transmission Lines

Birds are known to fly into human-made structures, including transmission lines, transmission towers, buildings, wind turbines, and communications towers (USFWS 2002). Avian collisions with transmission lines are known to be higher at river crossings and at known avian concentration areas and/or flyways (APLIC 1994). The Preferred Alternative involves crossing approximately 2,150 feet of open water below Grand Coulee Dam. This area is used by bald eagles during winter.

Bald eagles collisions with transmission lines was a concern in the 1980s when Reclamation was consulting with the USFWS for Endangered Species Act compliance for overhead transmission lines associated with the Right Powerplant -- lines that now cross in front of the main spillway of the dam. Reclamation records include no reports of bald eagle mortality from these lines during their 25 years of service to date, but Reclamation also has no record of bald eagle monitoring for mortality during that time.

Based on a review of the literature and analysis prepared for this EA, individual birds that have established regular foraging territories are likely to be aware of the lines and avoid them. This includes wintering bald eagles, nesting osprey and resident great blue herons, cormorants and gulls. Young birds and nomadic birds unfamiliar with the area would be at greater risks for colliding with lines, particularly during poor visibility, such as during nighttime or fog.

While the exact level of mortality cannot be predicted with accuracy due to the many variables involved, several factors point to a conclusion that significant mortality would not occur. First, the proposed lines would be visible to birds except during darkness and foggy conditions. The lines would be triplex conductors, meaning that each conductor would include three cables connected with spacers every few hundred feet. In addition, the lines would be located in a fairly dense array that would likely be clearly visible to birds. The proposed addition of more lines would increase the area that these lines occupy but would also increase the visibility of the lines. Second, the fact that existing lines do not seem to be causing significant mortality suggests that bird populations can adjust to lines in this area without significant population losses.

The primary concern would be associated with ground wires, which would be less visible than the proposed transmission lines due to their narrow diameter (about a half-inch). Ground wires are also strung as individual wires above the main transmission lines as seen in Figure 2-1. These lines would pose the greatest risk to birds as immature or nomadic birds unfamiliar with the area would be at greatest risk of colliding with the proposed overhead lines.

Based on these considerations, the Preferred Alternative is expected to increase the risk of avian mortality and would likely result in some birds striking the conductors or ground wires over time, including birds protected under the Migratory Bird Treaty Act and Bald and Golden Eagle Protection Act. Avian species most at risk have been identified to be immature and nomadic individuals. The overall level of mortality is expected to be similar to existing levels, which the evidence suggests is low. Overall impacts are likely to limited to individuals and would not cause significant population-level mortality.

3.3.3 Mitigation Measures

Construction disturbance could be avoided by the following timing restrictions:

- Avoid construction during long periods of cold, or whenever deer, elk and bald eagles are concentrated in the area.
- Remove the osprey stick nest from the north tower only when there is no activity at the nest. Avoid disturbance during the nesting season from April through August of any given year. The nest site could be replaced with an artificial nesting platform.

Additionally, Reclamation and BPA are currently consulting with the USFWS to obtain an incidental take permit (if required) for possible or potential harm caused to bald or golden eagles, including possible incidental mortality through collisions with lines. In addition, an Avian

Protection Plan may also be prepared in consultation with the USFWS to address impacts on bald and golden eagles, osprey, and other species protected under the Migratory Bird Treaty Act.

3.3.4 Unavoidable Impacts Remaining After Mitigation

Birds are known to collide with transmission lines and the risk of migratory birds – including bald and golden eagles – hitting the line over water or within terrestrial habitats on the upland portion of the project cannot be eliminated. Monitoring could be used to identify mortality problems with the proposed transmission lines and corrective actions, such as line marking or bird aversion structures, could be taken if mortality is found to be a problem. Monitoring details would be identified within the preparation of an Avian Protection Plan or Bald Eagle Incidental Take Statement (if required) as prepared by the Reclamation and BPA in coordination with the USFWS.

Aerial interference from the presence of increased transmission lines within known foraging areas for bald eagles and ospreys would result in unavoidable losses in foraging habitat quality or quantity. Additional perches or other habitat improvement could be added to help offset this loss.

Specific adverse impacts on species or designated critical habitat under the Endangered Species Act would be limited to possible startling of bull trout, a threatened species that may be present as wide-ranging individuals. The risk of startling an individual bull trout cannot be eliminated, but the overall risk of "take" of bull trout in the form of actually harming individuals is unlikely (the Proposed Action may affect, but is not likely to adversely affect).

The Preferred Alternative would have no effect on other listed species or designated critical habitats.

3.3.5 Cumulative Impacts

Potential startle effects on threatened bull trout would not be of sufficient duration or extent to contribute to cumulative effects that may be affecting recovery of the species.

Construction and operation of storage buildings for the TPP overhaul project could cause some disturbance to wintering bald eagles that would be additive to effects caused by the Preferred Alternative.

Construction noise and activity could disturb nesting osprey and wintering elk and deer.

The osprey nest located on the north tower on the Visitor's Center grounds would also need to be removed. Removing this nest during the nesting season is prohibited under the Migratory Bird Treaty Act and Washington State law.

Increasing the number of transmission lines that span over the aquatic zone could interfere with or reduce aerial habitat used by birds and bats that forage or travel over the river.

Increasing the number of transmission lines could also increase the risks of avian collisions with power lines. Immature and nomadic birds would be more at risk than seasonal and year-round resident individuals.

3.3.6 Environmental Consequences – Alternatives

3.3.6.1 Overhead Alternatives

The other Overhead Alternatives (Alternatives 1, 3, and 4) would involve three more towers to be constructed when compared to the Preferred Alternative. These towers would be located mid-slope on the upland slope area, resulting in more localized habitat impacts than the Preferred Alternative, where the mid-slope area would be spanned.

All alternatives involve the same number, width, and length of transmission lines. However, the Preferred Alternative, while lowest to the water, also has the lowest overall vertical profile and total height. In terms of overall impacts to bald eagle, osprey and other bird habitat or risks of collisions, the other overhead alternatives would be expected to result in similar effects as the Preferred Alternative

3.3.6.2 Rebuild Alternative

The Rebuild Alternative would not require towers to be constructed nor existing towers to be removed. Access roads to existing towers may be reopened during construction, since the backup transmission lines would likely be used maintain power transmission. This would involve mostly disturbed habitats along the roadway, including areas that had eroded due to the previous construction and areas needed to provide additional tunnel access points.

3.3.6.3 No Action Alternative

Under the No Action Alternative, no direct impacts on wildlife would occur immediately. A fire or other major incident within one of the tunnels containing the current transmission lines could require ground disturbing actions in response. Over time, roads to existing towers may need to be repaired for access, which would result in similar impacts as those described for the Preferred Alternative.

3.4 Geology and Soils

3.4.1 Affected Environment

Grand Coulee Dam is located at the geological boundary between the Columbia River Plateau to the south and Okanogan Highlands to the north. Unlike the Columbia Basin immediately south, the project area contains no thick layers of basalt but rather it is composed of three distinct formations:

1. river terrace
2. fine-grained slopes (ancient glacial lake deposits)
3. granite outcrops

River Terrace. Along the river terrace, shorelines below the dam have been extensively modified, including large amounts of rip-rap installed for bank stabilization. Within the proposed alignment, the river terrace consists of a broad floodplain and a rip-rap terrace leading to the graded lower parking and lawn area of the Visitor's Center.

Fine-Grained Slopes. The Visitor's Center itself is built upon the toe of a slope composed mainly of silts and fine sands deposited during periods of glacial advance. While general geologic maps (NRCS 2010) show deposits in this area to be glacial, site reconnaissance has shown soils to be ***varved silts***, in which fine soils are hundreds of feet deep deposited in glacial lakes (Cook pers. com. 2010). Varved silts are highly erodible on exposed, disturbed ground by both wind and water. Drill logs show sands and other deep glacial deposits on the slopes and at the site of the present day Visitor's Center (USBR 1971).

The slope toe has been extensively graded to create SR 155 as well as the Visitor's Center and associated park, creating a series of terraces leading to the river. The Visitor's Center grounds are composed of two graded areas separated by a slope. The Visitor's Center building is placed at the top of this intermediate slope and has experienced some down slope creeping.

Two existing backup towers are present on the lower, graded area of the visiting Center, two at mid-slope, and two at the top of the hill just behind the Spreader Yard. Near the top of the hill adjacent to the Spreader Yard are rock outcrops of hard granite.

Granite Outcrops. Granite outcrops are prominent geologic features in the area, including two that serve as right and left abutments to the dam, as well as Crown Point, a visually impressive outcrop behind the Visitor's Center and town of Grand Coulee Dam. However, no exposed granite is present in areas proposed for towers.

Erosion/Landslide Hazards. The steep, fine-grained slopes above the Visitor's Center are the most notable erosion hazard, as fine grained materials tend to be susceptible to water or wind erosion and steep slopes are subject to gravity movements.

Historically, numerous landslides have occurred along the shorelines of the Columbia River in northeast Washington State, and especially along the shoreline of Franklin D. Roosevelt Lake, the reservoir impoundment behind Grand Coulee Dam. One large slide occurred in March 1934 during the initial construction work for the dam, and affected the downstream (tailrace) area on the left abutment side of the dam, which is in the same general vicinity of the new support towers

and replacement lines. The literature indicates that the treatment measures that have been installed in this area by Reclamation from 1934 through 1953 have been successful and the Bureau's engineering staff now considers this slide area to be stabilized (Jones et al. 1961; Hansen 1989).

Evidence of erosion is present in this area (another indicator of potential erosion issues) with several small slumps occurring along the access roads to the existing mid-slope tower sites (Kerry pers.comm.). The access roads were cut into the slopes, and the uphill cut slopes have eroded in places, with crescent-shaped leading edges eroding up the hill, and loose sands forming unstable hills leading to the road. Most eroded areas are too unstable to support vegetation.

The combination of fine-grained soils, steep slopes and existing evidence of erosion and soil movements calls for some caution in design, siting, and construction of the proposed new tower structures.

3.4.2 Environmental Consequences – Preferred Alternative

3.4.2.1 Geology and Soils

Erosion is the primary issue related to soils and geology for the Proposed Action with primary focus on the fine-grained soils on slopes above the Visitor's Center. The following sections evaluate specific soil-disturbing components of the Preferred Alternative.

Tower Footings Graded to Flat Bench. Under the Preferred Alternative, the first set of towers (i.e., closest to the river) would be constructed near the base of the slope and just uphill from an abandoned railroad grade. Since this nearby area had been previously graded and compacted, BPA engineers and geologists have determined that this area is suitable for tower foundations needed to support the relatively tall, double-circuit towers proposed under the Preferred Alternative.

Design-level engineering and geotechnical investigations have not yet been completed. However, based on the known fine- grained sedimentary substrates, BPA engineers are envisioning towers foundations to be either drilled shaft or grillage installations. Existing tower sites are graded to a flat bench. New tower sites would also be graded to a flat bench. Excavated material would be hauled to disposal sites near the toe of the hill above the highway.

Under the Preferred Alternative, the primary concern for erosion would be if cuts are required into the slope to make sufficient base area for the towers. Such cuts on existing roads in the area have caused slump erosion, and excavations along the railroad grade may be at risks of similar results.

Existing Access Roads Expanded. Access roads would need to be widened and hardened to provide access to drills, augers, cranes, and other equipment. As with the tower foundation areas, the primary concern would be any cutting into the hillside.

Line Pulling Sites and Staging Areas. As shown in Figure 2-3, staging areas would be established to store and organize construction materials. Final staging areas and work sites have been initially selected at the time this report was prepared, but may change and/or vary prior to any construction activities commence assuming that this Project is approved. Based on available open areas, possible staging areas and material yards include areas within Reclamation's current warehouse yard associated with the Grand Coulee Power Office as well as potential areas in and

around the TPP complex. Additional staging areas and temporary material yards would be located in and around the 500-kV Spreader Yard on the bench, where level ground greatly reduces erosion potential.

Soils located near identified line pulling areas and staging areas will be compacted during construction, thereby affecting soil productivity, reducing infiltration capacity, and increasing runoff and erosion.

Erosion Hazards. The Preferred Alternative would require grading and excavations for towers as well as subsurface drilling/auguring should drilled shaft tower attachments be used. This would result in exposed fine grained soils and silts and the potential for being moved by wind, rain and/or gravity. The primary concern for erosion would be slumping at the leading edge of cuts made with the existing sloped surface, based on the fact that this type of erosion is already occurring in the Project Area.

Landslide Hazards. Landslides are generally not expected in this area because, while localized sloughing is present, the area has no history of landslides (Bjorkland pers.comm.) nor is evidence of mass wasting readily visible on the surface, as documented in field surveys.

The slopes above the Visitor's Center have been disturbed in several places including roads and the existing tower location without triggering large soil movements. Design-level engineering would determine the appropriate foundation type based on site-specific sampling. If necessary, pile foundations provide a proven technology for safe construction within sedimentary soils.

Soil Productivity. Sandy soils in the area have shown difficulty in reestablishing vegetation on disturbed areas, particularly where slopes are present.

Soil Permeability. This issue is closely related to storm water runoff. Available surface soil information suggests the soils contain a high percentage of silt which may require testing prior to selecting on-site infiltration for storm water treatment.

Farmland Soils. No farmlands or associated features such as irrigation systems are present within the site of action. All project facilities would be constructed on federal lands managed by Reclamation as part of the Columbia Basin Project. No additional analysis of farmlands is required to understand that no impacts would occur as a result of the Preferred Alternative.

3.4.2.2 Indirect Impacts

Storm water Flows. Storm water would be managed by design-level drainage systems that avoid channeling water to unstable soils or slopes. Storm water impacts would be adequately addressed through a Hydraulic Project Approval (HPA) that would include design-level review of soils, drainage, and storm water management.

In-water work and Sediment. The Preferred Alternative would not involve in-water work, nor would it involve ground disturbing activities within 200 feet of the Columbia River.

Critical Land Use Areas. No areas have been identified as Landslide Hazard Areas under Grant County's Critical Areas Ordinance.

Blasting. No blasting would be required as the sediments where the proposed towers and roads would be located are composed of fine-grained soils.

3.4.3 Mitigation Measures

While existing engineering protocols would likely adequately address landslide and erosion issues, two option measures have been identified that would increase accountability and reduce the likelihood of design-level oversights related to erosion. The first option involves the preparation of a technical report by a qualified geologist/geotechnical engineer that specifically addresses slope stability and erosion. This plan would then be incorporated into construction and contract documents. Additionally, if detailed geotechnical investigations indicate potential for slope instability at project facilities, ensure that design of these facilities included proper engineering to account for this risk or relocate the facilities on-site to avoid this risk. Secondly, this geotechnical plan would specify performance standards, monitoring and reporting for effectiveness of erosion control as part of an Adaptive Management Plan. Other mitigation measures related to soils and erosion issues include:

- For construction stormwater activities located in the State of Washington, the U.S. Environmental Protection Agency (EPA) has retained enforcement and permitting authority for Federal facilities. BPA would prepare and implement a Storm Water Pollution Prevention Plan (SWPPP) to control storm water pollution associated with construction activities. The SWPPP would be prepared to meet the requirements of the EPA Construction General Permit (CGP) of the NPDES permitting program. The SWPPP addresses project requirements utilizing low impact construction methods and project-specific erosion and sediment control measures. Best Management Practices (BMPs) for erosion control for the various activities will be developed. The BMP specifications to be utilized are taken from The Department of Ecology's "Stormwater Management Manual for Eastern Washington, Chapter 7, Sept. 2004, Publication 04-10-076. As part of the SWPPP, a Spill Prevention and Response section will also be prepared to address petroleum and hazardous materials handling and management procedures for this project.
- Limit clearing, excavation and grading to those areas of the project site absolutely necessary for construction of the project. Areas outside the construction limits would be marked in the field and equipment would not be allowed to enter these areas or to disturb existing vegetation and soils.
- Store additional erosion control supplies, including sandbags and channel-lining materials, on site for emergency use.

3.4.4 Unavoidable Impacts Remaining After Mitigation

Even with site-specific planning and adaptive management under the optional measures above, some erosion would be inevitable at tower construction sites and along access roads, and staging/line pulling areas. With site-specific planning, erosion would likely be limited to isolated points along roads or at cuts made for tower foundations on the lower hill.

Risks of a project-generated landslide would be mitigated through design-level engineering. Existing towers have proven to be successfully installed at mid-slope and proposed towers—though larger—would be located at more stable locations above the top and near the toe of the slope. Site conditions do, however, increase the reasonableness of additional precautionary measures, as noted in the following mitigation measure.

3.4.5 Cumulative Impacts

While agriculture has significantly altered soils throughout eastern Washington, the Preferred Alternative is not at a scale that is relevant to such regional discussions and efforts.

Cumulative effects do come into play at the site level, as soils in the Project Area have been previously compacted and graded. These previous activities include the construction of the Visitor's Center and TPP project in the late 1970's as well as the installation of backup transmission lines and access roads in response to the tunnel fire in the 1980s.

The Project would add impervious surfaces and total disturbed area to the drainages and slopes located between the Visitor's Center and Spreading Yard.

3.4.6 Environmental Consequences – Alternatives

3.4.6.1 Overhead Alternatives

For erosion potential, the Preferred Alternative is considered to be the environmentally preferred alternative. The Preferred Alternative would require three fewer towers than the other overhead alternatives being proposed. The proposed locations for the Preferred Alternative are near the foot and behind the top of the hill behind the Visitor's Center (*See* Figure 2-2). Both areas present fewer challenges from an erosion and slope stability standpoint than the more central locations required under Alternatives 1, 3 and 4. Since, Alternatives 1, 3, and 4 would require these mid-slope towers to be erected; these alternatives also have the potential to increase the likelihood of erosion.

3.4.6.2 Rebuild Alternative

Under the Rebuild Alternative (Alternative 5), soils near the existing facilities within and near the dam would likely be disturbed as part of required upgrades to the system, including exits and fire systems within the tunnel.

3.4.6.3 No Action Alternative

Under the No Action Alternative, no impacts on soils or geology would occur immediately. However, a fire or other major incident within one of the tunnels containing the transmission lines presently installed could require ground disturbing actions in response.

3.5 Water Resources, Wetlands, and Fisheries

3.5.1 Affected Environment

No wetlands or perennial streams are present within the project vicinity. However, several intermittent stream channels are present on the slopes above SR 155.

Rivers and Floodplains. The Columbia River is the primary water feature within the Project Area boundaries, and under all action alternatives, six 500-kV transmission lines would cross the river immediately below the dam. The Columbia River has inventoried shorelines within the State of Washington as referenced in WAC 222-16-031. As such, it is also a "Type 1 Water," which means all waters, within their ordinary high-water mark, as inventoried as "shorelines of the state" under chapter 90.58 RCW and the rules promulgated pursuant to chapter 90.58 RCW.

Wetlands and Streams. No wetlands or perennial streams are present within the Project vicinity. Washington DNR stream-typing maps indicate intermittent streams on the slopes above SR 155. Intermittent streams and drainages are located within the hillsides located above the Visitor's Center. These channels are within the "Type 5 Waters" classification, which is defined by WAC 222-16-031 as all segments of natural waters within the bank full width of the defined channels that are seasonal, non-fish habitat streams in which surface flow is not present for at least some portion of the year. Based on field inspections of stream channels, flows appear to be most likely during storm events, while otherwise these channels are dry. While surface flows and shading likely contribute to higher soil moisture in these channels (as evidenced by shrubby vegetation in portions of these dry channels), saturation levels and vegetation present does not meet the criteria for wetlands, with no wetland obligate plants and several upland obligate plants present within or near to these channels.

Water Quality. Water quality concerns related to the Proposed Action include sedimentation from erosion and oils and potential insulating oils associated with removal of the internal oil-filled lines proposed to be replaced under the Proposed Action.

Water quality conditions in the Columbia River below Grand Coulee Dam, also known as Rufus Woods Lake, include elevated water temperature (Ecology 2009a). Total dissolved gas levels (TDG) also exceed standards at times when water is spilled over the spillway at the dam.

Grand Coulee Dam is identified as a Medium Quantity Generator of Hazardous/Dangerous Wastes (Ecology 2009a). These wastes are generated as part of the facility's Operation and Maintenance (O&M) and include waste paints, solvents, used oils, lead, and asbestos (USBR 2009, Ecology 2009b). PCB levels are less 1 mg/L (ppm) within oil-filled lines associated with turbine generator G-19, but all of the other oil-filled lines do not contain any PCBs.

3.5.2 Environmental Consequences – Preferred Alternative

The scope of impacts on water resources has been divided into five issues: aquifers and water quantity; wetlands, streams and floodplains; storm water; and water pollution and water quality.

Aquifers. Proposed overhead transmission lines would not require a new water source. Water use would be limited to that used for dust control during construction. Total impervious surface would be less than 8.1 acres, an area too small to affect groundwater recharge at levels meaningful to aquifers (for Alternatives 1, 3, and 4). The Preferred Alternative would have little

to no effect on underlying aquifers, with 5.4 acres of impervious surface and all storm water being contained and infiltrated onsite.

Wetlands, Streams, and Floodplains. All overhead alternatives include six 500-kV transmission lines crossing the Columbia River and its floodplain. No in-water work would be conducted. No wetlands or perennial (permanent) streams are present within the Project Area. Intermittent drainages would be spanned. No trees, riparian or wetlands vegetation would be removed.

All overhead alternatives would require spanning of the Columbia River and its floodplain, but no work would be required in-water or within the floodplain. The floodplain is currently sparsely vegetated, but over time, willows and other riparian species could grow sufficiently tall to need to be pruned or removed.

Under the Preferred Alternative, the lowest conductors would be approximately 80 feet above the floodplain shoreline. Trees would not be allowed to grow to more than 30 feet underneath alignments within the floodplain. No trees are currently present in this area.

Storm water. Much of the Project Area is composed of glacially-deposited silts and other sediments, so storm water runoff will need to be managed wherever fine soils will be disturbed (e.g., tower foundations, access roads, and staging/tensioning areas), particularly in areas with steep slopes.

Fine, silty soils in the slopes above the Visitor's Center are at risk of being carried away by storm water and into intermittent channels. Tower footings would be located on flat benches constructed by excavating and grading the silts and fine sands that compose the hillside, as was done for the existing backup towers.

Topography would be altered at tower foundations, where topsoils would be removed and underlying sands and silts graded to flat benches. Compacted soils and impervious surfaces would generate storm water that may drain off constructed areas.

Water Pollution and Quality. Overhead line construction and operations would not involve contaminated soils or hazardous materials other than that standard for construction (e.g., fuels and lubricants for heavy equipment). Removing the existing oil-filled transmission lines would involve removal and disposal of these insulating oils.

Risks of spills during removal of the oil-filled lines are present for all proposed alternatives (Alternatives 1-5) except for the No Action Alternative. The preparation of a Storm Water Pollution Prevention Plan (SWPPP) to control storm water pollution associated with construction activities will also include a Spill Prevention and Response section to address any petroleum and hazardous materials handling and management procedures for this project. These Plans will be prepared by BPA and will be handled by the Washington Department of Ecology.

Additionally, a Hydraulic Project Approval (HPA) may also be required from the Washington Department of Fish and Wildlife (WDFW). If needed, the HPA review would include design-level review of construction plans to ensure that significant adverse impacts to Waters of the US would be avoided.

3.5.3 Mitigation Measures

While existing engineering protocols would likely adequately address drainage, two option measures have been identified that would increase accountability and reduce the likelihood of design-level oversights related to drainage. First, during the final design stage, prepare construction-level storm water drainage plans for each area where soils would be disturbed. Secondly these plans should specify performance standards, monitoring and reporting for effectiveness of storm water management as part of an Adaptive Management Plan. These plans would include mitigation measures as follows:

- Prepare and implement a Storm Water Pollution Prevention Plan (SWPPP) prior to construction of the proposed project to lessen soil erosion and improve water quality of stormwater run-off. The SWPP will be developed to prevent movement of sediment off-site to adjacent water bodies during short term or temporary soil disturbance at construction sites. The plan addresses stabilization practices, structural practices and stormwater management (as outlined by Section 402(p) of the Federal Clean Water Act and Chapter 90.48 RCW of the State of Washington's Water Pollution Control Act).
- Protect slopes less than 3:1 with silt fencing as appropriate. Silt fences would be installed in locations where they would trap silt eroded from slopes during construction and prior to reestablishing vegetation. The maximum flow path to each silt fence would be approximately 100 feet. No concentrated flows greater than 1 cubic foot per second would be directed toward any fence for the 25-year storm. Silt fences would be maintained throughout the construction period and beyond, until disturbed surfaces had been stabilized with vegetation. Silt fence construction would be determined by local construction conditions during final design of the facilities.
- Utilize the appropriate erosion control blankets designed for various weather conditions during the construction period, such as straw or jute matting or other suitable erosion control blankets, on any disturbed slopes to prevent erosion and control sediment migration.
- Design sediment control measures used during construction based on 10-year design storm specifications. Water quality measures (other than sediment removal) would be based on the 6-month, 24-hour design storm.
- Utilize sediment traps to intercept stormwater runoff and allow sediment to settle, thereby minimizing the amount of sediment flowing off site. Sediment traps would be sized for the specific disturbed area, for bare soil conditions, and typically for 75 percent sediment removal efficiency.
- Implement and emphasize erosion controls over sediment controls through non-quantitative construction activities such as:
  - Straw mulching and vegetating disturbed surfaces
  - Retaining original vegetation wherever possible
  - Timing grading operations to dry seasons
  - Directing surface runoff away from denuded areas

- Keeping runoff velocities low through minimization of slope steepness and length
- Providing and maintaining stabilized construction entrances

3.5.4 Unavoidable Impacts Remaining After Mitigation

Localized changes in storm water drainage and hydrology, including storm water flowing from compacted soils to predetermined infiltration areas would be unavoidable. Turbidity and sedimentation impacts would be most likely to occur during construction should a rainstorm hit when soils are exposed. Such risks would be temporary, being limited to the construction period of approximately 6-9 months. Seasonal restrictions may be identified as part of the HPA (if needed) to further minimize risks of storm water events during construction.

Even with optional mitigation (site-specific planning and adaptive management), some erosion would be inevitable at tower construction site and along access roads, and staging/tensioning areas. With site-specific planning, erosion would likely be limited to isolated points along roads or at cuts made for tower foundations on the lower hill and would not result in sediments being discharged into surface waters.

3.5.5 Cumulative Impacts

The proposed line replacement project would have no effect on ongoing cumulative impacts related to elevated water temperatures and TDG.

3.5.6 Environmental Consequences – Alternatives

3.5.6.1 Overhead Alternatives

With respect to drainage, Alternative 2 is the environmentally preferred alternative. All other alternatives would require three additional towers located at mid-slope above the Visitor's Center and associated construction disturbance for tower foundations, construction areas (e.g., places for a crane and other heavy equipment), access roads and staging/tensioning areas.

3.5.6.2 Rebuild Alternative

The Rebuild Alternative would not require towers to be constructed nor existing towers to be removed. No new water sources would be needed, and no construction would take place in-water or within the floodplain. Under this alternative, oil-filled transmission lines would be removed as under the Preferred Alternative with impacts addressed through specific plans developed in consultation with the Washington Department of Ecology.

3.5.6.3 No Action Alternative

Under the No Action Alternative, oil-filled lines could rupture and/or catch fire, resulting in possible releases to the Columbia River and/or ground waters. No impacts on water would occur immediately. A fire or other major incident within one of the tunnels containing the transmission lines presently installed could result in releases of insulating oil or other toxins to the ground and/or water.

3.6 Land Use

The proposed overhead transmission lines would be constructed below Grand Coulee Dam, generally following the path of existing backup lines, which would be removed. Proposed lines would cross over the open waters below the dam, the Visitor's Center, State Route 155, and an undeveloped slope to reach existing 500-kV towers. Total length would be about one mile (5,180 feet). The Town of Coulee Dam is located north of proposed lines (one segment of proposed lines would cross over lands incorporated by the Town). Nearby land uses include a hotel located about 55 feet north from proposed lines and residential properties starting about 475 feet away.

Reclamation received several public comments regarding the original Proposed Action related to land use:

- Proposed overhead lines would be too close to a single family home, a hotel, and the Visitor's Center;
- Proposed towers on Visitor's Center grounds would impact the popular laser show and the Independence Day festival held annually on the grounds;
- Proposed lines would eliminate the public tour of the TPP; and,
- Proposed towers and lines would reduce visitation and the associated spending that is critical to local community.

3.6.1 Affected Environment

3.6.1.1 Existing Land Ownership

Proposed transmission lines would be contained to federal lands except for the crossing of one strip of private land (that ranges from 20 to 60 feet wide). This private strip of land is owned by the Columbia River Inn LLC. The land is unoccupied except for a billboard advertising the Columbia River Inn.

Proposed transmission lines would be located within Section 1, Township 28, Range 30. This section also contains Grand Coulee Dam, the Visitor's Center, and the Reclamation office and maintenance compound. Within that above section, the land is further divided out by parcels. The majority of the Proposed Action will occur within the Reclamation-owned parcel (Grant County Assessor's Office #182116000) which covers almost all of this section. The federally-owned parcel contains 48 acres of developed ("improved") and 272 acres of undeveloped land, in addition to open water areas above and below the dam (Grant County 2010). As described earlier, the proposed lines would also cross over a parcel owned by Columbia River Inn LLC. Additionally, the proposed lines would pass very close to a third parcel that is owned by the Town of Coulee Dam. This parcel is undeveloped.

The Washington State Department of Transportation maintains a Highway right-of-way for State Route 155.

Bureau of Reclamation

As established under Land Ownership, the majority of the proposed transmission lines (97% by length) would be located on federal lands designated for use by Congress under:

- National Industrial Recovery Act of 1933, which allocated funds for Grand Coulee Dam.
- Rivers and Harbors Act of 1935 authorized construction of the dam.
- Columbia Basin Project Act of 1943 (57 Stat. 14), reauthorized the project, bringing it under the provisions of the Reclamation Project Act of 1939.
- Public Laws 89-448 (80 Stat.200) and 89-561 (80 Stat. 714) of 1966 authorized construction of the TPP.

The federal lands containing Grand Coulee Dam, the Visitor's Center and areas that are being proposed for new towers and overhead lines are not covered under the Banks Lake Resource Management Plan or the Lake Roosevelt National Recreation Area General Management Plan. Rather, Reclamation manages the dam and surrounding lands as a facility -- developing specific plans as needed to maintain the primary purposes of Grand Coulee Dam: provide for flood control, provide irrigation water, manage flows for fish habitat, generate electricity, and provide for recreational opportunities. Recreation and public access is provided where compatible with these primary purposes, including the Lake Roosevelt National Recreation Area and Banks Lake. While the original authorizations did not specify or fund any recreational facilities at the dam itself, Reclamation has long provided parking and viewing areas to accommodate visitors.

With the TPP (Public Law 89-448), Congress authorized and funded the Visitor's Center. Reclamation intended the TPP project and associated Visitor's Center to become a "*showplace for the scenic and recreational opportunities*" provided by the Columbia Basin Project. The eventual inclusion of the Incline Elevator, bridge and public viewing balcony used for the TPP public tour and the Visitor's Arrival Center, were key elements of the TPP master plan to provide public use and enjoyment of Grand Coulee Dam.

Confederated Tribes of the Colville Reservation

The TPP is located within The Confederated Tribes of the Colville Reservation. Colville Indian Reservation lands begin on the north side of the river in Okanogan County and extend out 1.4 million acres (2,100 square miles) primarily in Okanogan and Ferry counties. The Tribe manages land and shoreline uses and environmental protection through the *Colville Tribal Law and Order Code1, Title 4 Natural Resources and the Environment.* The Confederated Tribes of the Colville Reservation also has jurisdiction to enforce the tribal hydraulics project permit system in order to protect fish and wildlife and the waters of the reservation. A tribal hydraulics permit may be required in conjunction with the WDFW Hydraulics Project Approval.

Okanogan County

The TPP is also located within Okanogan County. The County's Comprehensive Plan does not define land use designations, or conditional or prohibited uses within The Confederated Tribes of the Colville Reservation and generally defers land and shoreline use considerations on reservation lands to the Colville Tribe.

Grant County

All proposed tower locations and most of the lands that would be crossed by proposed lines are within unincorporated Grant County. Based on discussions with the Grant County Planning Department, the county's comprehensive plan and land use zoning regulations do not apply to federal projects on federal lands, and therefore, would not apply to the Proposed Action (Rettig pers. comm..). The project would also be exempt under the county's Shoreline Master Program (UDC Title 24.12), as would be documented by a shoreline exemption to be issued by the county prior to project construction.

Town of Coulee Dam

Proposed lines would cross over or near to three parcels located within the Town of Coulee Dam.

The Visitor's Center building is located on a 1.07-acre parcel owned by Reclamation and within the Town of Coulee Dam. Two of the three double-circuit lines would cross over this parcel, covering approximately 150 linear feet, which is about three percent of total length of proposed lines (±5,780'). The Town of Coulee Dam manages land use via a Comprehensive Plan and zoning ordinance. The parcel is identified as "Government Entity" within those plans; The Town does not define allowable, conditional or prohibited land uses on federal lands.

A portion of SR 155 that would be crossed by proposed lines is also within the Town of Coulee Dam, as discussed under *Other Rights-of-Way* below. Finally, the strip of private land that would be crossed is located within the Town of Coulee Dam (as described in the Existing Land Ownership section). Reclamation holds existing rights-of-way for the backup lines that cross over this parcel.

Other Rights-of-Way

State Route 155 is the main north-south highway of the Grand Coulee Dam area. The transportation right-of-way is granted to the Washington State Department of Transportation.

Approximately half of the conductors would cross the highway over federal lands, while the northern half crosses the highway over non-federal lands. SR 155 and Grand Coulee Dam are also part of the *Coulee Corridor National Scenic Byway* administered by WDOT and the *Ice Age Floods National Geologic Trail*, which is administered by the National Park Service.

3.6.1.2 Existing Land and Shoreline Use

Adjacent Land Use (non-federal lands)

Non-federal land uses are located north of the proposed transmission corridor within the Town of Coulee Dam and include a motel (55 feet north at its closest point), a gas station (185 feet north), and a residence (475 feet north).

Commercial. Adjacent commercial properties include a Mini Mart, the Columbia River Inn, and CJ's Mini-Storage. The owner of the Columbia River Inn submitted scoping comments that the proposed lines would harm their business. The existing backup lines go over or nearly over the motel's swimming pool.

Rooms at the hotel are oriented toward the Visitor's Center and the TPP. Views from this location currently include the existing backup lines and towers.

Between commercial and residential land uses is a triangular area used for commercial storage, state highway department garages and emergency services buildings, including the Town of Coulee Dam fire station. Additionally, a utilities strip is located near the shoreline, which contains a shed owned by Reclamation as well as utility lines and trees and a lawn area which separate the Visitor's Center grounds and the proposed transmission corridor from residential areas.

Residential. The west Grand Coulee Dam residential area begins approximately 150 feet from the edge of federal land and approximately 275 feet from the northern backup tower and 475 feet from proposed lines. The community is characterized by historic, cottage-like homes, many of which were built to house engineers that worked on the construction of the dam. Residences of most interest for this project are 10 single-family homes located above the shoreline (between SR 155/Columbia Avenue and the river). Residences north of the bridge and east of SR155 are outside of the primary viewshed of the dam.

Reclamation Land Use

This section describes existing land use on Reclamation lands being evaluated for proposed lines and towers.

Grand Coulee Dam Facility. Grand Coulee Dam serves three primary purposes: power generation, flood control, and irrigation. The underlying purpose of the proposed line replacement project stems from the first purpose - electrical power. Grand Coulee Dam is the largest single electrical generating complex in the United States, meeting much of the Pacific Northwest's energy needs. Peak capacity is 6,809 megawatts; and, the average annual output is 2,300 megawatts which is enough energy to power three cities the size of Spokane.

The dam contains three powerplants:

1. The **TPP** generates more power than the other plants combined: three generators rate at 600 megawatts each and three at 805 megawatts each.
2. The **Left Powerplant** of the original dam, located left side of the dam, and
3. The **Right Powerplant**, also original, located right side of the dam.

Grand Coulee Dam Visitor's Center Grounds. The Visitor's Center provides exhibits and interpretive staff for the visiting public. The center was constructed in 1977 in conjunction with the TPP and opened in 1978. The interior and exhibits were completely revised in 2005-2006. The upper parking area is the primary viewing area for the dam and laser light show. The lower grounds provide less crowded viewing, picnic tables and an open lawn area that is used for the annual Festival of America.

The Visitor's Center includes the following features:

Upper grounds:

1. Grand Coulee Dam Visitor's Center (with exhibits and Reclamation guides)
2. Upper parking area (approximately 150 spaces)
3. Bleacher seating area (used most during laser show)
4. Trail leading to upper viewing area
5. Trail leading to lower grounds
6. Slope between lower and upper grounds

Lower grounds:

1. North lower parking area
2. Open lawn
3. Restrooms and picnic area
4. South lower parking area

Third Powerplant and Public Tour Area. Public viewing facilities were built in to the TPP, including an upper viewing platform on top of the Forebay Dam and an incline, glass-fronted elevator that descends to the TPP. The elevator makes two stops, the first at the mid-station visitor bridge that leads to a walkway overlooking the main floor of the TPP, providing views of the turbine housings and vast floor of the TPP. The bridge exits to a cantilevered balcony overlooking the turbulent waters exiting the TPP. The balcony also provides direct views of the dam and spillway. From the balcony, visitors return to the elevator and continue down to the second stop on their tour of the TPP powerplant located below ground level.

The tour can accommodate 30 visitors per tour. Tours run every half hour during peak season, which relates to a maximum of about 480 visitors a day. During shoulder season (before Memorial Day and after Labor Day) four tours are given per day.

The elevator has had repeated mechanical and structural problems and was out of commission during the 2010 season. Reclamation has tentatively scheduled repairs for spring 2011. The tour bridge also has structural problems related to age and water damage.

In response to the elevator being out of commission, Reclamation developed an alternative tour for the 2010 season that includes stops on top of the dam itself, something that was not available before. Visitors were not able to see the TPP from the balcony during 2010 but were still are able to see the floor, as accessed through an alternate route and entrance. Reclamation is providing vans to move visitors from place to place along the tour. Internal discussions for the 2011 season have included the possibility of adding vehicles that are easier for visitors to get in and out of, which is difficult in the vans currently being used. Otherwise, the modified tour has been well received by visitors.

SR 155 Crossing. Proposed lines would cross over SR 155, the major north-south route to Grand Coulee Dam. State Route 155 is part of the Coulee Corridor National Scenic Byway, a 150 mile long area from Othello to Omak and the Ice Age Floods National Geologic Trail.

Upland Crossing. After spanning the Columbia River, the Visitor's Center, and SR 155, the proposed transmission lines would gain approximate 700 vertical feet over a 2,500-foot horizontal distance to reach existing towers above the Spreader Yard. Except for SR 155 and a strip of private land, the upland crossing is on federal land managed by Reclamation.

Under the Preferred Alternative, three towers would be installed near the foot of the slope and just above of a historic railroad grade and a second set of towers would be located at the top of the hill near the Spreader Yard. The use of this land is currently managed as utility right-of-way for the two existing back up transmission lines. Other than some informal recreational use, this land provides no public uses.

Shorelines. The proposed transmission lines would span an approximately 25 acre floodplain terrace (normally dry but annually flooded). Vegetation is limited to sparse (<5% cover) patches of shrub-sized willow and other small shrubs are taking hold as seen in Figure 3-2. Substrate is primarily fist-sized and smaller granitic rock. Rip rap armors the short bank of about 12 feet elevation gain leading to a chain link fence and the Visitor's Center lower grounds. Weedy vegetation is present along the fence line (e.g. rabbitbrush, cheatgrass, etc).

The Columbia River is identified as a *shoreline of the state* and as a *shoreline of statewide significance* by the Washington State Shoreline Management Act.

3.6.2 Environmental Consequences – Preferred Alternative

3.6.2.1 Existing Land and Shoreline Use

Private Lands

Of the approximate 5,300-foot length of proposed overhead transmission corridor, approximately 60 feet cross private lands. The remaining 97% of the corridor is contained on federal lands managed by Reclamation for the Columbia Basin Project.

The two northernmost proposed transmission lines would span a narrow extension of the parcel on which the Columbia River Inn is located. The proposed lines would cross the average 60-foot width of the extension from the southernmost tip (where the motel sign is installed across from the Visitor's Center) approximately150 feet in to the property. Lines would be suspended approximately 180 feet above the parcel.

The parcel extension is located at the toe of the slope, with the only improvement being the motel's sign facing the Visitor's Center exit. Otherwise, this land appears too steep and narrow for improvements.

Shorelines and Washington Shoreline Management Act

All lands, shorelines and water bodies that would be crossed are managed by Reclamation as part of the Columbia Basin Project where local land use plans and regulations do not apply. However, the Washington State Shoreline Management Act (SMA) would apply because project shorelines are *shorelines of the state* (RCW 90.58.030(2))4 as well as *shorelines of statewide significance*. Because local shoreline regulations do not apply, the Proposed Action has been reviewed against the statewide shoreline polices outlined in the SMA.

Washington's SMA provides general rules for shoreline use under WAC 173-26-241. Two of these rules relate to transmission lines and the Proposed Action. For the first rule, an overhead transmission system for the TPP cannot be installed without crossing shorelines (i.e., they are necessarily located within the shoreline). Ecological functions would be maintained in part through consultation with the WDFW for the HPA permit and through the USFWS for bald eagle and other migratory bird use within shorelines. For the second rule, a portion of the project would be within the existing right-of-way established for the backup lines, which would be removed. The backup lines presently cross over an approximate 300-foot length of shoreline. These would be replaced by the proposed lines, which would cross approximately 740 feet of shoreline.

Adjacent Land Uses

The proposed towers and associated transmission lines would be visible from the Columbia River Inn, residential areas and local parks. Other than visual impacts, the proposed lines would have no effect on adjacent commercial, residential, and public open space land uses. As detailed in the Local Economy and Tourism section, proposed towers and lines would be unlikely to deter visitors from traveling to the area.

Columbia River Inn. The existing backup lines (which are not energized) cross near and over the motel's swimming pool. The Proposed Action would result in more lines visible but at a greater distance and height. Proposed lines would be set back further than existing lines by approximately 50 feet horizontally and 100 feet vertically. What would differ is that lines would be energized if the project is approved. During wet weather, high-voltage power lines make noise and, therefore, could be audible by guests at the pool. The effect could be to make some people uneasy with using the pool during wet weather. However, people use outdoor pools mostly during dry conditions when lines make little if any noise. In addition, the proposed lines would be triplex (three cable) conductors which make less noise than traditional duplex systems.

Shoreline Residences. The modified Proposed Action (Preferred Alternative) would provide 210 feet additional separation over that provided by the original proposal (Alternative 1), allowing for 480 feet between the closest conductor to residential property. Under the Proposed Action, towers would not be visible from shoreline residence, and the existing backup towers that are partially visible from some residences would be removed. Proposed lines would be visible within views of the TPP and spillway.

Visitor's Center

The primary concern regarding impacts to the Visitor's Center was the proposal to build three towers on the lower grounds (under Alternatives 1, 3, and 4). This would take much needed space away for the annual Festival of America as well as create visual impacts. Based on these concerns, Reclamation developed the revised Proposed Action (Preferred Alternative, or Alternative 2) that eliminated towers on the Visitor's Center grounds. Therefore, the most notable impact to the Visitor's Center has been avoided.

Public Tour

For safety and design reasons, Reclamation is proposing to remove the outer portion of visitor's tour bridge. The portion being removed is the bridge that connects the mid-point stop from the

incline elevator to the TPP building as seen in Figure 3-8. In addition to solving safety concerns with the aging tour bridge, its removal will also allow for more clearance of the proposed lines that begin behind the TPP. Additionally, the removal of the tour bridge will permanently affect the way tours were conducted prior to 2010 in which the public was able to access the cantilevered balcony that looks out over the river downstream from the dam as well as facing the Visitor's Center. This tour bridge portion of the tour also includes interior roof-level views within the TPP, allowing visitors to look down on the massive turbines covers. Seeing workers from this perspective likely provides a sense of large size of the building and the turbines. Floor level views may also provide a sense of scale but may not be as impressive as the roof-level view provided by the bridge.

Eliminating access to the inner tour bridge and the cantilevered balcony portion of the tour would cause visitors to no longer be able to see the size of the TPP's interior extending on either side of them, or the close views of turbulent water exiting the turbines within the TPP as they look out at main dam and spillway to the left when they are using the cantilevered balcony.

Even though the outer portion of the tour bridge would be removed, the elevator (once back in service) and the observation deck atop of the dam would remain part of the tour, though lines would be visible on either side of viewers.

Figure 3-8. Tour bridge that connects the Incline Elevator to the TPP, which will be removed as part of the Proposed Action.

Consistency with Original TPP Plan

Congressional authorizations for Grand Coulee Dam and the TPP include

- The Columbia Basin Project Act of 1943 (57 Stat. 14), reauthorized the project, bringing it under the provisions of the Reclamation Project Act of 1939; and
- Public Laws 89-448 and 89-561 of 1966, authorizing construction of the TPP.

Public Law 89-448 authorized funds for the TPP and Visitor's Center. However, it did not specify designs or facilities and contained no mention of the public tour or laser show. The authorization only specifies that a Visitor's Center be constructed. The Proposed Action would increase the presence of overhead lines and towers visible from the Visitor's Center and would remove the backup towers presently located on the lower grounds below the Visitor's Center complex. These changes would be visual and would have little or no effect on the Visitor's Center itself, including parking and access to the exhibits.

The TPP project did not include a Resource Management Plan, Master Use Plan or other formal land use decision document establishing specific goals and objectives. Therefore, there are no specific land use goals or objectives against which to evaluate project consistency. Still, the TPP project was built with a clear vision to make Grand Coulee Dam a "showplace for the scenic and recreational opportunities" offered by the Columbia Basin project. So, to evaluate consistency with the overall master plan concept of the TPP, the Proposed Action is examined for effect on the four primary features of that plan that related to public use and enjoyment of Grand Coulee Dam:

1. The Visitor's Center
2. Architectural and aesthetic values
3. The Third Powerplant public tour, and
4. The Laser light show

The primary question at hand is whether or not the combined effect of project changes on these primary features would result in a markedly different Grand Coulee Dam experience from that envisioned in the original plan developed for the TPP.

While adverse from an aesthetics standpoint, the overall "showplace" value of Grand Coulee Dam would not be expected to noticeably decline because most visitors would likely accept overhead lines as an expected aspect of a major hydroelectric project (*See* Visual Quality Section). Existing lines and towers that have been in place for almost 30 years have not substantially reduced the stature of Grand Coulee Dam and little evidence was found suggesting that the Proposed Action would influence the dam experience. Additionally, removal of the existing backup towers would offset some effects of overhead lines.

The Proposed Action would depart from two aspects of the original TPP project related to visitor use:

- the visual presence of transmission lines extending from the TPP and the Visitor's Center and towers located above SR 155 and visible from the Visitor's Center
- the loss of the tour bridge and viewing balcony portion of the public tour

While these effects would not be counter to the general provision of constructing "a Visitor's Center" specified in the congressional authorization for the TPP, these effects would depart from the original plan developed for the TPP which included the open air space created by the absence of overhead lines and towers and by eliminating the unique viewing platform built in to the TPP. Both of these features were integral components of the original plan.

3.6.2.2 Indirect Impacts

Land use changes from the Proposed Action would be limited to the site of action, and offsite impacts would be limited to visual changes. A primary concern raised by the public was that proposed lines would reduce visitation and associated visitor spending, resulting in indirect impacts on the local economy. However, based on the considerations presented within the Visual Quality Section and in Land Use Section above, the proposed line are not likely to deter visitors from coming to Grand Coulee Dam. The purpose of the Proposed Action is to increase the reliability of existing power generation at the TPP and would not effects future land use, such as inducing growth of industrial, residential, agriculture or other land uses.

3.6.3 Mitigation Measures

3.6.3.1 Private Lands

Reclamation would compensate the landowner if a revised right-of-way easement is required.

3.6.3.2 Shorelines

No mitigation specific to shorelines has been identified. Shoreline protection measures may be developed as part of an HPA to be issued by the WDFW.

3.6.3.3 Public Tour

The Value Engineering Report prepared for the project found that replacing and enclosing the tour bridge and repairing the Incline Elevator were possible, but not financially sound. Reclamation estimates costs for replacing the bridge to be $780,000, in addition to bridge maintenance costs. Several promising opportunities are available to replace the tour bridge and maintain an enjoyable and informative public tour. Even though a portion of the tour bridge will be removed, Reclamation is investigating other future options to allow the public to be able to access the inner portion of the tour bridge and the cantilevered observation deck.

3.6.3.4 Visitor's Center

The Visual Resource Section identifies possible options of incorporating the lines and towers into a revised laser show or possibly using lighting effects on the towers to highlight the tremendous power generating capacity of the dam.

3.6.3.5 Public Tour

Options Considered but Eliminated. Reclamation considered constructing a roof for the tour bridge to protect visitors from nearby overhead lines. However, the engineering team determined that this option was too expensive and would not completely eliminate risks to

visitors and Reclamation tour guides. Therefore, removal of the bridge is classified as an unavoidable adverse impact of the Proposed Action.

Replace Lost Opportunities from Tour Bridge. The loss the tour bridge and viewing balcony could be offset by providing new opportunities to view and experience Grand Coulee Dam. Reclamation has already developed an improvised replacement tour during the time the Incline Elevator has been out of service that includes alternate access to the main floor-level access and a tour stop on top of the dam. A permanent tour plan could be developed and implemented as long-term mitigation for eliminating the tour bridge.

Overhaul Incline Elevator for Long-term Reliability. The Incline Elevator has a history of breaking down, and the elevator has been out of service since 2009. Reclamation is exploring the option of repairing the elevator, and providing a long-term, reliable fix to the elevator would eliminate the cumulative loss of both the elevator and the bridge (a cumulative loss that occurs any time the elevator is out, with or without the tour bridge being available).

TPP or Visitor's Center. While mitigation options to replace the bridge and balcony portion of the public tour appear promising (e.g., a top-of-dam stop, or alternate viewing location for inside the TPP), a specific replacement tour would need to be defined before conclusions can be made as to whether or not it provides experiences of lesser, equal or greater value to those provided by the original tour developed for the TPP (i.e., the roof-level bridge and balcony).

In addition, any fencing, railings or other changes required by a proposed replacement tour would need to be evaluated for adverse effects on the identified historic properties at Grand Coulee Dam.

Visual changes of overhead lines in front of the TPP and towers behind the Visitor's Center cannot be mitigated. However, the level of visual clutter is not expected to be sufficient to reduce the overall "showplace" value of the TPP and Grand Coulee Dam.

3.6.4 Unavoidable Impacts Remaining After Mitigation

3.6.4.1 Private Lands

Crossing over the extension of the private parcel cannot be avoided under the Preferred Alternative.

3.6.4.2 Shorelines

Transmission lines crossing the shoreline would be unavoidable under the Proposed Action.

3.6.4.3 Adjacent Lands

Transmission lines would cross within 200 feet of the Columbia River Inn (approximately 55 feet horizontal distance, 180 feet vertical, 188 feet direct distance). As evaluated in a separate study (Bracken 2010), this distance does not pose a safety hazard.

3.6.4.4 Visitor's Center

None identified.

3.6.4.5 Public Tour

Elimination of the outer tour bridge portion of the public tour would be unavoidable under the Proposed Action. This would not, however, eliminate the public tour, which is the focus of this specific issue. The tour could continue under the Proposed Action just as it has with the improvised tour provided by Reclamation during recent elevator shutdowns. The improvised tour has been popular with the public, so a permanent replacement along similar lines could allow Reclamation to continue to provide enjoyable and informative public tours.

3.6.4.6 Consistency with the Original TPP Plan

The Proposed Action would unavoidably eliminate the roof level viewing provided by the tour bridge and the "visually-clean," open space component established with the internalized transmission line configuration of the original master plan for the TPP.

3.6.5 Cumulative Impacts

The baseline considered for this cumulative assessment on land and shoreline is 1978, the year that the Visitor's Center was completed and opened for the public. The TPP and Visitor's Center were designed at the peak of the US environmental movement, and Reclamation and Department of Interior placed a very high value on the aesthetics of the project.

Most notably for this project, the design included a completely enclosed transmission line system, with the six 525-kV lines of the TPP being installed inside the dam and within a tunnel leading away from the dam to the hills behind the Visitor's Center, where they exited via a Spreader Yard, located at the top of the hill, to reach 500-kV, double-circuit towers. These towers were specially designed tubular steel, rather than standard steel lattice towers.

The end result was a visibly transformed Grand Coulee Dam area, with no visible towers, transmission lines, or switchyards in the immediate vicinity of the dam and a new Visitor's Center and associated park grounds with striking views of the expanded structure, now stretching just short of one mile long. It is this setting that is considered the baseline for the visual cumulative impact assessment.

3.6.5.1 Land Use Impacts from Past Projects

Existing views of Grand Coulee Dam have been altered by two overhead line installations since the 1978 baseline condition.

- In 1981, two overhead, single-circuit, 500-kV lines were installed following a fire in one of the tunnels that destroyed three of the six internal transmission circuits. The overhead transmission lines were kept as backup after the internal circuits were replaced.
- In 1986, lines from the Right Powerplant were converted to overhead configuration, resulting in lines crossing in front of the spillway and a tower located next to State Route 155.

Backup Lines. As discussed under the Affected Environment, visual effects of the backup towers of the existing backup lines include:

- Towers are prominent visual features on the lower Visitor's Center Grounds, interrupt connections to downstream views, and reduce feeling of open space.

- Lines are prominent during early sunlight conditions, when lines are illuminated while the TPP remains in shade.
- Lines leaving the TPP also cross in front of the views to the plant.
- The arched and roughly parallel lines can be seen to "visually connect" the towers to the TPP.

Right Powerplant Lines. The Lines from the Right Powerplant are clearly visible in front of the spillway. Earlier environmental review for the work associated with moving the lines that originated from the Right Powerplant to overhead lines described the impact of lines in front of the spillway as follows:

> "*The reestablishment of numerous overhead transmission lines in the power-house and tailbay areas will noticeably change the view from below the dam, especially for permanent residents. The cumulative effect of the lines would change, but should not markedly diminish, the impressions of visitors and residents of the dam and the light display.*"

The most notable effect is one of contrast with the dominant line forms of the main dam. The arching and non-parallel lines (they visually cross) contrast in an uncomplimentary way with the strong vertical and horizontal linear forms of the spillway.

3.6.5.2 Non-Reclamation Lands

New Rights of Way or Acquisition of Property. The backup lines were installed over the narrow slice of private land sandwiched between Reclamation lands. The Proposed Action would replace these lines with the proposed new lines so that, while the proposed new lines would be further back, they would remain visible from the motel arrival and parking areas. No future plans for land acquisition or rights-of-way are planned.

The TPP Overhaul project required portions of the Town of Coulee Dam to be converted back to federal control. Part of this area remains undeveloped behind the north storage yard.

This area could be used in the future for expansion of the TPP. However, such expansion is not included in even long-term plans, so it is therefore not being considered as a reasonably foreseeable action under cumulative effects.

Conflict with Local or State Plans for Lands or Shoreline Use. Shorelines were extensively modified as part of the TPP Overhaul project. The backup lines have been spanning approximately 300 feet of shoreline since 1981. The proposed lines would increase the width of shoreline being spanned to approximately 740 feet.

Adjacent Land Uses. The owner of the Columbia River Inn has stated concern related to the existing backup lines. The Proposed Action would result in similar visual presence of lines, in which the proposed new towers may be more visible because of the height that would be required under the Preferred Alternative.

3.6.5.3 Reclamation Lands

Visitor's Center. The Proposed Action would redress a past impact by eliminating the two backup towers that have been present on the lower Visitor's Center grounds since 1981.

Proposed overhead lines and towers behind and above the Visitor's Center would replace existing lines and add to cumulative visual effects of the Right Powerplant lines, which currently cross in front of the spillway.

Public Tour. Permanent removal of the outer tour bridge portion of the public tour would make a permanent loss that is currently being experienced due to the temporary closure of the Incline Elevator. As previously state, the elevator and bridge were closed for the 2009 and 2010 visitor seasons. Return of the elevator to service would reduce the total cumulative effect.

Congressional Authorization. The Proposed Action would complete the conversion of Grand Coulee Dam from all underground transmission lines to all overhead transmission lines. Planned future construction of permanent and temporary storage buildings on the north storage yard (across from the TPP) as part of the TPP Overhaul Project would further add to changes from the original concept plan.

3.6.6 Environmental Consequences – Alternatives

3.6.6.1 Overhead Alternatives

Private Lands. All overhead alternatives considered would require that lines cross over a portion of the private land parcel identified above.

Shorelines. All overhead alternatives would reduce the total shoreline area with overhead lines with respect to cross over. However, cross over by all of the overhead alternatives would have no direct effects on shoreline functions or ecology.

Adjacent Land Uses. Alternative 4 would provide 105 feet of horizontal separation from the swimming pool, approximately twice as much as under the Preferred Alternative. Alternative 4 would also provide greater separation over the lower Visitor's Center grounds, with approximately 145 feet clearance compared to 115 under the Proposed Action. However, Alternative 4 would require towers to be placed in front of the lower Visitor's Center Grounds, rather than behind as proposed by the Preferred Alternative.

The Preferred Alternative provides the greatest vertical separation from the pool and upper Visitor's Center and the greatest horizontal separation from the closest resident.

Visitor's Center. Alternatives 1, 3 and 4 would require towers to be constructed on the lower Visitor's Center grounds, which could adversely affect recreational use associated with the popular Festival of America held each Independence Day on the Visitor's Center grounds.

Public Tour. Transmission line configurations near the tour bridge would not change substantially among the other overhead alternatives, so adverse effects on the tour would remain the same as the Proposed Action.

TPP. Alternatives 1, 3 and 4 would require towers to be constructed on the lower Visitor's Center grounds, resulting in a much greater departure from the TPP master plan as well as a loss of public open space.

3.6.6.2 Rebuild Alternatives

Private Lands. Under the Rebuild Alternative, the existing overhead backup lines would remain indefinitely and would likely be repaired and reenergized for at least two years during

installation of a new internal, underground system. Required modifications for the rebuild would take place on existing federal lands a minimum of 1,000 feet from non-federal lands.

Shorelines. Under the Rebuild Alternative, existing back up towers would likely to be reenergized for up to two years during reconstruction. Overhead lines that currently span the shoreline may be retained indefinitely as backups to offset increase risks of failure inherent to the Rebuild Alternative.

Adjacent Land Uses. Under the Rebuild Alternative, existing back up towers would likely to be reenergized for up to two years during reconstruction. Towers within the park and overhead lines may be retained indefinitely as backups to offset increase risks of failure inherent to the Rebuild Alternative.

Visitor's Center. The Rebuild Alternative would likely require the existing backup lines to be energized. The lines may also be left as backup.

Public Tour. The Rebuild Alternative would not require the tour bridge to be removed, though the existing bridge has structural problems and would likely require extensive repairs or may be removed due to its existing safety issues.

TPP. The Rebuild Alternative would not require the tour bridge to be removed. Therefore, the current open space, non-cluttered visual landscape provided by the original plan for the TPP and Visitor's Center would remain intact. The existing backup lines would likely need to be reenergized during the rebuild for up to two years and would be expected to remain indefinitely as backup unless sufficient reliability could be provided in the enclosed installation.

3.6.6.3 No Action Alternative

Private Lands. Under the No Action Alternative a failure of the underground lines would likely result and the overhead backup lines would also require maintenance and possible repairs over time. Additionally, the overhead backup lines would need to become reenergized should any failures occurs within the underground tunnel lines so that at least a portion of lost transmission could be diverted onto the FCRTS. Lines could be energized for two years or more, depending on how replacement lines are designed and installed.

Shorelines. Under the No Action Alternative, the existing backup lines would be expected to remain over shorelines below the lower Visitor's Center grounds.

Adjacent Land Uses. Under the No Action Alternative existing backup towers would be expected to remain on the lower Visitor's Center grounds. The No Action Alternative would not have any direct effect on existing public uses of the TPP and Visitor's Center. However, the eventual failure of the aging underground transmission lines would likely disrupt visitor use as repairs would need to be planned and implemented.

Visitor's Center. Under the No Action Alternative there would not be any direct effects on the Visitor's Center. However, the inevitable failure of the aging oil-filled transmission lines would likely disrupt visitor use for several years as repairs are planned and made.

Public Tour. Under the No Action Alternative there would not be any immediate effects to the public tour. However, emergency replacement actions in response to any possible failure of the lines could disrupt the tour.

TPP. The No Action Alternative would severely compromise one of the underlying purposes of the TPP and Grand Coulee Dam, which is to safely and reliably generate and transmit power to the regional power grid (the FCRTS).

3.7 Recreation

3.7.1 Affected Environment

Recreational use at Grand Coulee Dam is addressed under Land Use. This section considers effects on off-site recreational uses.

Grand Coulee Dam is centrally located within an area of high recreational opportunity and use. Recreational use is primarily seasonal, with the vast majority of use occurring between Memorial Day and Labor Day.

Grand Coulee Dam is a recreational destination itself, with a Visitor's Center and landscaped grounds, viewing areas, public tours of the TPP and dam, and the popular laser light show shown on the spillway of the dam.

In addition to the dam, many other recreation-oriented destinations are present in the area, including:

- **Banks Lake and Steamboat Rock State Park.** The Banks Lake Management Area covers 44,500-acre area managed by Reclamation. The area includes Steamboat Rock State Park, managed by Washington State Parks and Recreation Commission. The popular park contains 3,522 acres, 126 campsites; a swimming beach; seven boat launches; hiking biking and horse trails; and a day-use area (USBR 2010).
- **Lake Roosevelt National Recreation Area (NRA).** Lake Roosevelt NRA follows the ancient channel of the Columbia River upstream from Grand Coulee Dam approximately 132 miles, providing 312 miles of shoreline and adjacent lands for recreational use, as well the waters of the lake. The NRA supports campgrounds, marinas, boat launches, and other facilities for recreational uses.
- **Recreation-Related Businesses.** Recreation and tourism is a major component of the Grand Coulee Dam area economy. Many local business focus on visitors, including motels, restaurants, RV parks and campgrounds, convenience stores, gas stations, emergency road services, gift shops, marinas and golf courses. In addition, many private campgrounds are located in the general area, providing more total accommodations than area hotels. Privately owned operations catering to visitors include Coulee Playland Resort, Grand Coulee RV Park, King's Court RV Park, Sunbanks Resort, Lakeview Terrace, Reynolds Resort, and Spring Canyon Campground.

3.7.2 Environmental Consequences – Preferred Alternative

Proposed towers and roads would be contained on Reclamation lands and would not encroach on other lands designated for recreation or other public uses. Tower effects would be primarily visual and would not be expected to change off-site recreational opportunities. No indirect effects were identified.

3.7.3 Mitigation Measures

None identified.

3.7.4 Unavoidable Impacts Remaining After Mitigation

None identified.

3.7.5 Cumulative Impacts

None identified.

3.7.6 Environmental Consequences – Alternatives

As with the Proposed Action, none of the alternatives would have direct, indirect, or cumulative effects on recreation.

3.8 Visual Quality

3.8.1 Affected Environment

The viewshed of Grand Coulee Dam includes two distinct Landscape Units (also called viewsheds): the upper viewshed of Lake Roosevelt and Town of Grand Coulee and the main viewshed that includes the face of the dam and spillway and the TPP, the Visitor's Center, the North Storage Yard, and the Town of Coulee Dam.

The two viewsheds are visually separated by the dam and the granite formations that compose the dam's abutments. Proposed towers and lines would be constructed in the main viewshed.

3.8.1.1 Upper Viewshed

The upper viewshed is not a major part of the affected environment because proposed towers and lines would not be visible from most places above the dam. This includes the lower end of Lake Roosevelt, portions of SR 155 and SR 174, and residential lands in the East Heights area of the Town of Grand Coulee.

Primary components are the top of the dam and arch spillway structures, Reclamation facilities and parking areas, residential areas within the Town of Grand Coulee, Crescent Lake, Lake Roosevelt and surrounding granite outcrops and hillsides.

Viewshed character and quality are broken down by viewer type:

Travelers. Visitors traveling along this route are expected to be anticipating and looking for the dam. The overall character of views as people approach Grand Coulee Dam is developed land in the foreground with background views of non-forested hills and granite outcrops.

Views for northbound travelers on SR 155 include the commercial zone of the Town of Grand Coulee, a roadside park, and a visitor's parking area. Partial views of Lake Roosevelt lead to views of the top of Grand Coulee Dam and Reclamation facilities. Passing the top of the dam provides only a glimpse of a view and rates low on vividness (i.e., is generally unremarkable). A circular convex curve transitions drivers to main viewshed that includes views of face of the dam and spillway.

Residents. Views for the East Heights residents are primarily water views of Roosevelt Lake and landform views of hillsides above. Human built features include the top of the dam, a log boom and Reclamation facilities. These views are considered scenic due to the combination of water, natural landforms, views of the top of the dam, and background views of distant topography below the dam.

Recreationists. Views for recreationists at Roosevelt Lake are at or near lake level and include open water and adjacent upland landforms. The top of the dam is conspicuous at the extreme lower end of the lake. The proposed lines and towers would not be visible from the lake and shoreline.

3.8.1.2 Main Viewshed

The main viewshed runs north to south between the main dam to Crown Pont State Park and east to west from the granite formations that form the dam's abutments and surrounding hills that

continue north (downriver). The viewshed is similar to a "box canyon," with the granite landforms on either side of the river creating the sidewalls, the dam and spillway creating the headwall, and the level surface of the water and relatively level lands of town creating the "floor."

The main Grand Coulee Dam viewshed as seen in Figure 3-9 contains several large human-built features within a small space:

- **Grand Coulee Dam**, which includes (a) a spillway and top bridge; (b) Right and Left Powerplants (and dam walls), (c) TPP (and Forebay Dam), and (d) north storage yard
- the **Visitor's Center** building and grounds
- the historic **Columbia River Bridge**
- the **historic residential area** of west Coulee Dam (known as "Engineers Town")
- **overhead transmission lines** in front of the spillway and strung between the TPP and the Visitor's Center

Other major components include the granite landforms that flank either side of the viewshed and the open water and shorelines.

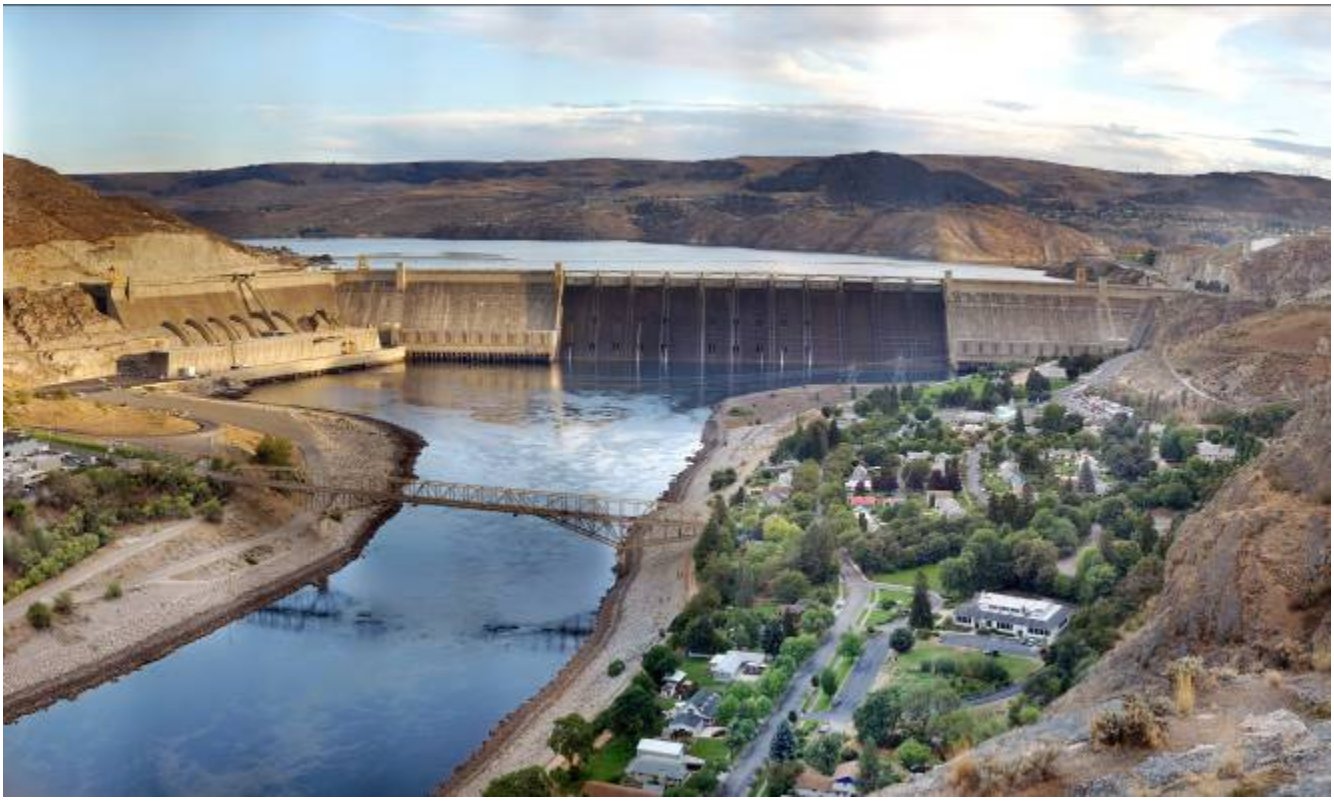

Figure 3-9. The main Grand Coulee Dam viewshed.

General Character. The lower viewshed presents highly scenic views with a wealth of architectural, historic, and geologic visual components. Architectural features such as repeated forms of the original dam and the TPP complement the extreme scale of the overall structure of

the Grand Coulee Dam. As one of the largest construction projects ever undertaken in human history, the dam also visually represents a historic moment of the nation's development. Geologic features, including the granite formations that serve as the dam's abutments, also contribute to the overall character of the view.

Distance Zones. Almost all views are within the "foreground-middle ground" distance zone have a "box canyon effect" that is created by the granite landforms on either side of the river, the dam as a "headwall, and the level surface of the water and relatively level lands of town as the "floor." Total viewing distance is less than two miles in most directions less than one mile for major visual components, including the dam.

Built Features. Grand Coulee Dam (Figure 3-10) and the TPP (Figure 3-11) are dominant and vivid elements of the view. The architecture of the dam and TPP contribute greatly to the viewshed character and quality. Notable architectural accents of Grand Coulee Dam include the iconic, arched structures above the spillway that evoke *art deco*-style of the 1930's. The TPP addition also included several aesthetic aspects intended to make the project visually appealing and accessible to the public. Visual components of that project included V-shaped features and visible penstocks (which carry water from above to the turbines) set against exposed rock. The modern *brutalism* style is intended to contrast and complement the *art deco*-style of the original structure.

Other visual components of the TPP include the glass, inclined elevator and cantilevered viewing balcony platform. The architecture of the TPP is in the *brutalism* style, which emphasizes clean surfaces (often concrete), strong lines, rhythmic forms (and contrasting light and shadow), and large scale.

Another visual component of the TPP project – and that which is most relevant to the Proposed Action – was the installation of all transmission lines internally, resulting in a very clean view of the dam and its now angular connection to the TPP and Forebay Dam. The internal transmission lines were short-lived, however, as a tunnel fire resulted in overhead backup lines and towers for the TPP and subsequent replacement of the Right Powerplant's lines with external lines that drape across the front of the spillway. Because of the importance of these existing lines to the impact assessment, they are addressed separately following this general view analysis.

Landforms. The granite outcrop and cut face that forms the east abutment provides a framing background to the TPP, presenting a transition from built to natural forms and materials.

Water. As previously noted, water is a major element of the view, adding open space as well as a visual reinforcement of the dam and its harnessing of water. Water leaving the TPP can be seen roiling below it and during spring runoff and seasonally for the laser show, the spillway present a wall of white water.

Vegetation. Vegetation is notably absent from most views, and the overall texture of the view is smooth, including the flat surfaces of the dam, open water, and lower Visitor's Center grounds. The granite outcrops and associated geologic formations include only very low vegetation and exposed rock. The manicured landscaping of the lower Visitor's Center grounds is composed of mostly open, flat lawn areas accented by small- and medium-sized shrubs and trees.

Figure 3-10. The Grand Coulee Dam with views of the TPP, the Visitor's Center, and the backup overhead lines that span above the Visitor's Center.

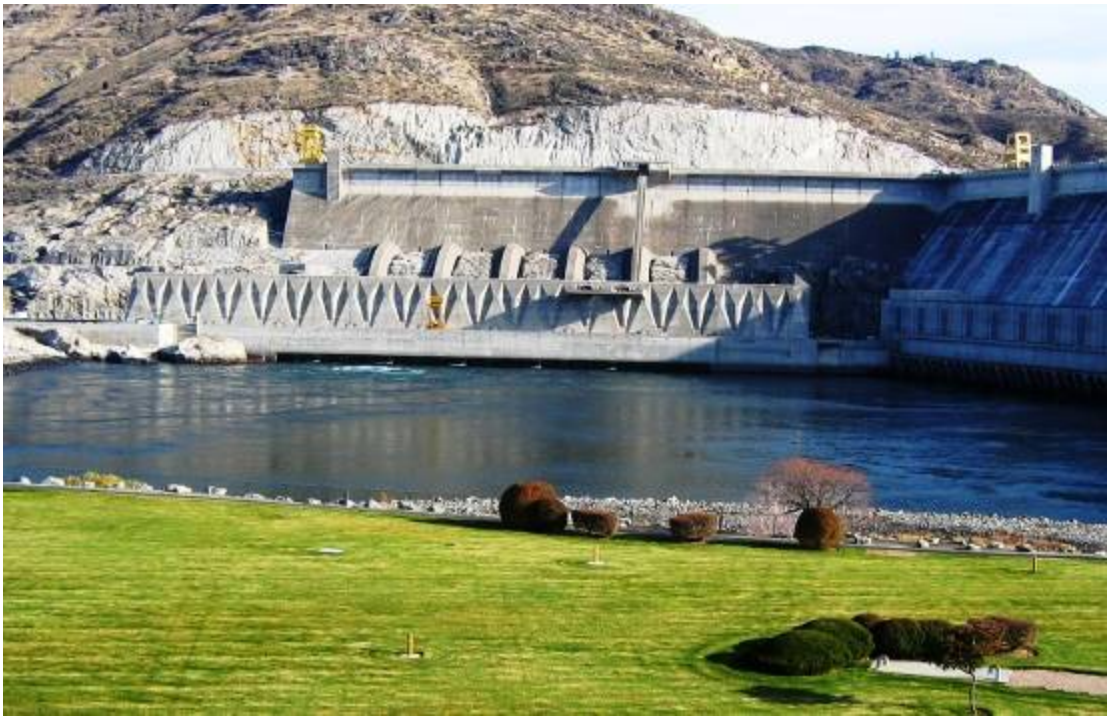

Figure 3-11. Views of the TPP which depict its brutalism style of architecture.

Viewers

Viewer Types. Viewers have been classified as:

- visitors to Grand Coulee Dam
- residents of the Town of Coulee Dam, particularly who live along the west shoreline of the river
- guests at the two motels with views of the dam

Viewer Numbers. Visitors are by far the largest groups of viewers, with an estimated 300,000 people per year. Residents with direct views of the dam reside in approximately 12 single-family homes located along the banks of the river. The two motels in town have a total occupancy capacity of approximately 200. The Coulee House Inn and Suites has approximately 30 rooms with direct views oriented toward the dam. The Columbia River Inn does not provide full views of the dam but provides approximately 25 rooms oriented toward the dam that provide views of the Visitor's Center and partial views of the TPP.

Views of Public Interest. Views at Grand Coulee Dam are of very high public interests, due to (1) its stature as a historic landmark of national and international significance, (2) the opportunities provided for public use and appreciation, and (3) the attraction value of the dam to support tourism, something that the local and regional economies are highly dependent upon.

3.8.1.3 Aesthetics and the Third Powerplant Project

The TPP addition created a major change in the overall visual landscape of Grand Coulee Dam. Reclamation intended the TPP project and associated Visitor's Center to become a *showplace for the scenic and recreational opportunities* provided by the Columbia Basin Project.

The TPP was designed at the peak of the US environmental movement, and Reclamation and Department of Interior placed a very high value on the aesthetics of the project, hiring architect Kenneth Brooks of Spokane to prepare an environmental master plan for the "aesthetic development of the Grand Coulee Dam area." And for the architectural features of the TPP and the Visitor's Center, Reclamation hired world-renowned architect Marcel Breuer of New York, known for his *brutalism* style, characterized by massive concrete structures of repeated forms – a style deemed fitting for Grand Coulee Dam.

Aesthetic elements of the TPP project included *brutalism* style architecture, the Visitor's Center grounds, and public tour facilities (Incline Elevator, bridge, and cantilevered viewing balcony). Also, and most notably for this project, the TPP design included a completely enclosed transmission line system, with the six 525-kV lines of the TPP being installed inside the dam and a tunnel leading away from the dam to the hills behind the Visitor's Center.

Even the towers for the TPP transmission lines after the tunnel (on the hills above the dam) were tubular steel, rather than standard steel lattice towers (*See* Figure 3-12)

The end result was a visibly transformed Grand Coulee Dam area, with no visible towers, transmission lines, or switchyards in the immediate vicinity of the dam and a new Visitor's Center and associated park grounds with striking views of the expanded structure, now stretching just short of one mile long.

Existing backup lines and lines from the Right Powerplant that drape across the spillway were a departure from this *vision* of the Third Power Plan project. The backup lines were installed following a fire in one of the tunnels that destroyed three of the six internal circuits. Lines from the Right Powerplant were converted to overhead configuration in 1986, resulting in lines crossing in front of the spillway and a tower located next to State Route 155.

Figure 3-12. Example of the tubular steel towers that were built in conjunction with the TPP.

3.8.1.4 Special Highway Designations

Coulee Corridor Scenic Byway. State Route 155 – the main north-south highway of the Grand Coulee Dam area – is part of the 150-mile Coulee Corridor National Scenic Byway administered by WDOT and supported by communities and other area stakeholders. The National Scenic Byways program is part of the U.S. Department of Transportation, Federal Highway Administration.

National Scenic Byways are designated based on one or more archeological, cultural, historic, natural, recreational and scenic qualities. According to the byway's Corridor Management Plan (WSDOT 2005), the Coulee Corridor has been designated based on all of these attributes, with an emphasis on geology and water. Major elements of the corridor include the geology of the ice age floods.

Ice Age Flood National Scenic Trail. Related to the Coulee Corridor, Grand Coulee Dam is a stop on the Ice Age Floods National Geologic Trail which is administered by the National Park Service.

The trail is 500-mile auto route from Montana to the Pacific Ocean that will include a series of interpretive stops telling the story of the massive water flows that created the area's unique geology, including *coulees*.

3.8.1.5 Visual Effects of Existing Overhead Lines and Towers

The component of existing view most relative to the alternatives is the presence of overhead lines installed after the completion of the TPP Project. Existing lines and towers within the viewshed include: the towers and backup lines from the TPP and the lines that cross in front of the spillway from the Right Powerplant and the tower at the SR 155 turnoff.

These existing overhead lines factor into the impact assessment in two fundamental ways:

1. Identifying how the existing lines and towers affect views of the dam and how viewers respond to these effects may provide insights of how people would react to the Proposed Action, should it be implemented.
2. The presence of existing lines factor into the cumulative effect of increasing the number of overhead lines, as would occur under the Proposed Action.

This section considers the first factor: the effects that existing lines and towers are having on views.

Backup and Towers Lines

The existing backup lines and towers are prominent visual features, particularly during early sunlight conditions, when lines are illuminated while the TPP remains in shade.

The primary effect of the backup lines and towers relates to line and space.

From a line standpoint, the conductors are arranged in a relatively flat band that visually bridges the area between the TPP and the tower. The lines do sag, which contrast somewhat with the straight vertical and horizontal lines of the TPP and main dam.

The towers located on the lower grounds of the Visitor's Center interrupt downstream views, which may reduce the feeling of open space (open space is a primary aesthetic characteristic of the view). The lines and towers also partially obscure views of background topography and sand hill, a prominent hill of sand left after construction of the dam that provides an interesting historic component to the view.

The transmission lines leaving the TPP also cross in front of the views to the plant. The lines provide backup to two of the six generators, so that the appearance of the lines is not balanced with the shape of the TPP. The lines extend from only the last one-third of the TPP's length.

Right Powerplant Lines

Lines from the Right Powerplant are clearly visible in front of the spillway. The Environmental Assessment for the Right Powerplant overhead lines described the impact of lines in front of the spillway as follows:

> "*The reestablishment of numerous overhead transmission lines in the power-house and tailbay areas will noticeably change the view from below the dam, especially for permanent residents. A number of the lines will have a blaze orange reflective tape wrapped on them to assist in preventing eagles from colliding with the transmission lines. The cumulative effect of the lines would change, but should not markedly diminish, the impressions of visitors and residents of the dam and the light display*."

From the Visitor's Center and points downriver, the Right Powerplant's lines visually contrast against the dark background of the spillway. The sag in the lines also contrasts with the vertical line forms of the spillway.

From the upper viewpoint, the lines cross in front of views of the spillway. From this perspective, the lines span from across the spillway directly toward the viewer to attach to a double-circuit (230-kV) tower co-located with the viewpoint. This creates an interesting effect.

While the lines from the Right Powerplant create some visual clutter, the effect is moderate and does not spoil overall views.

Effects of Existing Lines on Visitor Enjoyment

Both the backup lines and the Right Powerplant lines could be seen as reducing the "intactness" of the view in terms of reducing the clean, open views envisioned for the TPP project. However, based on review of online comments and Visitor's Center guest books, and on discussions with Reclamation staff, existing overhead lines do not seem to be detracting from the public's enjoyment of the dam and Visitor's Center.

3.8.2 Environmental Consequences – Preferred Alternative

3.8.2.1 Visual Components of Proposed Action

Table 3-4 describes the specific visual components considered in identifying adverse impacts to visual quality.

Table 3-4. Visual Components Considered for Impact Analysis of Visual Quality

Component	Description
Towers	Proposed towers would be steel lattice, the standard design most commonly used for transmission. Towers would also be *double-circuit*, with each tower carrying two circuits. Height would range from 280 to 316 feet tall, compared with the existing backup towers that are approximately 160 feet tall.
Tower Footings and Access Roads	Proposed towers would be accessed via existing, unpaved roads. Footings are proposed to be constructed on a hillside and will include some cuts within sandy soils, resulting in exposed, light gray or brown soil.
Tower Lighting	The Federal Aviation Administration often requires *obstruction lights* to notify pilots of tall structures, FAA requires notification for structures taller than 200 feet and determines lighting specifications on a case-by-case evaluations. Night-time lighting typically consists of red lights set at 40 flashes per minute and may consist of from one to seven levels of lights depending upon the height of the structure. Where more than one level is used the vertical banks flash simultaneously
Backup Tower Removal	The Proposed Action includes removing the existing six towers used for the backup lines. Towers to be removed include two located on the lower grounds of the Visitor's Center, two at mid-slope and two at the top of the hill near the 500-kV switchyard.
Conductors	Electricity generated from each of the TPP's six generators needs to connect to the regional transmission grid as a circuit composed of three phases. Each phase would use a three-bundle design that includes three, 1.38-inch conductors per phase. This will result in 9, 1.38-inch transmission lines per generator, or a total of 54 total lines strung between the TPP and the Spreading Yard (and supported by 6 towers). Existing single-circuit backup line consists of two-bundle conductors, for a total of 12 lines. Transmission lines would be approximately 150 feet above the upper Visitor's Center grounds and 113 feet above the lower grounds. Lines would be overhead over the northern and central portions of the Visitor's Center (furthest from the dam), with the width of crossing approximately 680 feet from the northernmost to the southernmost conductors.
Spacers	The three lines that compose each triplex conductor will be held in place by spacers located at various points along the lines. BPA has not yet specified the number or type of spacers that would be used, but typically, spacers are not major visual elements of overhead lines.
Ground Wires	Ground wires (also called static lines) are installed above conductors to ground out lighting strikes. The proposed lines would include three, 0.5-inch diameter ground wires per tower on the first section (i.e., 9 ground wires crossing the river) and two for each tower between the first and second set of three towers (i.e., 6 ground wires) on the hillside.
Markers	The proposed lines would probably not require line markers because they fall below the elevation of the dam. Transmission lines may be marked to discourage birds from inadvertently flying into the lines. Line marking with florescent orange tape was included as a mitigation measure for the Right Powerplant overhead lines (USBR 1985), though lines are presently not marked. The Proposed Action does not call for line marking but marking could be added as a result of planned consultations with the Federal Aviation Administration for aircraft safety and with the US Fish and Wildlife Service for avian mortality avoidance.
Attachments to Dam	The six circuits from the transformers behind the TPP would first need to gain elevation by tracking back to the face of the dam, from which they would then cross back over the top of the powerplant and the Columbia River, similar to how the existing backup lines are installed. The Proposed Action calls for four circuits to be attached to the north side of the Incline Elevator (the side where the two backup circuits are presently attached) and two on the south side (closest to the spillway). Attachments may include plates and other features that may be visible from the Visitor's Center.

Component	Description
Conductor Configuration	In contrast to the existing lines, which are strung on single-circuit towers with three conductors attached horizontally, proposed lines would be strung on double- circuit towers with three conductors stacked vertically on each side. Because conductors would be attached to the Forebay Dam in a horizontal configuration, each set of three transmission lines (i.e., each of the six circuits) would have to rotate 90 degrees from horizontal to vertical alignment. This rotation would take place between the attachments and the towers, primarily over the water and Visitor's Center. Visually, the lines would appear to be more horizontal as they leave the Forebay Dam (two stacks, with transmission lines comprising one and ground wires above) and would then spread out vertically to eventually be a stack of four of lines (as seen from the side) as the lines approach the first set of towers. However, even with this rotation, the relative positions of the lines appear more as symmetrical curves than as a crisscrossing jumble of lines, based on 3D perspectives examined from individual viewpoints (and presented later in this assessment). Symmetry tends to be more aesthetically pleasing to the human eye than asymmetry.

Visitor Arrival Views from SR 155

Arrival viewpoints are important to the overall visitor experience since these first views of the dam are often the most memorable, and people are generally at a high level of attention to views during arrival. The following representative viewpoints were evaluated for effects to visitor arrival views: SR155 Viewpoint turnout, SR 155 approach to Visitor's Center (southbound), Grand Coulee Bridge and SR 155 (approach from north).

SR 155 Turnout Viewpoint

This arrival viewpoint depicted in Figure 3-13 – built and maintained by Reclamation– provides the first full view of the dam for northbound travelers and provides direct and close views of the spillway and TPP, Town of Coulee Dam, Columbia River, and the historic Columbia River Bridge. Lines from the Right Powerplant travel directly to views to reach a tower co-located at this viewpoint. Backup towers and lines are visible on the left side of the field-of-view. Viewpoint includes walkway leading to a railing, a bench, and a trail connecting the viewpoint with the Visitor's Center, which lies below and north.

Proposed lines would be visible to the left of the main view of the spillway. Towers would also be visible on the left edge of the view, though the bases would be partially blocked by topography. Together, the lines and towers would be notable features within the left-hand portion of the field-of-view.

Figure 3-13. View of the Grand Coulee Dam from the SR 155 Turnout Viewpoint.

SR 155 Approach to Visitor's Center (Southbound)

Arriving via SR 155 provides a sequence of views greeting visitors from this less used approach, with views of TPP, spillway, open water, and the Columbia River Bridge as depicted from Figure 3-14. The proposed lines and towers would be visible in front of viewers as they approach the Visitor's Center. Lines would cross about 150 above the roadway (existing lines are approximately 100 feet above the roadway). Viewers would drive under one set of lines and then cross under another as they enter the Visitor's Center upper parking area.

Towers would come into view as drivers leave the historic residential area and travel uphill toward the Visitor's Center.

Figure 3-14. Northbound Viewpoint into the City of Coulee Dam on SR 155.

Grand Coulee Bridge. SR 155 continues through the Town of Coulee Dam, crossing the Columbia River about 1/2 mile downstream of the dam via the Columbia River Bridge [2] as seen in Figure 3-15, the original bridge constructed in the 1930s during the building of Grand Coulee Dam. Views from the bridge include the bridge itself and open water below as well as a direct view to the spillway and main dam. The bridge includes several informational readers anchored to the bridge as part of the self-guided walking tour of the town. Existing backup lines and lines from the Right Powerplant cross in front of the spillway but are not prominent in the view.

Proposed lines would be visible crossing in front of the Spillway but, due to distance, the overall effect would be similar to that of existing lines, with lines visible but not prominent. Towers would not be visible to northbound travelers but would be visible near the entrance of the bridge for southbound travelers.

Due to distance, proposed lines would be less likely to detract from or dominate views than from closer viewpoints at the Visitor's Center. The lines would be most visible when illuminated by sunlight, when they may come to dominate the view and detract from views of the spillway.

SR 155 (Approach from North)

Visitors arriving from north follows river upstream and cross the Columbia River Bridge and continue through the historic residential district to reach the Visitor's Center as seen in Figure 3-16. From this arrival perspective, the dam is only partially visible until inside the Town of Coulee Dam. The first direct views are from the approach to the Columbia River Bridge. The Visitor's Center exhibit building and landscaped lawn are prominent upon approach to the turnoff lane. Backup towers visible on hillside above.

With the Proposed Action, lines would be visible across the spillway as drivers approach and cross the Columbia River Bridge. Towers would be prominent and silhouetted against the sky as visitors approach the Visitor's Center.

[2] The bridge is also known as Grand Coulee Bridge, Washington State Department of Transportation (WSDOT) Bridge Number 155/101, and WSDOT Historic Bridge Number WA-102.

Figure 3-15. The Grand Coulee Columbia River Bridge.

Figure 3-16. Approaching the City of Coulee Dam from the North as seen from the Grand Coulee Columbia River Bridge.

Visual Changes to Formal (Reclamation) Visitor Viewing Areas

The following viewpoints were evaluated for visual impacts to formal visitor viewing areas provided by Reclamation: Visitor's Center, TPP tour, top of dam.

Visitor's Center

The Visitor's Center upper parking lot (Figure 3-17) is the main and most visited public viewing area of the dam, with clear view of the spillway, TPP, open water, and landscaped lower grounds. The views from this location set the stage for experiencing Grand Coulee Dam and how it is set against a background of the granite outcrop that serves as the dam's east abutment. The left field of view includes two backup towers set against the background of the North Storage Yard, adjacent vacant lands, and hillsides.

Figure 3-17. Grand Coulee Visitor Center (above) and its upper parking lot (below).

Under the Proposed Action, all lines would be attached near the top of the dam above the TPP and would sag to a low point above the river, partially veiling views of the TPP. Lines would span approximately 150 above the Visitor's Center grounds, including the lower grounds, exhibit building and parking areas very similarly to how the backup transmission lines currently span as noted in Figure 3-18.

Figure 3-18. View of Grand Coulee Dam from the Visitor Center parking lot. (Note the backup transmission lines on the left-hand side of the photo)

Potential effects on views from the Visitor's Center that have been identified include the following:

- Overhead lines may create a ceiling effect and reduce feeling of open space for visitors (as seen in the computer simulated Figure 3-19).
- Lines may also create a veil effect to looking downriver (left field of view), particularly for viewers closer to the dam.
- Non-parallel overhead lines (due to the required twist from horizontal to vertical) stemming from the TPP could contrast with parallel lines and shapes of the TPP and main dam.

Additionally, the two existing backup towers would be removed under the Preferred Alternative, rather than being replaced by three taller towers, as was originally proposed in Alternative 1. This would open up downriver views and reduce visual clutter created by the existing towers.

The visual encroachment of the transmission lines may affect views, but overall views of the dam are expected to remain extremely scenic, with visual components of the dam, water, and landforms remaining moderately intact and overall view unity maintained.

Figure 3-19. Computer-simulated view from the Visitor's Center upper parking lot oriented eastward with the proposed transmission lines proposed by the Preferred Alternative.

Visitor Arrival Center (Building)

Views from the Visitor's Center include more than just the dam. The historic Visitor's Center's white, circular shape (designed to suggest a turbine) is accented by a flag pole and set against the rock wall backdrop of Crown Point as partially seen in Figure 3-20. Backup transmission lines cross over the building. A tower is visible on the hillside in the left field of view.

With the Preferred Alternative, lines would also be seen crossing over the Visitor's Center exhibit building. The proposed lines would be taller than the existing backup lines (shown in Figure 3-21) when looking west-ward and would visually cross above the background view of Crown Point when looking northwest from the Visitor's Center parking lot.

Towers would be visible behind and left of Visitor Center. The towers' closeness (approximately 300 feet), height (also approximately 300 feet) and footing elevations (approximately 150 feet higher than the Visitor's Center) could make the extra tall towers appear to be looming over the Visitor's Center from certain perspectives (as seen in the computer simulated Figure 3-22).

Figure 3-20. The entrance to the Visitor's Center upper parking lot. (*Note the backup transmission lines that currently span over the Visitor's Center*)

Figure 3-21. View of the existing backup towers looking west from the Visitor's Center.

Figure 3-22. Computer-simulated view from the Visitor's Center upper parking lot oriented westward with the proposed transmission lines proposed by the Preferred Alternative.

Third Powerplant Tour Viewing Balconies and Incline Elevator

The TPP included a built-in public tour and viewing areas.

As depicted in Figure 3-23, an upper viewing platform on top of the Forebay Dam provides views behind the TPP, the spillway, open water, Visitor's Center, and Town of Coulee Dam. An incline, glass-fronted elevator descends to a mid-point stop in which an exterior tour bridge connects to the TPP building. This tour bridge also extends to the interior, providing views of the turbine housings and vast floor of the TPP. The tour bridge continues through the TPP and exits out to a cantilevered balcony overlooking the turbulent waters exiting the TPP. The balcony also provides direct views of the dam and spillway.

Views with Preferred Alternative. For safety and design reasons, Reclamation is proposing to remove the TPP visitor tour bridge to make way for proposed lines leading from the TPP, eliminating use of the TPP visitor tour bridge and viewing balcony portions of the tour.[3]

Views from the elevator (once back in service) and top observation deck would include lines either side of viewers and continuing across the river before them.

[3] *Note:* Mitigation may include top-of-dam tours as an alternative to the bridge and viewing balcony. The incline elevator and bridge portion of the tour has been closed since the 2009 season. An alternative tour that includes the top of the dam (not previously available) has been popular with the public.

Figure 3-23. TPP Viewing Balcony (in yellow) and the Incline Elevator (in red).

Top of Dam Replacement Tour Viewpoint

The top-of-dam viewpoint (See Figure 3-24) is currently being used as a temporary alternative viewpoint when the elevator and bridge have been unusable. The view provides a tremendous sense of height, with the spillway immediately below viewers and continuing 325 feet to the water below. The viewpoint also provides views of the TPP, open water below, Columbia River Bridge, and downstream reaches.

With the Preferred Alternative, lines would be visible crossing in front of and below viewers, from left to right as depicted in Figure 3-25. The lines would be sufficiently spread out so as not to block views, but would rather have a see-through, *veiling* effect. As discussed for impacts to views on the Visitor's Center, the context of the dam reduces the overall severity of impacts, since the lines can be considered visually consistent with a hydroelectric plant, particularly the largest in the US. Still, the lines could be considered an adverse visual effect due to the added visual clutter and loss of open space component to the view.

Visual Changes to other (Non-Reclamation) Public Viewing Areas

Two city parks and one state park were evaluated for visual impacts: Douglas Park, Freedom Point in Mason City Park, and Crown Point State Park. No public comments specifically voiced concerns regarding views from these parks. The parks are used by both visitors and Coulee Dam residents.

Figure 3-24. Existing view from the top of the dam looking west towards the Visitor's Center.

Figure 3-25. Computer simulated view of the Preferred Alternative looking west towards the Visitor's Center.

Douglas Park

This small city park is located along the shoreline approximately 700 feet south of Visitor's Center property line. Shoreline area of park leads to dike road with views of the Columbia River Bridge to the left, shoreline and river in the foreground, and direct views of TPP and spillway. Existing backup lines cross in front of views as seen in Figure 3-26.

With the Proposed Action lines would be seen leading form the TPP and crossing in front of spillway. Proposed towers would not be visible.

Figure 3-26. View of Grand Coulee Dam from Douglas Park.

Freedom Point in Mason City Park

Mason City Park is located just to the north of the gate that allows access to the TPP. It is across the street from the Coulee Dam Post Office, and the play structures present in the park are used heavily by local residents. The park also includes a small visitor's reception facility that is frequented by tourists in the summer. Freedom Point is a viewing area developed the Town of Coulee Dam, with the support of local businesses, including the Coulee House Inn and Suites, located across the street from the park as shown in Figure 3-27.

The park is also promoted by the Coulee House Inn and Suites as a place to view the laser show and is regularly used, but with much lower numbers than typically occur at the Visitor's Center. Views from this area include dominant horizontal lines of the main dam saddled between two granite formations, framed against the sky. The TPP is not fully visible from this area. The flag pole and simple park layout and visually vacant middle ground tend to bring focus on the background of the dam, water, granite formations and combined silhouette

With the proposed lines, conductors would cross in front of views of the spillway as depicted in the computer-simulated Figure 3-28. Lines would be most noticeable in morning sunlight.

Figure 3-27. View of Grand Coulee Dam from Freedom Point..

Figure 3-28. Computer-simulated view of Grand Coulee Dam from Freedom Point.

Crown Point State Park

Crown Point is a viewpoint park that provides panoramic views of the river, Town of Coulee Dam, Columbia River Bridge, TPP and spillway as seen in Figure 3-29. Existing lines are most noticeable when illuminated by morning sunlight. Later in the day, the 0.75 mile distant lines are not prominent in views.

Figure 3-29. View of the Grand Coulee Dam from Crown Point.

From this viewpoint, proposed lines would be visually positioned over the lower portion of the spillway and wall behind the Right Powerplant and over most of the wall behind the Left Powerplant and TPP.

Proposed lines may appear silhouetted in front of the dam, particularly before noon on sunny days, when lines would be illuminated while the dam would remain in shade. The lines may be less visible than from other parks due to the distance (approximate three quarter mile to lines and one mile to spillway). Towers would be visible in the right field of view. Lines-of-sight from downstream views would be perpendicular to the lines, so that lines would be visible arching from the TPP to the first set of towers.

Views from the Coulee Scenic Byway and Ice Age Floods National Geologic Trail

The primary purposes of both the Scenic Byway and National Geologic Trail are to tell the story of the ice age floods. Therefore, a key question is whether the visual changes of the Proposed Action on highway approaches to Grand Coulee Dam would detract from the telling of the story. The story told by both the Byway and Trail described how the convergence of geologic events has shaped natural and human history.

Grand Coulee Dam is located at the site of ice-age dam that diverted flow south, creating the Grand Coulee. This same channel was further carved by the ice age floods. The Columbia Basin Project is now part of this story, as it has utilized the ice-age pathway to irrigate croplands. The dam also presents a clear demonstration of the power of water, one of the overall themes of the Byway/Trail.

The Grand Coulee Dam part of the story is told primarily from the Visitor's Center. A self-guided walking trail is also provided through the Town of Coulee Dam, where numerous small display boards provide interpretive information about the dam and its history.

The primary impact of the Proposed Action would be visual, so the question can be further defined to ask if the visual presence of the lines and towers would interfere with or detract from the telling of the story. Based on the extent and context of visual change, the visual impact of the proposed overhead transmission lines would not likely interfere with the telling of this story. While the lines and towers may *visually encroach* on views as visitors travel to the Visitor's Center, they would not detract from the story being told.

Views from hotels, restaurants, resorts or other businesses

This section focuses on the visual effect of proposed lines on the Columbia River Inn and Coulee House Inn and Suites on the east side of the river and nearby restaurants and other businesses on the east side of the river.

Columbia River Inn

Existing backup lines (i.e., not energized) cross near and over the motel's swimming pool. Two towers located on the Visitor's Center lower grounds, approximately 550 feet from the motel, are visible from street-side rooms and from the front arrival and parking area in front of the motel. Another tower located behind and above the motel and 850 feet away, is visible from across the street as depicted in Figure 3-30.

The Proposed Action would result in more lines visible but at a greater distance and height. Proposed lines would be set back further than existing lines by approximately 50 feet and would also be 100 feet higher. The three existing backup towers visible from the motel would also be removed. Proposed towers would be visible from outside the motel but not from rooms as shown in the computer-simulated representation, Figure 3-31. The 306-foot tall northernmost tower would be closer to the motel and taller than the existing tower, though at a lower elevation. Topography would block the lower portion of the tower. The middle section and top of the tower would be visible and silhouetted against the sky, as would the transmission lines. The tower would likely be prominent from the parking area.

Coulee House Inn and Suites and Nearby Businesses

Rooms above the motel's back parking lot are oriented toward the dam. Views include foreground views of Freedom Point Park and background views of the spillway.

Proposed lines would be visible from the Coulee House Inn and Suites and from the window seats at Melody restaurant similar to that as seen from Freedom Point in Mason City Park. Lines-of-sight from this area are perpendicular to the location of proposed transmission lines, so that the lines would be visible in a spanning arc across the river and in front of the spillway. Towers would be visible but set against the background of the hillside above the Visitor's Center.

The visibility of the lines would vary with natural lighting conditions, with morning sunlight reflecting off the lines set against the dark and shaded background of the spillway and dam. The Coulee Dam Casino does not highlight views of the dam or laser show. Guest services and

facilities focus on gaming, so that the proposed project would have no direct effect on casino guest experience.

Figure 3-30. View of the existing backup lines from the Columbia River Inn.

Figure 3-31. Computer-simulated view of the Preferred Alternative lines from the Columbia River Inn.

Views from Residential Areas

The Proposed Action was determined to be visible from two residential areas: from the adjacent neighborhood in the Town of Coulee Dam and from the 1.75 mile distant East Heights

neighborhood. The adjacent neighborhood, historically referred to as Engineers' City, is eligible for listing in the National Register of Historic Places.[4] In addition, public comments included concerns about the scope and scale of the project on property values, noting the "sheer intimidating nature of newly constructed towers rising at least 50 feet higher than those that currently exist."

East Height Residential Area, Town of Grand Coulee

Views for East Heights residents are primarily water views of Roosevelt Lake and landform views of hillsides above. Human built features include the top of the dam, a log boom and Reclamation facilities.

Proposed towers and lines would be visible about 1.75 miles distant against the brown background of surrounding topography (i.e., not silhouetted against the sky). Due to the distance, the lines are not expected to be prominent in views, nor would they be expected to detract from primary views and landforms.

As discussed in the *Light and Glare* section below, the upper towers would include one or two flashing red lights that would be visible at night. A single white strobe light would be visible during daytime and dusk. With many similar lights present within existing views, lights from the Proposed Action would not be expected to create a noticeable change over the existing situation.

Nearest and other Shoreline Residents

Approximately ten shoreline residences between the dam and the Columbia River Bridge have backyard views of the TPP and spillway. Front yards are oriented toward the street and houses are set back from the shoreline by backyards and by a levee/roadway that follows the shoreline, so some houses may not have actual window views of the dam.

The closest residence is located approximately 150 feet from the edge of federal land, approximately 275 feet from the existing northern backup tower and lines, and approximately 475 feet from proposed lines. The yard area has full views of the TPP and partial views of the spillway. A vegetated strip of land and Reclamation grounds maintenance garage are located between this property and the existing Tower and Visitor's Center grounds, providing partial screening. The top of the closest tower is visible.

View with Preferred Alternative. Lines would be visible from these homes and would appear to cross in front to the TPP and spillway. The Preferred Alternative would shift towers further away from residential areas, locating them behind the Visitor's Center and above SR 155. Existing towers within views would be removed and the new towers would be set back and away from shoreline residential views of the TPP and spillway. Towers would be visible from front lawns and sidewalks of residences closest to the Visitor's Center on Columbia Avenue (SR 155).

Town of Coulee Dam, Grant Avenue Area

Most houses are oriented toward tree-lined streetscapes and do not have direct views of the dam or areas proposed for towers and lines. From Grant Avenue, the two towers on the Visitor's Center grounds that are presently visible would be removed.

[4] Note that compliance with Section 106 of the National Historic Preservation Act is being addressed separately.

Proposed lines would be visible, similar to existing lines but extending further to the right. Proposed towers and lines may be visible silhouetted against the sky to viewers looking south.

Light and Glare

Under all alternatives, BPA expects that one or two of the towers proposed for the top of the hill would be equipped with aviation safety lights consisting of white flashing strobe lights for daytime and red flashing lights for nighttime. The immediate area around Grand Coulee Dam includes numerous transmission towers, many of which have aviation safety lighting. The overall result is that aviation lighting dispersed across the landscape is common. The Proposed Action would add to this but would not likely result in a tipping point of cumulative effects. The lights are not expected to detract from views from residential, motels or visitor use areas. Daytime lighting would not be expected to be noticed, though nighttime lighting would be visible to all areas with views of the towers.

Visitor Response

The effect on visitors is expected to be mixed. Some people would likely react negatively to the presence of lines and towers. Others would be expected to accept the presence of overhead lines as part of the hydroelectric facility, and would focus attention on the dam and spillway and not the lines overhead or towers behind (while looking toward the dam).

First time visitors of the dam would be less likely to see the lines or towers as a visual disturbance, since they would have fewer preconceptions. Overall, the visual encroachment of the transmission lines may adversely affect views but with neutralizing and positive effects as previously described. Views of the dam are expected to remain extremely scenic, with visual components of the dam, water, and landforms remaining moderately intact and overall view unity maintained. The visitor experience is expected to remain similar to existing conditions, with visitors continuing to enjoy viewing the dam and taking the public tours, assuming that the top-of-dam opportunities remain as mitigation.

3.8.2.2 Indirect Impacts

In some ways, almost all visual impacts are indirect as the impact takes place at locations away from the direct action area. One visual impact that may occur later in time would be the placement of line markers should avian collisions becomes a problem. Line markers are effective in preventing birds form colliding with lines, but also add visual clutter to the scene. Based on the evaluation conducted regarding the potential for avian collisions, line marking at some time in the future would probably not be necessary but cannot be ruled out.

3.8.3 Mitigation Measures

3.8.3.1 TPP Visitor Tour Bridge and Viewing Balcony

- **Replace Lost Opportunities from Tour Bridge.** The loss the tour bridge and viewing balcony could be offset by providing new opportunities to view and experience Grand Coulee Dam. Reclamation has already developed an improvised replacement tour during the time the Incline Elevator has been out of service that includes alternate access to the floor-level access and a tour stop on top of the dam. A permanent tour plan could be

developed and implemented as long-term mitigation for removing the TTP visitor tour bridge.

- **Overhaul Incline Elevator.** The Incline Elevator has a history of breaking down, and the elevator has been out of service since 2009. Reclamation is already planning to repair the elevator. Providing a long-term, reliable fix to the elevator would eliminate the cumulative loss of both the elevator and the TPP visitor tour bridge (a cumulative loss that occurs any time the elevator is out, with or without the TPP visitor tour bridge being available).

3.8.3.2 Visitor's Center

- **Vegetative Screening.** Existing trees between the Visitor's Center parking area and SR 155 would partially screen the towers from some viewing locations. Additional tree plantings could be considered for additional screening and buffering of the towers.
- **Visually Enhance Towers and Lines.** Proposed towers cannot be hidden, so another category of potential mitigation would be to somehow enhance the look of the towers. During initial planning, Reclamation considered using a different, more attractive tower design, including interesting designs that could actually improve visitor experiences. However, a review of the market found that such towers are not readily available for the required 500-kV, double-circuit configurations and tension loads for the long span across the river. Painting towers above the Visitor's Center flat black was also considered as possibly reducing glare and overall visual encroachment. However, this approach works primarily with distant towers and would not likely reduce visibility of towers and could even increase the looming effect on some visitors.
- **Lighting Effects on Towers and/or Lines**. A third option to visually enhance towers would be to create lighting effects on the towers and/or lines. With the long use of lighting effects at Grand Coulee Dam, use of effects lighting on towers or even lines may be an option to enhance the towers as visual amenities.

3.8.3.3 Coulee Scenic Byway and Ice Age Floods National Geologic Trail

- To offset possible visual impacts to these two roadway designations, Reclamation could provide additional information about the ice age floods and how Grand Coulee Dam is part of the story. The lines and towers could be incorporated into the story as illustrating the power of water and relevance of Grand Coulee Dam to the Pacific Northwest.

3.8.4 Unavoidable Impacts Remaining After Mitigation

The visual presence of towers and lines cannot be avoided, including views from:

- arrival routes to Grand Coulee Dam
- the Grand Coulee Dam portion of the Coulee Scenic Byway and Ice Age Floods National Geologic Trail
- the Visitor's Center and public tour
- nearby city and state parks

- nearby hotels
- residential areas, including shoreline residential properties

In addition, removal of the tour bridge cannot be avoided without significant design changes, though a replacement tour is likely to provide similar visitor experiences.

The severity of unavoidable adverse impacts would be lessened by removing the existing backup towers from the lower Visitor's Center grounds. In addition, the context of the dam as the largest producer of hydroelectricity in the US reduces the likelihood that visitors would react negatively to the lines. Transmission lines are visually consistent with what people would expect at a hydroelectric dam, and are also consistent with the interpretive and historic theme of the power of water, as presented by the national scenic byway and geologic trail. Therefore, the overall aesthetic, recreational, and educational values of the area would likely remain intact.

3.8.5 Cumulative Impacts

The baseline considered for visual cumulative assessment is 1978, the year that the Visitor's Center was completed and opened for the public. The Proposed Action would result in a change from the cumulative effects baseline of no overhead transmission lines to all overhead transmission lines. The effect would be to:

- reduce the open space component as originally presented in 1978, including open space in front of viewers, to the side and overhead;
- partially veil views of the TPP;
- add three steel lattice towers (in addition to the existing 230-kV double-circuit tower for the Right Powerplant's lines);
- add visual clutter in addition to the Right Powerplant lines in front of the spillway. Collectively, the number and shape and breadth of overhead lines could detract from the clean, bold architectural lines and vast open space of the baseline condition.

Because the backup towers and lines would be removed, the project would replace and expand the effects of those lines. Removal of towers from the Visitor's Center grounds would reduce overall cumulative effects, restoring the lower grounds to their baseline condition.

The permanent loss of the TPP visitor tour bridge and viewing balcony portions of the tour would permanently extend a loss that has already occurred on a temporary basis.

The Proposed Action would also convert what can still be considered temporary overhead lines with permanent lines. While Reclamation had no plans to remove the backup lines, they are redundant features and conceptually could be removed should a fully reliable and repairable internal configuration be designed. With the Proposed Action, such an option would no longer be considered, making an irreversible commitment to overhead lines from the TPP at Grand Coulee Dam

The effect of future storage buildings planned as part of the TPP Overhaul Project considered collectively with all overhead lines would result in further departure from the 1978 baseline condition. However, since the area has been used as a storage and staging area for various items related to the dam since 1978, the presence of buildings in this area would not be a significant

change in overall aesthetics of the views. Architectural enhancements of the buildings could serve to allow the buildings to fit better within the built setting dominated by the TPP and Dam.

3.8.6 Environmental Consequences – Alternatives

3.8.6.1 Overhead Alternatives

The other overhead alternatives would not reduce overall impacts to visual resources. The closure of the tour bridge would occur under all overhead alternatives.

Arrival Views

Alternatives 1, 3 and 4 would all involve towers on the lower Visitor's Center grounds, which would eliminate views of towers above SR 155 but which could create a greater visual encroachment as viewers pull into the upper parking area at the Visitor's Center.

Visitor's Center and Public Tour Views

The major visual differences with other overhead alternatives would be as follows:

- The first set of towers would be constructed on or near the lower Visitor's Center grounds and within the field of view for people looking at the TPP, and
- Lines would be closer to the ground as they pass over the main viewing area of the Visitor's Center (97 feet for the original proposal, 150 feet for the Proposed Action).

Table 3-5. Vertical Separation of Visitor Center from Transmission Line

Alternative	Upper Visitor's Center Vertical Separation	Lower Visitor's Center Vertical Separation
No Action	140	150
Preferred Alternative (Alternative 2)	150	115
Alternative 1	97	115
Alternative 3	80	90
Alternative 4	129	145

= alternative with largest separation

Columbia River Inn and Coulee House Inn and Suites

Under the Alternative 1, towers would be farther and less visible from Columbia River Inn. However, lines would be cross over the pool area. Alternative 4 would provide greater horizontal separation of lines from the motel and pool, but lines would be closer to the ground.

Table 3-6. Key Distances to Columbia River Inn from Transmission Line

Alternatives	Distances (in feet)		
	Horizontal Distance Pool to Lines	Vertical Distance Pool to Lines	Closest Tower to Motel
No Action	cross over	100 (est)	620 (lower Visitor's Center. Tower visible behind motel is approx. 1,000 feet distant)
Preferred Alternative	55	180	260
Alternative 1	3	80	688
Alternative 3	60	80	800
Alternative 4	105	105	500

= alternative with largest separation

Residential Areas

Towers would be more visible from shoreline residences under Alternatives 1, 3 and 4 as considered.

Table 3-7. Separation Distances of Transmission Lines from Closest Residence

Alternative	Horizontal Distance to Line	Horizontal Distance to Closest Tower
No Action Alternative	270	270
Preferred Alternative	478	1,000
Alternative 1	270	270
Alternative 3	350	400
Alternative 4	390	400

= alternative with largest separation

Light and Glare

All overhead alternatives would likely require lighting for one or two of the top towers. Other than a lower height of towers and lighting, the overall effect would be the same as the Preferred Alternative.

3.8.6.2 Rebuild Alternative

The Rebuild Alternative would not involve additional towers or overhead transmission lines and would result in little visual impact over that already in place from existing lines. Existing backup lines would likely need to be reenergized during the rebuild for up to two years and would be expected to remain indefinitely as backup.

3.8.6.3 No Action Alternative

The No Action Alternative would have no immediate impact on visual quality. However, response to a major line failure could result in emergency measures which may include installing overhead lines.

3.9 Laser Light Show

Many visitors to Grand Coulee Dam attend the laser light show presented nightly at the dam (May through September), and the local Chamber of Commerce promotes the show as a reason to visit the area. Reclamation's original proposal (Alternative 1) called for three towers to be constructed on the lower Visitor's Center grounds, between the laser projection booth housed in the visitor's Center and the face of the dam, potentially forcing a modification or elimination of the laser show.

3.9.1 Affected Environment

The laser show debuted Memorial Day weekend 1989. According to Reclamation staff at the dam, the show's purpose is primarily education: to tell the story of Grand Coulee Dam and the Columbia Basin Project. While Reclamation's primary purpose of the show is education, to the local business community, the laser show has been seen from the start as a visitor attraction and a centerpiece of summer events, supporting patronage of local restaurants, hotels and other visitor-based businesses.

Nighttime lighting has long been used to provide entertainment and visually enhance the dam. Reclamation first provided a formal light show called the *Bank of Lights* in 1957 using high-powered lights with color filters. The debut of the bank of lights coincided with the *Colorama* festival that the local business community continues to hold each year. Use of the bank of lights was discontinued shortly after the current laser show debuted in 1989.

3.9.1.1 Summary of Laser Show Contents

The show runs seasonally from May (Memorial Day) through September. The show is played nightly at 10:00 PM through June, 9:30 PM through July and August and 8:30 in September.

The show tells the story of Grand Coulee Dam, narrated by a strong, male voice portraying the voice of the river. Lasers are used to illustrate the story with images such as fish, wagons, and historic figures, as well as abstract patterns choreographed to music. The show presents patriotic and utilitarian themes of harnessing the power of nature, as well as sections that describe the environmental costs of the dam, including lost salmon runs and traditional uses of lands and the river by native people. The show has remained unchanged for more than twenty years, yet it remains well attended and, based on observations made at shows and on reviews posted online, the show continues to provide an enjoyable experience. For some people, the show's content may have gained traditional and other sentimental value over time.

The show is not without criticism. Some visitors have expressed disappointment that the show is the same as they saw several years before. Along the same lines, others have commented that parts of show seem dated. Music includes songs popular 20 years ago but that may or may not appeal to contemporary audiences. Others have commented that the show is too promotional of the Bureau of Reclamation and its programs. The show's content on native peoples has also drawn criticisms from some members of the Confederated Tribes of the Colville Reservation.

3.9.1.2 Technical Aspects

Existing Equipment and Planned Replacement

At more than twenty-years old, the equipment used to create the laser show is near the end of its useful life. While some components have been upgraded, the main system remains unchanged. It now requires regular maintenance and is well below the current state of the art. When first installed in 1987, the equipment was state of the art and the show was one of the largest and best laser shows in the world. Laser technology has greatly improved over the 20 years since the lasers were installed. For example, the current system requires large amounts of electricity and a complex cooling system, whereas newer equipment has much lower energy and cooling requirements.

Reclamation has requested as a budget item replacement of the laser equipment (i.e., trading out entire system). Use of the latest technology could result in dramatically different equipment and capabilities, including smaller size, less weight, reduced need for cooling systems and associated portability.

Laser Projection Zones

The laser show vendor has divided the show into six zones on the wall of the dam, spillway and Forebay Dam above the TPP, presented here from right to left as viewers would see them.

1. Above Left Powerplant
2. Spillway West
3. Spillway East
4. Above Right Powerplant
5. South of Incline Elevator above TPP
6. North of Incline Elevator above TPP

The spillway (zones 2 and 3) provides the primary screen for the show. Water is spilled across the spillway specifically for the show, creating a brilliant white backdrop. Approximately 80 percent of the laser show is projected onto the spillway. Bleachers at the main viewing area face toward the spillway, and this is the closest and by far the visually largest screen as seen from all viewing areas. The other screens above the powerplants (zones 1, 4, 5 and 6) are used primarily for accent projections that extend the show's horizontal length and enhance the visual dynamics and sense of scale and distance. One commenter noted that "*some have dubbed the laser show the largest in the country precisely because it reaches that mile across the river* (to the TPP)." Moving shapes that go from one end to the other (zone 1 to 6) add to show's drama. According to the vendor that maintains the shows equipment and performance, concrete does not reflect lasers as well as the spillway, and the wall above the TPP in particular tends to mute the laser colors, softening the overall appearance of images.

3.9.1.3 Viewing Areas

Main Viewing Area

The primary and most popular location to watch the laser show is at the Visitor's Center, the only area formally provided by Reclamation for the public to view the laser show. As seen in Figure 3-32, the area includes bleacher seating at the main parking level and lawn seating on the lower level. Several high quality speakers are distributed throughout the viewing area to broadcast the show's narration and music.

Figure 3-32. Bleachers at the Visitor's Center main parking lot.

Secondary (non-Reclamation) Viewing Areas

Douglas Park is a City park located off Columbia Ave (SR155) two blocks past the Visitor's Center. This small city park provides access to good views along the dike. Speakers are not provided.

Freedom Point in Mason City Park was developed by the Town of Coulee Dam and local businesses. The Coulee House Inn and Suites has installed speakers to broadcast the audio signal provided by a local FM station.

Crown Point State Park Vista. One mile off of Hwy 174 West, this are provides a view from about 0.6 miles and 1,200 vertical feet higher than the top of the dam. No speakers are provided, and reception for the local FM broadcast is spotty.

Existing Lines (conductors) and Effects on Laser Show

While existing conductors number only about a third of that proposed, effects of existing lines may indicate how proposed lines might adversely affect the laser show.

3.9.1.4 Location of Lines in Relation to Laser Trajectories

Existing lines cross at two locations:

- **Right Powerplant (RPP) lines** cross in front of spillway; and,
- **Third Powerplant (TPP) backup lines** cross 1,250 feet downriver from the spillway

The RPP lines are within the path of laser trajectories for much of the show, as they drape across the spillway, the show's focal point. Backup lines intersect only with trajectories toward the TPP (zone 6).

RPP lines also span between all viewers and images, while the TPP backup lines are left of the main viewing area, but span in front of downriver viewing areas (Douglas Park, bridge, Freedom Point in Mason City Park, and Crown Point).

Existing Effects

Existing lines were evaluated for three types of effects:

1. Visible reflections from lasers hitting lines,
2. Shading or distortion of image caused by lines blocking laser; and,
3. Silhouetting of lines between viewers and projected image.

Visible Reflection

The RPP Lines cross the main laser projection zones of the Left Powerplant (zone 1), spillway (zones 2 and 3), and Right Powerplant (zone 4). Visible reflections occur intermittently along the length of the lines, changing with projection angles, location and movement.

The TPP backup lines intersect with trajectories toward the north end of the TPP (zone 6), and reflections may be seen from that area when images are projected toward the TPP left of the Incline Elevator (zone 6).

While reflections can be easily seen if looking for them, it is possible that most visitors may not even notice them, since the laser images are so powerful that they tend to dominate attention, leaving the scattered lines of light from reflection to fade in with the background. Even if noticed, line reflections do not seem to be of sufficient intensity to seriously interfere with enjoyment of the show. Reclamation staff and the contractor that manages the laser concur that existing lines are having little effect and that visitors have not complained about the lines and/or reflections.

Shading and Distortion

Existing lines do not noticeably distort images. According to the laser show manager, some blurring can be seen, but only if you are specifically looking for it and know what to look for.

For most people, the dynamic nature of the laser images masks any minor and intermittent distortions.

Silhouetting

Existing lines are silhouetted in front of bright laser images, but as with distortion effects, the narrow dark lines are difficult to notice, even when looking for them. From downstream viewing areas, the TPP backup lines also cross in front of views to the spillway (i.e., in addition to the RPP lines). From Douglas Park, TPP's backup lines appear to cross near the top of the spillway. From Freedom Point in Mason City Park area in east Coulee Dam, backup lines appear to cross along the lower edge of the spillway.

3.9.2 Environmental Consequences– Preferred Alternative

3.9.2.1 Direct Impacts

Proposed lines were evaluated for three types of effects: visible reflection from lasers hitting lines, shading or distortion of image caused by lines blocking laser, and silhouetting (lines silhouetted between viewers and projected image).

Location of Proposed Lines in Relation to Laser Trajectories

Based on three-dimensional project plans of the Preferred Alternative (prepared by BPA), the proposed overhead lines from the TPP would intersect with laser trajectories within four of the six zones that define the show:

- **Zones 5 and 6** above the TPP
- **Zone 4** above Right Powerplant, and
- **Zone 3** on the upper, far edge of the east spillway.

The amount of intersection with conductors would be greatest within zone 6 above the TPP, where four of the six proposed circuits (12 triplex conductors) would be present within and roughly parallel to laser trajectories. The proposed lines would also intersect with laser trajectories projected to the right of the elevator on above the TPP (zone 5), to the RPP (zone 4) and spillway (zone 3).

Reflection

As described under the affected environment, laser lights hitting transmission lines may reflect back to viewers, possibly distracting them from enjoying the show. Based on the number of lines and distance of possible reflection, lasers projected to zone six have the highest potential to generate reflections. For projections toward zone 6, lasers trajectories would cross the four circuits to be attached north of the Incline Elevator (12 triplex conductors and 12 ground wires) from a point approximately 950 feet in front of the projection booth. Reflections could continue along the entire length of the lines to the Forebay Dam.

For zones 5 and 4, lasers trajectories would cross the two circuits that would be attached south of the Incline Elevator. Reflections could start at a point approximately 2,000 feet and 1,400 foot distance from the projection booth, respectively, and continuing to the Forebay Dam wall (zone

5). For zone 3, lasers would cross the last (southernmost) circuit starting approximately 750 feet from the projection zone, and reflections may be seen from nearly in front of the main viewing area.

The visibility of reflection would change with viewing location. From the main viewing area, reflections would appear mostly left of line of sight to the main spillway. For downstream viewing locations, reflections may appear in front of the spillway when lasers are projected to zones 3 through 6.

Shading and Distortion

The effect considered here is that lines intersecting laser trajectories may cast shadows on the image being created. Three key factors tend to weigh toward a determination that shadowing effects would be minor on the main spillway (zone 3) and Right Powerplant (zone 4):

1. the lines are narrow (1.38 inch diameter),
2. the lines are relatively far from the projection booth (the closest of which would be 750 feet away) so that they are only intercepting a small portion of projected light, and
3. the lines are relatively far from projection screens and the screens are oriented at an angle to laser trajectories so that shadows would be dispersed over a large area.

The greatest potential for shading and/or distortion would occur to images projected on zones 5 and 6 (above the TPP), since these zones would have the most lines in between them and the projection booth. Effects could range from dimmed to blurred images. Dark concrete surfaces of the Forebay Dam of zones 5 and 6 tend to mute the colors reflected back to the viewing area, so the cumulative effect could exacerbate an existing lack of brilliance from this area.

Silhouetting

This section considers the effect of lines between viewers and projection zones. As described under the Affected Environment, existing lines cross in front of the spillway and are within line of sight from all viewing areas, while backup lines cross in front of downstream viewing locations only.

Under the Proposed Action, most lines would still be to the left of the spillway from the main viewing area at the Visitor's Center and, therefore, would not detract from the main and most vivid portion of the show. The majority of lines would be in front of views to the TPP (zones 5 and 6), where they may be sufficiently dense to interfere with views of images to these zones and, as evaluated in the previous section, where line reflections are likely to be visible.

For downstream viewers, lines would be directly in front of views of the spillway as are the existing back up lines. Existing lines do not interfere with views from this area, but the 12 transmission lines (6 duplex conductors) plus four ground wires would be replaced with 54 transmission lines (18 triplex conductors) and 18 ground wires. Proposed lines would also be more spread out vertically, compared to the existing lines that lay relatively flat. This creates more area of possible visual interference, but also disperses the profile of the lines (existing lines tend to stack up visually in one plane). Proposed lines would span across much of the spillway as viewed from the bridge and the Freedom Point in Mason City Park viewing area. The overall effect could range from some reduced perception of brightness to lines visibly silhouetted against

images projected on the main spillway. Silhouetting would be more likely when large, bright images are being projected onto the spillway.

Due to the brightness, size and movement of images, and darkness and thinness of the lines, the overall effect of the lines may be minor and it is possible that viewers may not notice the lines or that the lines may be noticeable but not distracting. However, the specific effect cannot be predicted with accuracy. Therefore, the assumed effect of proposed overhead lines would be that they would be noticeable from downstream viewing locations during portions of the laser show when a large area of the spillway is illuminated, particularly with green light, which creates the brightest images.

3.9.2.2 Indirect Impacts

The primary concern regarding indirect effect of adverse impacts on the laser show is that impacts to the show could reduce visitation and associated spending, with adverse effects rippling through the local economy. These effects are addressed in a separate section, but the primary conclusion made is that the intensity of predicted impacts on the laser show is not likely to be sufficient to cause reduce tourism or associated spending. With the possibility of a completely new laser system to replace the aging system now in place, opportunities exist to increase visitation by presenting and marketing a new show with new features.

3.9.3 Mitigation Measures

Because the existing laser equipment is out of date and due for replacement, Reclamation has an opportunity to avoid or minimize reflection and or other interference from proposed lines through design of a new show with new and improved equipment. An analysis of a revised show is outside the scope of this assessment, but based on conversations with the existing laser show contractor, improvements in laser technology made over the past 20 years provide many features that could be useful in creating a new and improved show, including:

- Laser projectors that are much smaller and less expensive and energy demanding than the existing units;
- Wireless technology that allow multiple projectors located at multiple projection points to be operated from a single location;
- Ability to generate a wider variety of laser images and effects;
- Use of LED technology to produce lighting effects to augment lasers, potentially replicating the functions of the *Bank of Lights* effects on the spillway;
- Ability to create multiple shows rather than a single show that is repeated (e.g., new shows could be made to appeal to specific audiences or for special events).

Collectively, these and other technologies provide promising opportunities for Reclamation to continue to provide the education and entertainment values provided by the existing laser light show.

3.9.4 Unavoidable Impacts Remaining After Mitigation

3.9.4.1 Main Viewing Area

The proposed overhead lines would likely interfere with laser projections, as currently configured, on the Forebay Dam above the TPP (zones 5 and 6). All 18 triplex conductors would be within the path of laser trajectories to these zones and interference could include reflections from various points along the lines or distortion of the image on the Forebay Dam. Effects would change with the image being projected, its movement, and its trajectory, among many other factors. While existing lines in front of the spillway do not appear to be detracting from visitor enjoyment, the number of lines within laser trajectories and views would be much greater, along with associated reflection. Because this question cannot be answered with certainty, for the purposes of evaluation and decision making, a worst-case conclusion would be that reflections may be sufficient to warrant elimination of zones 5 and 6 (above the TPP) from the show. Loss of these projection zones could reduce the sense of scale produced by images being shown across all six zones. However, the main viewing screen of the spillway would not likely be noticeably affected, leaving the broad, main projection area from zones 1 through 4 available for the laser show.

3.9.4.2 Secondary Viewing Areas

The area most affected (above the TPP) by lines is generally not visible to downstream viewers, so loss of that area would have less of an effect on these areas. Viewers from downriver locations may be able to see silhouetted lines in front of the spillway or reflections from lines in front or right of the spillway (when lights are directed toward the TPP and in the path of the 54 overhead transmission lines crossing over the river). Reflections are more likely to be noticeable than silhouetting, since reflections involve bright light whereas silhouetting involves thin dark lines. Silhouetting may be more noticeable when large, bright images are projected on the spillway, providing contrast and potentially reflecting light back toward the lines and illuminating them.

As with the main viewing area, most people may not notice line interference due to inattentional blindness as described under direct impacts. In addition, downstream viewers are further away from the lines and are also already exposed to background and street lighting, local distribution lines, passing cars and other disturbances. No complaints about these distractions could be found on on-line reviews or in discussions with Reclamation staff. This indicates that interference from the lines would likely be accepted by most people as just part of the overall visual setting of the show.

Changes to the existing laser show are unavoidable. Either the existing show would be slightly reduced in size (due to line interference above the TPP) or a new and different laser show would be provided. A new laser show that employs recent technology could replace and would likely improve the experience provided by the existing show. With careful planning and design, Reclamation could continue to provide an enjoyable light performance fitting for the scale and stature of Grand Coulee Dam, with no net adverse effect on visitor enjoyment or associated visitor numbers and spending.

3.9.5 Cumulative Impacts

Because the existing lines do not seem to be interfering with visitor enjoyment of the show, the primary effects to be considered remain with the direct impact of reflections, shadow and silhouetting from the proposed line. Reflections, shading, distortion and/or silhouetting from proposed overhead lines in zones 3 through 6 would add the interference already caused by the Right Powerplant lines that drape across the front of the spillway and Left Powerplant in front of projection zones 1, 2 and 3. The cumulative effect is that some line interference would occur in all zones of the show.

Another consideration for cumulative effects is that interference from lines in zones 5 and 6 (above the TPP) would be additive to existing limitations of this area caused by the dark color of concrete in this area, which already reduces the brightness of laser images above the TPP. The proposed lines would also interfere with images in this area so that collectively, zones 5 and 6 area may no longer be suitable for the show.

3.9.6 Environmental Consequences – Alternatives

3.9.6.1 Overhead Alternatives

Alternatives 1, 3 and 4 would interfere more with the laser show than the Preferred Alternative. The key difference with the other overhead alternatives is that towers would be located in front of the Visitor's Center. Even if the laser show projection booth was relocated to avoid the towers, they would still be visible from portions of the main viewing area in front of the Visitor's Center. The other overhead alternatives would also present a greater profile (length from lowest to highest line) than the Preferred Alternative. The Preferred Alternative would have the lowest total vertical profile at approximately 85 feet.

3.9.6.2 Rebuild Alternative

Under the Rebuild Alternative, no additional overhead lines would be placed within existing laser trajectories, so there would be no effect on the laser show.

3.9.6.3. No Action Alternative

Under the No Action Alternative, no direct impacts to the laser show would occur.

3.10 Cultural Resources and Tribal Consultation

3.10.1 Affected Environment

For cultural resources, the area of potential effect, or APE, is the geographic area where the character or use of historic properties (significant cultural resources) may directly or indirectly be altered because of a project undertaking (36 CFR 800.16) as depicted in Figure 3-33. A cultural resource is *significant* if it is found to meet criteria for eligibility to local, state or national registers, and if it possesses integrity of its original historical features and characteristics. The APE for the Proposed Action was developed in accordance with state and federal guidelines. The APE consists of a corridor spanning the Columbia River between the TPP and the Grand Coulee Dam, in portions of Douglas, Grant and Okanogan counties, Washington. The APE corridor buffers the proposed route of new transmission lines across the main channel of the Columbia, running in an east-west direction from the Forebay Dam toward the Grand Coulee Visitor's Center and surrounding public park, and then continuing across North Columbia Avenue and upslope to the 500-kV Switchyard, where Reclamation's project merges into the transmission network of the Bonneville Power Administration. The project's visual impacts extend the APE to the face of the Grand Coulee Dam (Kramer 2010).

3.10.1.1 Belowground Resources

In addition to literature reviews and background research, archaeologists conducted an inventory of the areas within the APE where proposed ground disturbing activities would take place. The purpose of this inventory was to relocate previously documented cultural resources, assess their condition, and identify additional new cultural resources. The inventory was conducted according to state and federal guidelines regulating cultural resource practice. Inventory transects were walked and spaced no more than 20 meters apart.

Research and fieldwork for the project resulted in the identification of four cultural resources in the APE, all located on the west side of the river. Table 3-4 summarizes these resources and National Register of Historic Places (NRHP) eligibility status.

Table 3-5 lists the Determination of Effect for sites for which the Washington Department of Archeology and Historic Preservation (DAHP) has concurred with NRHP Eligibility. These determinations of project effect have been discussed and coordinated by Reclamation, BPA, Washington DAHP, and the Confederated Tribes of the Colville Reservation Tribal Historic Preservation Office (THPO).

3.10.1.2 Aboveground Resources

Grand Coulee Dam, located across the main channel of the Columbia River, is the key feature in an irrigation and hydroelectric generation project that includes over 300 miles of canals, irrigating more than half a million acres in north central Washington State. The core industrial area surrounding the Grand Coulee Dam includes three powerplants that produce a peak capacity of 6,809 megawatts, and provide about 30 percent of the electricity used in the Pacific Northwest, making Grand Coulee one of the largest hydroelectric projects in the world. Additional resources located within the APE include transmission and recreation related

resources that were built as part of either the initial development of the Grand Coulee Dam or the subsequent TPP project. Individual built resources include:

- Grand Coulee Dam,
- The TPP, and public tour facilities including the tour bridge and viewing balcony,
- Specially designed steel tube transmission towers located above the 500-kV Spreader Yard where underground lines "daylight" from the tunnel,
- Visitor's Center,
- The 500-kV Spreader Yard,
- Spillway lighting (laser light show)

The Grand Coulee Dam complex, including the TPP and the Forebay Dam, has been previously determined eligible for listing on the National Register (Reclamation 2006, MOA 2010).

Table 3-8. Summary of Cultural Resources in the Project APE

Site # or Name	Site Type	NRHP Status
45GR2559	Historic railroad grade	Recommended Eligible
GC-Site-1	Historic building foundation	Recommended Not eligible*
GC-Iso-1	Fragments of historic glass	Recommended Not eligible*
GC-Iso-2	Historic wooden stumps	Recommended Not eligible*
Grand Coulee Dam	Historic dam	Recommended Eligible
TPP	Historic powerplant	Considered Eligible
Forebay Dam	Historic dam	Considered Eligible
Visitor's Center	Historic building	Recommended Eligible
500-kV Spreading Yard	Historic structure	Recommended Eligible

***** Consultation with SHPO regarding NRHP eligibility ongoing.

+ "Recommended eligible" means that a contractor or agency technical representative has recommended that the cultural resource be considered eligible for listing on the NRHP, but neither the land-managing agency or the appropriate SHPO/THPO have agreed that the property be considered eligible.

± "Considered eligible" means that there is a written document signed by Reclamation and the appropriate SHPO/THPO indicating their agreement that the property should be considered eligible for listing on the NRHP, but the Keeper of the National Register has not yet offered a determination.

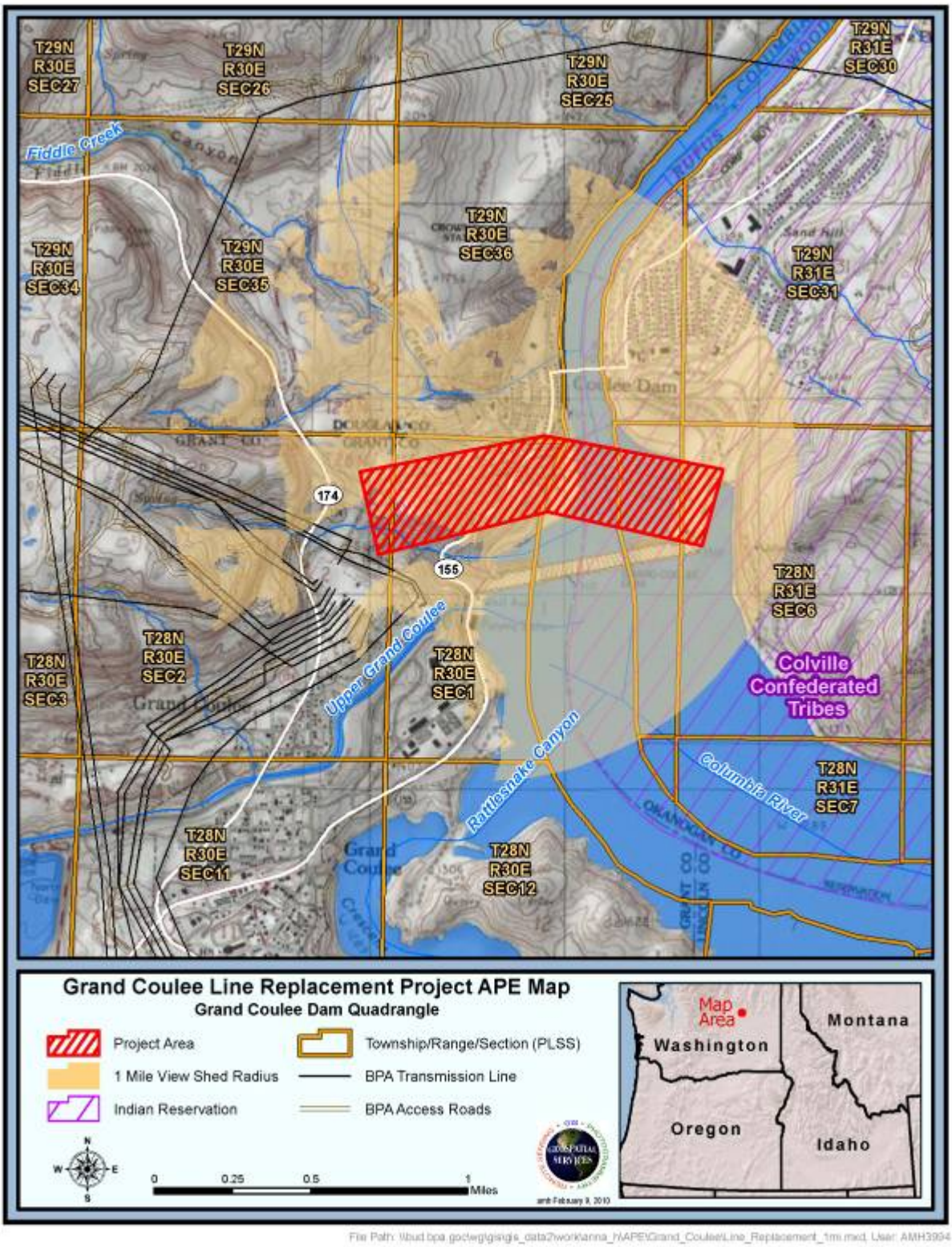

Figure 3-33. The Area of Potential Effects for the Proposed Action.

3.10.2 Environmental Consequences – Preferred Alternative

Analysis of the Preferred Alternative found multiple physical and visual effects on properties within the APE that have been previously considered eligible for listing on the National Register. These effects are further described below.

3.10.2.1 Belowground Resources

Physical Effects

Physical effects of the Preferred Alternative begin with the installation of metal anchor brackets, as described above, directly on the face of the Forebay Dam, necessary to anchor the individual takeoff cables, conductors, and ground wires of the overhead transmission line system. These brackets are to be made of galvanized steel and will be mounted to the Forebay Dam with masonry anchors. Figure 3-34 represents the anchoring that is present currently and gives an impression as to how the Proposed Action would also be anchored but with different transmission lines configurations if the project is approved.

Figure 3-34. Current anchoring of the backup lines to the Forebay dam.

Designed in a simple and generally compatible industrial fashion, the galvanized metal anchors will replace existing features of similar function as installed in 1981 as part of the temporary transmission line installation (shown in Figure 3-34). Because of the expansion to include all TPP generation, the anchors, and the lines, will be spaced in a manner that will occupy a considerable horizontal portion of the Forebay Dam. This will increase the visual, as well as physical, impacts of the installation by spreading the conductors out horizontally, to span much of both the Forebay Dam and TPP.

As noted above, the existing pedestrian tour bridge, a significant Breuer-designed element and a character-defining feature of the original TPP design, located between the Mid-Station of the Incline Elevator and TPP, will be removed. It is unclear at this point what, if any, of the bridge connection will remain at either the Mid-Station or the connection to the TPP wall, however concrete supporting elements of the bridge connections on both sides of the span will likely remain to document the change.

On the opposite shore of the Columbia River, below the Visitor's Center, the Proposed Action will require the removal of the existing lattice towers currently located within the park area. These features are not original to the TPP project, having been installed as an element of the 1981 emergency transmission line installation, and while their removal will alter the existing character, this aspect of the proposed line replacement project is not seen as having any effect on identified historic resources. The installation of new lattice towers, as required to support the new overhead lines, occurs entirely upslope from SR 155 and, amid the other extant transmission lines of the project, should have minimal impact.

The Proposed Action includes the removal of the existing lines in the tunnel through the Grand Coulee Dam which will return the tunnel to its original internal access function. Other tunnels will be abandoned in place. The 500-kV Spreader Yard will have oil-filled lines terminating-bushings removed. The existing take off structure will be used to terminate the new overhead lines and support connections to existing overhead conductors which lead to the 500-kV Switchyard. Most visible features will remain abandoned in place.

3.10.2.2 Aboveground Resources

Visual Effects

The proposed alternative requires an increase in the number of cross-channel overhead lines at Grand Coulee from six to eighteen, including the replacement of the existing lines (six) and the expansion of overhead transmission to accommodate the entire generation output the TPP's six units. As evaluated under Visual quality, the Proposed Action would result in the following visual effects:

1. Visible lines partially veiling views of the TPP and background topography;
2. Visible lines spanning over the open water below the dam, the Visitor's Center and the Visitor's Center grounds;
3. Three, approximately 300-foot tall towers would be visible behind the Visitor's Center and above SR 155;
4. Lines and towers may reduce the feeling of open space.
5. Visitors taking the public tour would no longer be able to enjoy views from the tour bridge, TPP and internal mezzanine, and external viewing balcony.

Effects would vary with ambient lighting. Transmission lines are expected to be most visible during morning to mid-day sunlight. Views of the main spillway of Grand Coulee Dam would not be affected.

Analysis of visual impacts of this three-fold increase in the number of cross-channel lines at the Grand Coulee Dam is complicated by the history of transmission systems at the site over the past seven decades. Overhead lines and latticework towers were intrinsic elements of the original construction at the Grand Coulee project. Overhead transmission remained at Grand Coulee, in varying degree, until the mid-1960s removal of the Right Switchyard. The routing of the RPP lines through the dam and the completion of the consolidated 230-kV Switchyard were performed as part of the modifications associated with the construction of the TPP. Overhead lines returned with the construction of the current overhead backup lines. As a result, with the exception of the short period during 1968 to 1981, Grand Coulee Dam has always had overhead transmission lines across the channel of the Columbia River downstream from the dam. The Preferred Alternative, while certainly differing in scale and design, in a sense simply re-establishes elements that were originally an obvious visual element in the character of the Grand Coulee Dam project.

However, the installation of overhead lines from the TPP is clearly in conflict with the original aesthetic intent that governed the design of the TPP. Reclamation's designs for TPP were in no small part driven by aesthetics and specifically led to a decision to reduce the visual impact by routing conductors through the dam. As a result, the Preferred Alternative would introduce non-historic overhead conductors above the TPP, Columbia River, Visitor's Center, and adjacent landscaped and parking areas.

Visual impacts on historic resources at the Grand Coulee Dam result from the potential superposition of the new overhead conductors in front of the TPP and over the Visitor's Center. Visual impacts to these resources, particularly the laser light show, have by design been substantially minimized by the adoption of the Preferred Alternative, with its high placement of lines specifically intended to avoid such effects.

Locating the proposed towers above the Visitor's Center under the Preferred Alternative would eliminate the possibility of them interfering with the laser light show. The transmission lines may cause some shadows during the show, but a revised show is planned that could be adjusted to accommodate the lines. Visual impacts of lines crossing SR 155 and heading upslope to the new towers flanking and east of the 500-kV Spreader Yard are minimal and generally compatible with the existing character. New towers will not duplicate the existing, historically significant, TPP Tubular towers, which will be retained to carry the new conductor at their existing locations.

Analysis of Effects

The visual changes of new transmission line attachments at the Forebay Dam, multiple overhead cabling across the river channel directly above the TPP and Visitor's Center, as well as the installation of new and taller transmission towers above SR 155, will have a moderate visual effect on the historic character of the core area of Grand Coulee. These visual changes would differ from the historic setting of the TPP project as initially envisioned by Reclamation and its design team, which purposefully minimized overhead transmission lines. These effects on historic character and intent of the TPP project are partially mitigated by the following factors:

- Overhead lines have been present at Grand Coulee Dam except for a small window of time immediately following the TPP addition. The historic condition of Grand Coulee Dam before the TPP addition included towers atop the Left and Right powerplants with

lines that ran to their respective switchyards. Overhead backup lines were reinstalled in 1981, including two towers located in on the lower Visitor's Center grounds. These lines and towers have been in place for nearly thirty years. In addition, overhead lines were added in 1985 from the Right Powerplant. These overhead lines both change the historical baseline as well as indicate that overhead lines do not appear to be reducing public enjoyment of the historic property.

- Power lines are similar in industrial nature to powerplants. People are generally not surprised to see power lines near powerplants, and lines may be considered visually consistent with the overall historic context of the TPP as one of the world's largest powerplants.
- Existing backup towers would be removed from below the Visitors Center, offsetting the effect of proposed lines creating overhead by providing more open space in front of the main visitor viewing area.

Direct physical effect, including the installation of new transmission line attachment points on the Forebay Dam, the abandonment of the existing transmission line route through the dam, tunnel and 500-kV Spreader Yard, would have little to no physical impacts to the historically significant character of the Grand Coulee Dam, the TPP, Visitor Center and other features.

High voltage overhead transmission lines at the Forebay Dam in the vicinity of the existing Visitor Bridge require removal of that feature and the denial of public access to the Mid-Station on the Incline Elevator. The tour bridge, integrally designed as part of the increased public amenity that was part of the TPP project, is considered a key element in the Breuer design. The abandonment of the Mid-Station, while of minimal physical impact, alters the functional role of that facility and diminishes visitor access to the interior of the TPP by precluding access to the bridge, and from the bridge to the interior visitor overlook.

The cumulative and individual effects of the proposed line replacement project are visual and physical impacts to historically significant elements of the TPP, determined a historically significant resource under National Register Eligibility criteria "A" and "C." Analysis of those effects confirm that this project will result in the physical removal of original elements of the TPP and Forebay Dam and the introduction of new, non-historic, visual elements that reduce the integrity of the Forebay Dam, TPP, Visitor's Arrival Center and associated historically significant properties.

Table 3-9. BPA Effect Determinations for Cultural and Historic Sites

Site	Effect Determination*	Notes
45GR2559	No Adverse Effect	Existing route of travel
GC-Site-1	No Effect	Not eligible, will be avoided
GC-Iso-1	No Effect	Not eligible, will be avoided
GC-Iso-2	No Effect	Not eligible, will be avoided
Grand Coulee Dam	Adverse Effect	Mitigation measures will be implemented
Third Powerplant	Adverse Effect	Mitigation measures will be implemented
Forebay Dam	Adverse Effect	Mitigation measures will be implemented
Visitor's Center	No Adverse Effect	Project will not adversely impact
500-kV Spreading Yard	No Adverse Effect	Project will not adversely impact

* Determinations of Effect resulted from the application of Criteria of Adverse Effect from 36s CFR 800.5.

3.10.3 Mitigation Measures

Reclamation is consulting with the Washington State DAHP under Section 106. This would likely result in a Memorandum of Agreement (MOA) that outlines agreed-upon measures that the agency will take to avoid, minimize, or mitigate the adverse effects. In some cases, the consulting parties may agree that no such measures are possible, but that the adverse effects must be accepted in the public interest.

The Preferred Alternative would result in a reduced visual impact (and associated impacts on historic character) by placing towers behind the Visitor's Center, rather than in front of it and on the Visitor's Center grounds as originally proposed by Alternative 1. Remaining effects of overhead lines cannot be avoided.

The loss of the historic tour bridge and viewing balcony portion of the TPP tour could be offset by providing an alternate tour, including opportunities to view from the top of the dam above the main spillway, as is currently being provided as a temporary tour replacement while the Incline Elevator has been out of order. Any improvements required for a replacement tour, such as railing or fencing, would need to be further evaluated for potential adverse effects on the historic character of the dam.

3.10.4 Unavoidable Impacts Remaining After Mitigation

Specific impacts include impacts to visitor's view of the dam from the Visitor's Center, and the removal of the tour bridge and viewing balcony portion of the TPP.

Provided that Reclamation, the Washington DAHP, and the Confederated Tribes of the Colville Reservation come to a MOA, there will be no unavoidable impacts remaining after mitigation.

3.10.5 Cumulative Impacts

The Proposed Action would result in a change from the cumulative effects baseline of no overhead transmission lines to all overhead transmission lines. The effect would be to:

- reduce the open space component as originally presented in 1978, including open space in front of viewers, to the side and overhead;
- partially veil views of the TPP;
- add three steel lattice towers (in addition to the existing 230-kV double-circuit tower for the Right Powerplant's lines);
- add visual clutter in addition to the Right Powerplant lines in front of the spillway.

Collectively, the number and shape and breadth of overhead lines could detract from the clean, bold architectural lines and vast open space of the baseline condition.

Because the backup towers and lines would be removed, the project would replace and expand the effects of those lines. Removal of towers from the Visitor's Center grounds would reduce overall cumulative effects, restoring the lower grounds to their baseline condition.

The permanent loss of the tour bridge and cantilevered balcony-portion of the tour would permanently extend a loss that has already occurred on a temporary basis due to mechanical problems with the elevator and bridge.

The Proposed Action would also convert what can still be considered temporary overhead lines with permanent lines. While Reclamation had no plans to remove the backup lines, they are redundant features and conceptually could be removed should a fully reliable and repairable internal configuration be designed. With the Proposed Action, such an option would no longer be considered, making an "irreversible commitment" to overhead lines from the TPP at Grand Coulee Dam

The effect of future storage buildings planned as part of the TPP Overhaul Project considered collectively with all overhead lines would result in further departure from the 1978 baseline condition. However, since the area has been a storage and staging area for various items related to the dam since 1978, the presence of buildings in this area would not be a significant change in overall aesthetics of the views. Architectural enhancements of the buildings could serve to allow the buildings to fit better within historic setting of the TPP and Dam.

3.10.6 Environmental Consequences – Alternatives

3.10.6.1 Overhead Alternatives

Alternatives 1, 3 and 4 would not reduce impacts to visual quality. The closure of the tour bridge would occur under all overhead alternatives. The major visual differences with other overhead alternatives would be:

- the first set of towers would be constructed on or near the lower Visitor Center grounds and within the field of view for people looking at the Third Powerplant; and,

- lines would be closer to the ground as they pass over the main viewing area of the Visitor Center (97 feet for Alternative 1; 150 feet for the Preferred Alternative).

3.10.6.2 Rebuild Alternative

The Rebuild Alternative would remove the existing oil-filled transmission lines and replace them with new lines of improved design and configuration, still within the dam gallery and transmission line tunnel. The Rebuild Alternative would not involve additional towers or overhead transmission lines and would result in little visual impact over that already in place from existing lines. Existing backup lines would likely need to be reenergized during the rebuild for up to two years and would could remain indefinitely as backup. Additionally, this alternative could allow removal of the existing backup lines installed in 1981 which would again consolidate all transmission lines from the TPP within the transmission line tunnel, re-establishing the original TPP design intent. Under this alternative, the TPP tour bridge would either need to be repaired, rebuilt, or removed.

3.10.6.3 No Action Alternative

Under the No Action alternative, existing backup lines and associated visual effects on historic properties would remain indefinitely. The TPP tour bridge would either need to be repaired, rebuilt, or removed.

3.11 Indian Trust Assets

3.11.1 Affected Environment

The Secretary of the Interior has defined Indian Trust Assets (ITAs) as *lands, natural resources, money or other assets held by the Federal government in trust or that are restricted against alienation for Indian tribes and individual Indians* (Interior Departmental Manual 303 DM 2, Secretarial Order No. 3215). Reclamation usually interprets this to mean that ITAs include water rights, lands, minerals, hunting and fishing rights, money and claims (USBR 1994).

Following this definition, Reclamation has not identified any potential ITAs within the area to be directly affected by the proposed project. All of the proposed construction activities would take place within Federal lands withdrawn or acquired by the U.S. for project purposes, and they are not held in trust for the Confederated Tribes of the Colville Reservation or for individual Indians. Congress also expressly directed the Secretary of the Interior (54 Stat. 703) to not establish *rights of hunting, fishing, and boating to the Indians in the areas* withdrawn for project purposes. Therefore, no reserved hunting or fishing rights exist within the project area.

It is important to note, the Confederated Tribes of the Colville Reservation have ITAs related to water rights on the Columbia River which runs through the middle of the Project Area. The Confederated Tribes of the Colville Reservation has water rights within the Reservation, and they have asserted claims for analogous rights in the waters that border the Reservation, including the Columbia River (Columbia River Initiative Agreement in Principle between the State of Washington and the Colville, January 4, 2005).

3.11.2 Environmental Consequences

Impact Indicator/Methods for Evaluating Impacts. The purpose of this discussion is to determine if implementation of the Proposed Action would impact the current ITAs that may be in the Project Area. This is a qualitative analysis which identifies the affected environment and perceived variables subsequent to the implementation of the Proposed Action. The indicator variable used in this analysis is the potential for the project, during either construction or operation, to affect access to ITAs or to reduce their value.

Alternatives 1, 2, 3, 4, and 5 would not result in any significant negative effects on ITAs. The project would not involve actions on trust lands nor would it further reduce the ability of Indians to hunt, fish, and boat within the Reservation. The project would not affect the amount of water available in the Columbia River below Grand Coulee Dam and would not affect any water rights that might be claimed by the Confederated Tribes of the Colville Reservation.

3.11.3 Mitigation Measures

None identified for any of the alternatives.

3.11.4 Cumulative Impacts

Many of the other projects to be undertaken at the Grand Coulee Dam over the foreseeable future involve other kinds of large maintenance projects. None of these other projects are likely to

result in significant negative impacts to ITAs. Therefore, this project would not result in cumulative effects.

3.12 Indian Sacred Sites

3.12.1 Affected Environment

Executive Order 13007, which was signed by President Clinton on May 24, 1996, defines "sacred site" as:

> "*Any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site* (E.O. 13007, Section 1(b)(iii))."

Members of the Confederated Tribes of the Colville Reservation often recognize that, in general, many aspects of the natural environment should be considered sacred, including water, land, air, and various plant and animal species. In their Cultural Resources management Plan (CCT 2006), the Confederated Tribes of the Colville Reservation grouped "sacred sites" with Traditional Cultural Properties and properties of traditional religions and cultural importance to tribes, both of which are address in the Cultural Resources Section.

The Project Area has undergone extensive construction-related disturbance, and the physical integrity of any sacred sites in this area would have been severely compromised. Furthermore, as a part of its security procedures, Reclamation has been obligated to curtail access to lands within the Project Area.

At this point in time, the Confederated Tribes of the Colville Reservation have not specifically identified any sacred sites within the immediate vicinity of the proposed Project Area. A number of locations with traditional Indian place names and traditional cultural value are in the general area of Grand Coulee Dam, but none of these have been specifically identified as having established religious significance or ceremonial use and they are well outside of the area of direct effects.

3.12.2 Environmental Consequences

Because no Indian Sacred Sites were identified in the Project Area, there would be no environmental consequences.

3.13 Socioeconomics and Environmental Justice

This section addresses socioeconomic conditions within the study area, including population, housing, principal economic activities, income and revenues, and a discussion of environmental justice as it relates to the Proposed Action.

For the purposes of this EA, the socioeconomic study area includes the Town of Coulee Dam, Grand Coulee, Electric City, and Elmer City as primary entities potentially affected by the proposed project. For comparison purposes, the Counties associated with the above cities (Douglas, Grant, and Okanogan Counties), Lincoln County, and the State of Washington are also included for a more robust comparison. In some instances, Coulee Dam data has been aggregated under Okanogan County, though the City is physically split between Douglas, Grant, and Okanogan Counties.

3.13.1 Affected Environment

3.13.1.1 Population and Demographics

The State of Washington and Douglas, Lincoln, Okanogan, and Grant Counties have undergone considerable growth in the last 20 years. As shown in Table 3-10 and Table 3-11, the State's population increased by 21.1% between 1990 and 2000 and another 15.2% between 2000 and 2010. Douglas, Grant, and Okanogan Counties have experienced similar growth, with the exception of Lincoln County, which has experienced only moderate growth in the last decade.

Cities in the study area have not experienced the same level of growth as the counties that represent them. Both Coulee Dam and Elmer City have experienced an overall population decrease since 1980. Between 1990 and 2000 Coulee Dam decreased in population by 7.4% with another 1.8% decrease in total population between 2000 and 2009. Elmer City has experienced heavier losses in the last 20 years, with a 10.1% loss in population between 1990 and 2000, and another 10.1% loss between 2000 and 2009 (Table 3-11). In contrast, Electric City and Grand Coulee have experienced growth in recent years, though each has a history of fluctuations. Between 2000 and 2009, Electric City and Grand Coulee increased their population by 6.8% and 4.8%, respectively.

Population estimates assume continued growth across both the state and County study areas for the next 20 years. Lincoln and Douglas Counties are expected to experience population growth that exceeds estimates for the State while Grant and Okanogan Counties are projected to experience slower growth rates in the next 20 years. Projection data for cities in the study area were unavailable for comparison.

Table 3-10. Historic Population Data and Projections 1960–2030

Location	Year of Incorporation or Formation[1]	Census Data[1]					Population Estimates[1]			Population Projections[2]		
		1960	1970	1980	1990	2000	2005	2008	2009	2010	2020	2030
Douglas County	**1883**	**14,890**	**16,787**	**22,144**	**26,205**	**32,603**	**34,700**	**37,000**	**37,600**	**39,222**	**44,877**	**49,627**
Coulee Dam *part*	1959	-	249	242	218	125	175	175	175	-	-	-
Grant County	**1909**	**46,477**	**41,881**	**48,522**	**54,798**	**74,698**	**79,100**	**84,600**	**86,100**	**88,389**	**95,623**	**100,449**
Coulee Dam *part*	1959	-	8	2	3	4	0	0	0	-	-	-
Electric City	1950	-	651	927	910	922	950	980	985	-	-	-
Grand Coulee	1935	-	1,302	1,180	984	897	925	935	940	-	-	-
Lincoln County	**1883**	**10,919**	**9,572**	**9,604**	**8,864**	**10,184**	**10,100**	**10,400**	**10,450**	**10,393**	**11,907**	**13,601**
Okanogan County	**1888**	**25,520**	**25,867**	**30,663**	**33,350**	**39,564**	**39,600**	**40,100**	**40,500**	**42,739**	**46,526**	**49,239**
Coulee Dam *part*	1959	-	1,201	1,195	906	915	850	850	850	-	-	-
Elmer City	1947	-	324	312	297	267	265	240	240	-	-	-
Washington State	**-**	**2,853,214**	**3,413,250**	**4,132,353**	**4,866,663**	**5,894,143**	**6,256,400**	**6,587,600**	**6,668,200**	**6,792,318**	**7,698,939**	**8,509,161**

[1] OFM 2009
[2] OFM 2009c

Table 3-11. Historic and Projected Population Change, 1980–2030

Place	Percent Change 1980–1990	Percent Change 1990–2000	Percent Change 2000–2010[1]	Percent Change 2010–2020	Percent Change 2020–2030
Douglas County	**18.30%**	**24.40%**	**20.30%**	**14.40%**	**10.60%**
Grant County	**12.90%**	**36.30%**	**18.30%**	**8.20%**	**5.00%**
Electric City	-1.8%	1.3%	6.8%	–	–
Grand Coulee	-16.6%	-8.8%	4.8%	–	–
Lincoln County	**-7.70%**	**14.90%**	**2.10%**	**14.60%**	**14.20%**
Okanogan County	**8.80%**	**18.60%**	**8.00%**	**8.90%**	**5.80%**
Elmer City	-4.8%	-10.1%	-10.1%	–	–
Coulee Dam	-21.7%	-7.4%	-1.8%	–	–
Washington State	**17.80%**	**21.10%**	**15.20%**	**13.30%**	**10.50%**

[1] City data are only calculated up to 2009, where data were available

As summarized in Table 3-12, U.S. Census Bureau numbers indicate the median age for residents statewide is 35.3. Lincoln County has a much higher overall average at 42.8. Although their respective counties are similar to the statewide average, cities in the study area are represented by a population 10 years older, suggesting that a high level of retirees or families with older-aged children represent their overall population. Individuals aged 55 years and older represent the highest demographic in Electric City, Grand Coulee, Coulee Dam, and Elmer City, at 37.7%, 36.6%, 30.7 percent, and 30.4 percent, respectively. In comparison, the statewide average for individuals over 55 is 19.6% (*See* Table 3-12).

Table 3-12. Age Characteristics, 2000

Place	Under 5 years	5–9 years	10–14 years	15–19 years	20–34 years	35–54 years	55–64 years	65+ years	Median Age (years)
Washington	**394,306**	**425,909**	**434,836**	**427,968**	**1,231,315**	**1,821,059**	**496,580**	**662,148**	**35.3**
	6.70%	**7.20%**	**7.40%**	**7.30%**	**20.90%**	**30.90%**	**8.40%**	**11.20%**	
Douglas County	**2,464**	**2,683**	**2,815**	**2,595**	**5,450**	**9,591**	**2,867**	**4,138**	**35.7**
	7.60%	**8.20%**	**8.60%**	**8.00%**	**16.70%**	**29.40%**	**8.80%**	**12.70%**	
Grant County	**6,524**	**6,600**	**6,719**	**6,519**	**14,645**	**19,232**	**5,841**	**8,618**	**31.1**
	8.70%	**8.80%**	**9.00%**	**8.70%**	**19.60%**	**25.70%**	**7.80%**	**11.50%**	
Electric City	41	59	73	63	95	298	123	170	46
	4.40%	6.40%	7.90%	6.80%	10.30%	32.30%	13.30%	18.40%	
Grand Coulee	49	41	67	73	100	247	108	212	45.3
	5.50%	4.60%	7.50%	8.10%	11.10%	27.50%	12.00%	23.60%	
Lincoln County	**584**	**675**	**802**	**726**	**1,200**	**3,017**	**1,248**	**1,932**	**42.8**
	5.70%	**6.60%**	**7.90%**	**7.10%**	**11.80%**	**29.60%**	**12.30%**	**19.00%**	
Okanogan County	**2,493**	**3,008**	**3,374**	**3,137**	**6,156**	**11,694**	**4,145**	**5,557**	**38.2**
	6.30%	**7.60%**	**8.50%**	**7.90%**	**15.60%**	**29.60%**	**10.50%**	**14.00%**	
Coulee Dam	52	75	69	67	151	309	109	212	44.5
	5.00%	7.20%	6.60%	6.40%	14.50%	29.60%	10.40%	20.30%	
Elmer City	8	12	28	28	27	83	41	40	43.1
	3.00%	4.50%	10.50%	10.50%	10.10%	31.10%	15.40%	15.00%	

Source: U.S. Census 2000

3.13.1.2 Housing Characteristics

The project vicinity is characterized by historic, cottage-like homes, many of which were built to house engineers that worked on the construction of the dam. Ten single-family homes are located above the shoreline and are the closest residences to the proposed project. Residences north of the bridge and east of SR 155 are outside of the primary viewshed of the dam.

Since 2005, the State of Washington has experienced a downturn in housing production when compared to rates experienced between 2000 and 2005. Cities representing the study area have experienced similar downturns. Since 2005, only one house has been constructed in Coulee Dam town, two in Grand Coulee, ten in Elmer City, and 12 in Electric City (*See* Table 3-13).

Table 3-13. Change in Total Housing Units, 2000–2009

Geography	2000[1]	2005[2]	2009[2]	Total Change 2000–2005	Total Change 2005–2009	Total Change 2000–2009
Washington	**2,451,075**	**2,665,702**	**2,837,528**	**8.8%**	**6.4%**	**15.8%**
Douglas County	**12,944**	**13,992**	**15,544**	**8.1%**	**11.1%**	**20.1%**
Grant County	**29,081**	**31,442**	**34,665**	**8.1%**	**10.3%**	**19.2%**
Electric City	408	444	456	8.8%	2.7%	11.8%
Grand Coulee	534	542	544	1.5%	0.4%	1.9%
Lincoln County	**5,298**	**5,572**	**5,849**	**5.2%**	**5.0%**	**10.4%**
Okanogan County	**19,085**	**20,133**	**21,112**	**5.5%**	**4.9%**	**10.6%**
Coulee Dam[3]	505	533	534	5.5%	0.2%	5.7%
Elmer City	129	129	139	0.0%	7.8%	7.8%

[1] US Census 2000b
[2] OFM 2009c

Cities in the study area have also experienced high vacancy rates compared to the state, which could explain the low housing construction rates. Home values in the study area are also much lower than their representative counties, and particularly when compared to the state. Part of this disparity could be attributed to an aging housing stock, slow population growth, and a relatively older and entrenched population (*See* Table 3-14).

Table 3-14. Selected Housing Characteristics, 2000

Geography	Total Housing Units	Vacancy Rate	Total Owner-Occupied Units	Median Home Value	Median Age of Housing
Washington	**2,451,075**	**7.30%**	**1,157,462**	**$168,300**	**1974**
Douglas County	**12,944**	**9.40%**	**5,630**	**$134,600**	**1975**
Grant County	**29,081**	**13.30%**	**10,066**	**$99,500**	**1973**
Electric City town	408	7.10%	235	$85,900	1972
Grand Coulee city	534	22.80%	181	$69,200	1955
Lincoln County	**5,298**	**21.60%**	**2,064**	**$83,500**	**1961**
Okanogan County	**19,085**	**21.30%**	**5,745**	**$91,400**	**1973**
Coulee Dam town	505	10.90%	296	$80,700	1949
Elmer City town	129	14.70%	61	$66,400	1964

Source: US Census 2000b

3.13.1.3 Employment & Income

Douglas County

Douglas County has a land mass of 1,801 square miles and a population density of 20.65 persons per square mile, suggesting a predominately rural character. Its largest city is East Wenatchee, followed by Bridgeport with 11,660 and 2,080 in population, respectively (OFM 2009b). The service industry is the primary employer in Douglas, followed by goods production, natural resource mining, and trade, transportation and utilities (*See* Table 3-15).

As of December 2009, Douglas County's unemployment rate was at 9.3%, a rate that fluctuated as high as 10.1% in March and as low as 6.0% in July (*See* Table 3-16). Median household income in Douglas County was at $43,777 in 2000, higher than other counties representing the study area, but 19% less than the statewide average of $53,750 (*See* Table 3-17).

Grant County

Grant County has a land mass of 2,681 square miles and a population density of 32.00 persons per square mile in 2009. Its largest city is Ephrata, followed by Electric City with 7,110 and 985 in population, respectively (OFM 2009b). The service industry is the primary employer in Grant, followed by goods production, natural resource mining, and local government (*See* Table 3-15).

As of December 2009, Grant County's preliminary unemployment rate was at its highest of 12.5%, a rate that fluctuated throughout the year, but was as low as 7.2% in September (*See* Table 3-16). Median household income in Grant County was at $35,276 in 2000 – midrange than compared to other counties representing the study area, but 34% less than the statewide average of $53,750 (*See* Table 3-17).

Okanogan County

Okanogan County has a land mass of 5,268 square miles and a population density of 7.69 persons per square mile, suggesting a predominately rural character. Okanogan County is also the largest in the State (OFM 2009b). Its largest city is Omak, followed by Okanogan with 4,780 and 2,495 in population, respectively. Trade, transportation and utilities are the primary employer in Okanogan, followed by goods production, local government, and natural resources and mining (*See* Table 3-15).

As of December 2009, Okanogan County's unemployment rate was at 12.5%, a rate that was as high as 13% in March and as low as 6.5 percent in July (*See* Table 3-16). Median household income in Okanogan County was at $29,726 in 2000, the lowest of any county representing the study area and 45% less than the statewide average of $53,750 (*See* Table 3-17).

Lincoln County

Lincoln County has a land mass of 2,311 square miles and a population density of 4.52 persons per square mile, the lowest in any county representing the study area (OFM 2009b). Its largest city is Davenport, followed by Odessa with 1,740 and 960 in population, respectively. Local Government is the primary employer in Lincoln, followed by service industries, trade and transportation, and goods production (*See* Table 3-15).

Table 3-15. Employment by Industry, 1st Quarter 2009

Ownership	Washington		Douglas County		Grant County		Lincoln County		Okanogan County	
	Average	% of Total	Average	% of Total	Average	% of Total	Average	% of Total	Average	% of Total
Total Covered	**2,809,239**	**100.0%**	**9,548**	**100.0%**	**31,182**	**100.0%**	**2,734**	**100.0%**	**15,039**	**100.0%**
Federal Government	**70,366**	**2.5%**	**180**	**1.9%**	**618**	**2.0%**	**66**	**2.4%**	**410**	**2.7%**
State Government	**131,550**	**4.7%**	**127**	**1.3%**	**745**	**2.4%**	**59**	**2.2%**	**264**	**1.8%**
Local Government	**323,199**	**11.5%**	**1,873**	**19.6%**	**6,099**	**19.6%**	**1,159**	**42.4%**	**4,133**	**27.5%**
Private	**2,284,124**	**81.3%**	**7,367**	**77.2%**	**23,720**	**76.1%**	**1,449**	**53.0%**	**10,232**	**68.0%**
Goods-Producing	*493,191*	*17.6%*	*2,734*	*28.6%*	*11,578*	*37.1%*	*416*	*15.2%*	*4,519*	*30.0%*
Natural Resources and Mining	*69,953*	*2.5%*	*2,008*	*21.0%*	*6,541*	*21.0%*	*282*	*10.3%*	*3,695*	*24.6%*
Construction	*15,3137*	*5.5%*	*377*	*3.9%*	*1,213*	*3.9%*	*101*	*3.7%*	*498*	*3.3%*
Manufacturing	*270,101*	*9.6%*	*350*	*3.7%*	*3,824*	*12.3%*	*34*	*1.2%*	*325*	*2.2%*
Service-Providing	*1,790,933*	*63.8%*	*4,633*	*48.5%*	*12,142*	*38.9%*	*1,033*	*37.8%*	*5,713*	*38.0%*
Trade, Transportation, and Utilities	*510,452*	*18.2%*	*1,954*	*20.5%*	*5,107*	*16.4%*	*499*	*18.3%*	*2,076*	*13.8%*
Information	*104,546*	*3.7%*	*135*	*1.4%*	*204*	*0.7%*	*23*	*0.9%*	*114*	*0.8%*
Financial Activities	*141,460*	*5.0%*	*270*	*2.8%*	*733*	*2.4%*	*92*	*3.4%*	*352*	*2.3%*
Professional and Business Services	*318,851*	*11.4%*	*400*	*4.2%*	*1,047*	*3.4%*	*88*	*3.2%*	*429*	*2.9%*
Education and Health Services	*349,913*	*12.5%*	*640*	*6.7%*	*1,822*	*5.8%*	*118*	*4.3%*	*1,223*	*8.1%*
Leisure and Hospitality	*258,455*	*9.2%*	*992*	*10.4%*	*2,221*	*7.1%*	*132*	*4.8%*	*1,102*	*7.3%*
Other Services	*107,256*	*3.8%*	*242*	*2.5%*	*1,007*	*3.2%*	*82*	*3.0%*	*419*	*2.8%*

Source: BLS 2009

As of December 2009, Lincoln County's preliminary unemployment rate was at 8.9%, a rate was as high as 10% in March, and as low as 7.2% July through September (*See* Table 3-16). Median household income in Lincoln County was at $35,255 in 2000, midrange when compared to other counties representing the study area, but 34% less than the statewide average of $53,750 (*See* Table 3-17).

Table 3-16. County Labor Force Statistics, December 2009

Area	Labor Force	No.of Employed	No.of Unemployed	Unemployment Rate %
Okanogan County	20,130	17,610	2,520	12.5
Lincoln County	4,710	4,290	420	8.9
Grant County	39,640	34,690	4,950	12.5
Douglas County	19,920	18,070	1,850	9.3
Washington State	3,502,840	3,168,570	334,270	9.5

Source: ESD 2010

Table 3-17. Median Income, 2000

Place	Median Family Income	Per Capita Income	Median Household Income
Washington	**$53,760**	**$22,973**	**$45,776**
Douglas County	**$43,777**	**$17,148**	**$38,464**
Grant County	**$38,938**	**$15,037**	**$35,276**
Electric City	$47,969	$19,388	$42,321
Grand Coulee	$29,375	$13,639	$21,818
Lincoln County	**$41,269**	**$17,888**	**$35,255**
Okanogan County	**$35,012**	**$14,900**	**$29,726**
Coulee Dam	$45,066	$18,791	$37,391
Elmer City	$38,000	$16,366	$32,500

Source: U.S. Census 2000b

3.13.1.4 Tourism

Tourism is a major component of the Grand Coulee Dam area's economy. Many local businesses depend on visitor spending, including motels, restaurants, RV parks and campgrounds, convenience stores, gas stations, gift shops, marinas and golf courses. People who work in these businesses also support base community businesses such as grocery and hardware stores, restaurants, pharmacies, health and professional services, car dealerships, and contractors, among others.

Two hotels are located in the Town of Coulee Dam: the Columbia River Inn, immediately north of the Visitor's Center, and the Coulee House Inn and Suites, located across the river in east Coulee Dam. The Columbia River Inn is located on a lot abutting Reclamation lands and/or right-of-way. Existing backup lines cross over the pool area. The Coulee House Inn and Suites is located downstream of the dam at approximately 0.6 mile distant from the spillway.

Many campgrounds are located in the general area, providing more total accommodations than area hotels. Privately owned operations catering to visitors include Coulee Playland Resort, Grand Coulee RV Park, King's Court RV Park, Sunbanks Resort, Lakeview Terrace, and Reynolds Resort. Spring Canyon Campground is a federally owned campground managed by the National Park Service and is located within the Lake Roosevelt National Recreation Area. Steamboat Rock State Park is a popular facility on Reclamation lands operated by the Washington State Parks and Recreation Commission.

The Coulee Dam Casino is one of two casinos serving the North Central Washington area. The casino generates revenues from the project vicinity as well as from visitors coming specifically for the casino.

Grand Coulee Dam

Visitors come to Grand Coulee Dam from around the world. Regional visitors include people who drive to the area from throughout the Pacific Northwest. In general, regional visitors are more likely to stay at local motels, eat at local restaurants, and attend the laser light show. International visitors are more likely to travel through the area as part of tours.

Visitor opportunities at Grand Coulee Dam include the dam and Visitor's Center, the powerplant tour, and the nightly laser light show. The typical season for visitation falls between Memorial Day and Labor Day. The Fourth of July celebration is known as the biggest annual event with several thousand people attending each year.

Reclamation conducts traffic counts at the upper parking lot to estimate visitor numbers. Estimated annual attendance is approximately 300,000 and varies from year to year depending on several outside factors. About an eight percent down trend in visitors was noted for 2008, a year of record high gas prices. Vacation travel was down nationwide during the summer of 2009 due to the economic downturn. The summer of 2010 showed improvement, with an eight percent increase in travel over 2009 for the Pacific region. This is attributed to the strengthening economy and pent-up travel demand (Seattle Times 2010).

3.13.1.5 Environmental Justice

Presidential Executive Order 12898, entitles *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 Fed. Reg. 7629 1994), instructs Federal agencies to incorporate environmental justice as part of their mission. As such, Federal agencies are directed to identify and address as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations.

Minorities are defined as individuals who are members of the following population groups: Native American or Alaska Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. To classify as a minority population, an area must have a population of these groups that exceeds 50 percent of the total population, or the minority population percentage of the

affected area should be meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis (59 Federal Register 7629).

The population in the study area is predominately white, with a high percentage of American Indian populations in the towns of Coulee Dam, Elmer City, and Grand Coulee (29%, 36% and 13%, respectively) (*See* Table 3-18). A 4.9% Hispanic population resides in Grand Coulee and Elmer City (*See* Table 3-19). More information related to minority demographics and Hispanic or Latino populations in the study area can be found in Table 3-18 and Table 3-19.

The Confederated Tribes of the Colville Reservation represent the majority of the American Indian population in the study area. The Reservation is located in the southeastern section of Okanogan County and in the southern half of Ferry County. Approximately 12% of Okanogan County residents are of American Indian descent.

Low-income populations are groups with an annual income below the poverty threshold, which was $17,463 for a family of four in 2000. Poverty status for families in the study area varies from place to place. Grand Coulee City has the highest poverty rate at 11.7%, followed by Electric City at 11.6%, Elmer City at 11.74%, and Coulee Dam at 6.7%. Each City in the study area has a lower family poverty rate than its representative County (*See* Table 3-20).

Table 3-18. Minority Demographics within the Study Area.

Place	Total Population		White		Black or African American		American Indian and Alaska Native		Asian		Native Hawaiian and Other Pacific Islander		Some Other Race	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Washington State	**5,680,602**	**96.4**	**4,821,823**	**82**	**190,267**	**3.2**	**93,301**	**1.6**	**322,335**	**6**	**23,953**	**0**	**228,923**	**3.9**
Douglas County	**31,794**	**97.5**	**27,599**	**85**	**101**	**0.3**	**355**	**1.1**	**178**	**1**	**31**	**0**	**3,530**	**11**
Grant County	**72,451**	**97**	**57,174**	**77**	**742**	**1**	**863**	**1.2**	**652**	**1**	**53**	**0**	**12,967**	**17**
Electric City	901	97.7	826	90	2	0.2	65	7	6	1	1	0	1	0.1
Grand Coulee	888	99	729	81	10	1.1	112	13	12	1	0	0	25	2.8
Lincoln County	**10,020**	**98.4**	**9,740**	**96**	**23**	**0.2**	**166**	**1.6**	**25**	**0**	**7**	**0**	**59**	**0.6**
Okanogan County	**38,440**	**97.2**	**29,799**	**75**	**109**	**0.3**	**4,537**	**12**	**176**	**0**	**28**	**0**	**3,791**	**9.6**
Coulee Dam	992	95	674	65	3	0.3	304	29	5	1	0	0	6	0.6
Elmer City	254	95.1	145	54	4	1.5	96	36	1	0	0	0	8	3

Source: US Census 2000b

Table 3-19. White and Hispanic or Latino

Place	Hispanic or Latino (of any race)		Not Hispanic or Latino		Not Hispanic or Latino; White Alone	
	#	%	#	%	#	%
Washington	**441,509**	**7.5**	**5,452,612**	**93**	**4,652,490**	**79**
Douglas County	**6,433**	**19.7**	**26,170**	**80**	**25,179**	**77**
Grant County	**22,476**	**30.1**	**52,222**	**70**	**48,883**	**65**
Electric City	17	1.8	905	98	814	88
Grand Coulee	44	4.9	853	95	716	80
Lincoln County	**191**	**1.9**	**9,993**	**98**	**9,632**	**95**
Okanogan County	**5,688**	**14.4**	**33,876**	**86**	**28,362**	**72**
Coulee Dam	29	2.8	1,015	97	662	63
Elmer City	13	4.9	254	95	142	53

Source: US Census 2000b

Table 3-20. Poverty Status, 2000

Place	Family Poverty Status	Percent	Individuals; 18 Years and Over	Percent
Washington	**110,663**	**7.3%**	**409,479**	**9.6%**
Douglas County	**996**	**11.2%**	**2,614**	**11.5%**
Grant County	**2,458**	**13.1%**	**7,439**	**14.9%**
Electric City	34	11.6%	79	11%
Grand Coulee	28	11.7%	118	17.4%
Lincoln County	**249**	**8.4%**	**812**	**10.8%**
Okanogan County	**1,697**	**16%**	**5,233**	**18.5%**
Coulee Dam	21	6.7%	66	8%
Elmer City	8	11.4%	32	15.4%

Source: US Census 2000b

3.13.2 Environmental Consequences – Preferred Alternative

3.13.2.1 Impacts Common to All Overhead Action Alternatives

Economy

The Proposed Action would require a relatively small and temporary work force. Workers are expected to be contractors primarily from outside the area. Workers would likely stay at local area hotels and eat at local restaurants during the work week and may stay over or travel home, depending on where they live. Changes in local population and local employment and/or unemployment rates resulting from construction of the Proposed Action are expected to revert to pre-construction levels once construction is complete.

Local workers are expected to remain in their existing lodging, creating no demand for new lodging. Non-local workers would require local lodging during the project construction period. Existing local lodging is expected to be sufficient for both the local construction workers and the potential temporary relocation of non-local workers to the area, as a result of the existing the number of hotels/motels throughout in the area. Public services and utilities (police protection, fire protection, medical services, schools, and utilities) would not be adversely affected because no long-term increase in the local population is expected to occur as a result of implementation of the Proposed Action.

The Proposed Action is an upgrade to an existing transmission line, with the upgraded replacement poles to be located in substantially the same location as the existing poles, so construction impacts would occur in an area that has already been disturbed. The percentage of minority and/or low-income populations in the four counties is low, and because the majority of the area in the vicinity of the ROW is undeveloped open space (rather than residential), minority and/or low-income populations would not be exposed to disproportionately high and adverse human health or environmental effects, so no impacts on minority or low-income populations (environmental justice impacts) are expected.

Tourism

Public Safety Perceptions. It is possible that some visitors may be intimidated by the presence of live lines over much of the Visitor's Center grounds, particularly during wet weather, when the lines may emit buzzing and crackling sounds. Returning visitors may be more likely to notice the lines than would first time visitors, who would not have preconceived expectations. However, transmission lines are a necessary and expected feature of a major hydroelectric dam, and visitors have a reasonable expectation that public safety will be provided for in a facility run by the Bureau of Reclamation. Based on these considerations, people are not likely to be deterred from visiting Grand Coulee Dam out of fears for their safety posed by the lines.

Columbia River Inn. The Proposed Action would result in more lines visible but at a greater distance. Proposed lines would be set back further than existing lines. Proposed overhead lines would be energized, where existing overhead lines within the vicinity of the Inn are not. During wet weather, high-voltage power lines make noise and could be audible by guests at the pool. This could make some people uneasy with using the pool during wet weather. However, the overall visual and audible effect would not be expected to reduce the use or amenity value of the pool, as people typically use outdoor pools during dry conditions, when lines make little if any

noise. It is difficult to predict with confidence how hotel guests (or potential hotel guests considering a stay) would react to the lines near the motel pool, but the fact that lines already cross the near the pool and that proposed lines would be set back farther increase the likelihood that most people would not react negatively to the lines.

Coulee House Inn and Suites. For the east Coulee Dam commercial area, proposed overhead lines would be visible from the Coulee House Inn and Suites and from the window seats at Melody's restaurant. This could interfere with views of the show from east Coulee Dam, including guests at the Coulee House, but the show is expected to remain viewable and enjoyable from this area, resulting in no impact to visitor experience.

Grand Coulee Dam. Under the Proposed Action, Reclamation would remove tour bridge portion of the public tour that travels to and through the TPP to an observation balcony. These components were built into the TPP specifically for public use and enjoyment of the facility, and loss of these features would reduce visitor experiences and opportunities associated with the tour. However, mitigation options identified as part of the public tour special report provide promising opportunities to replace the values lost from closure of the bridge and balcony, such as providing visitor access to the top of the dam as has been done when the Incline Elevator is out of service.

Environmental Justice

None of the counties or communities in the study area have minority populations that exceed 50 percent of their respective total populations or have minority populations that are meaningfully greater than the state average. None of the nearby communities or the counties had 20 percent or more of residents below the poverty level. Construction and operation of the proposed overhead alternatives is not expected to have high and adverse human health or environmental effects on nearby communities and no environmental justice impacts are anticipated.

3.13.2.2 Preferred Alternative

Housing

High-voltage transmission lines have variable effects on residential property values, with five key contributing factors:

1. proximity to towers and lines;
2. the view of towers and lines;
3. the type and size of structures;
4. the appearance of easement landscaping; and
5. surrounding topography (Pitts and Jackson 2007).

Many studies have found no adverse effect on property values. Where found, property value reductions have ranged less than 10 percent.

The Preferred Alternative would provide 478 feet of separation between conductors and the nearest residential property. Proposed towers would not likely be visible from the closest residences located along the shoreline. Existing towers that are partially visible from these

residences would be removed. Transmission lines would be visible within views of the TPP and spillway.

Towers would be in the range of 300 feet tall and are proposed to be set back further from residential properties. Towers would not be visible from shoreline residences and would be separated from residential properties by several trees located along the northern edge of Reclamation's Visitor's Center grounds. Proposed towers would be located behind the Visitor's Center and would likely be screened from nearby residential properties by topography.

Current conditions include existing overhead lines and many local distribution transmission lines. The Preferred Alternative would not result in a dramatically different visual setting from residential properties, with the exception of views to the dam.

Based on the above factors, the Proposed Action is expected to have no impact on property values of nearby homes.

Tourism

Grand Coulee Dam

- **Laser Light Show**. The proposed line configuration for the Preferred Alternative would span over the Visitor's Center and avoid visual impact to the main viewing areas for the laser light show. It is expected that visitors would have the same experience as with current configurations, resulting in no change to visitor willingness to attend the show. With no impact on the main viewing areas, project effects on the laser show are not likely to reduce visitor numbers to Grand Coulee Dam and would not affect visitor spending or occupancy rates at local hotels.
- **Visitor's Center Grounds**. This alternative would span over the Visitor's Center and eliminate the need for towers in the park, thereby reopening the area currently occupied by backup towers.

3.13.3 Mitigation Measures

As evaluated in the key issue assessments, the project is not likely to adversely affect visitor experiences or opportunities to the point that the local economy would be noticeably harmed.

3.13.3.1 Preferred Alternative

Alternative 2 was developed specifically to minimize impacts by:

- increasing separation from adjacent, non-federal lands; and
- placing towers on the hills behind the Visitor's Center, rather than below it as originally planned, thereby eliminating the direct project footprint within theVisitor's Center grounds and impacting the laser light show.

3.13.3.2 All Overhead Alternatives

Additional mitigation options identified for other key issues would also serve to maintain and potentially enhance visitor experiences and opportunities, including

- Laser Show Upgrade Plan

- Visitor's Center Grounds Restoration Plan

Finally, Reclamation coordinates with the local business community by participating in weekly meetings of the Grand Coulee Dam Area Chamber. Reclamation also participates in the Lake Roosevelt Forum,[5] together with the National Park Service, BPA, county and tribal governments, and several members of the business community, general public and organizations.

Because of theses mitigating factors and overall low level of anticipated impacts additional mitigation options may not be needed to address public concerns regarding the local economy. However, the following option has been identified for consideration as part of the overall planning effort.

3.13.3.3 Project Promotion and Publicity

An improved laser show and the addition of top-of-dam public tour stops or other new tour components would likely prompt additional visits to the dam as well as present opportunities to promote the dam. Mitigation options for the laser show include possibly multiple shows to be performed, with options for laser shows intended for specific audiences or events, rather than the single "one-size-fits-all" show that is presented now. The proposed project presents new opportunities to tell the Grand Coulee Dam story, including the ongoing overhaul of the TPP and replacement of existing transmission lines. A new documentary genre has developed around large engineering-related projects, such as the National Geographic program "World's Toughest Fixes" and "Extreme Engineering" of the Discovery and Science Channels. In addition, local and regional TV magazines might be interested in telling the ongoing story. Marketing efforts could include discussions with these and similar programs on interest in documenting the effort and in promoting Grand Coulee Dam.

3.13.4 Unavoidable Impacts Remaining After Mitigation

No unavoidable impacts on socioeconomics or minority or low-income populations (environmental justice impacts) are expected.

3.13.5 Cumulative Impacts

3.13.5.1 Reasonably Forseeable Future Projects

- Proposed Osbourne Bay vacation homes and golf course
- Proposed New Marina at Cescent Bay on Lake Roosevelt.
- Proposed new school and the possibility of a community center.
- Reclamation funding future upgrades to laser light show equipment.
- Reclamation's TPP Overhaul Project

[5] http://www.lrf.org/index.html

3.13.5.2 Other Economic Stressors

The local economy is under stress from several sources, including many inherent to struggling rural areas throughout the nation, such as low employment, out-migration of younger people, and the national recession and housing crisis (Pew Research Center 2010). Effects of the project on the local economy need to be considered collectively within this existing context.

However, based on the evaluation just presented, the proposed line replacement project would not be expected to reduce visitation to the dam at levels meaningful to discussions regarding the overall economy resulting from the cumulative stress factors currently affecting the region and nation.

3.13.6 Environmental Consequences – Alternatives

3.13.6.1 Overhead Alternative

Alternatives 1, 3 and 4 require towers to be placed in or below the Visitor's Center grounds, directly impacting both the laser show and festival grounds. Alternative 4 would address space issues by locating towers below the Visitor's Center grounds. However, the placement of the towers here would likely interfere with the laser show as well as overall visual setting of the dam.

3.13.6.2 Rebuild Alternative

With a Rebuild Alternative, existing towers would remain in the park until probably at least 2014 and could remain indefinitely. The central portion of the Visitor's Center grounds would remain free of overhead lines and the visual character of the area would remain the same. No changes to existing economic conditions are expected as a result of this alternative.

3.13.6.3 No Action Alternative

Under the No Action Alternative, the existing backup towers would remain within the lower Visitor's Center grounds. The lines could be reenergized at any time in the event of failure of one or more transmission lines within the dam. Should such an event occur, Reclamation estimates that replacement in-kind (i.e., internal transmission lines) could take up to three years, so an addition line may need to be installed.

3.14 Public Health and Safety

3.14.1 Affected Environment

3.14.1.1 Vehicle Travel and Aircraft

The existing environment includes persons who live or recreate near the existing transmission line, as well as travelers on State Route 155 on the west side of the river. Traffic on roads in the vicinity of the ROW is higher during the summer and early fall than during winter and early spring. State Route 155 is a major access route to tourist visiting the dam.

Transmission facilities can potentially harm humans through contact. The Federal Aviation Administration (FAA) establishes requirements for towers and other tall structures that would potentially interfere with aircraft safety. Typically, structures taller than 200 feet would require flashing warning lights for aircraft safety.

3.14.1.2 Electric and Magnetic Fields

The existing environment considered for effect of electric and magnetic fields are primarily focused on the public living in proximity to or traveling along the route of the proposed transmission lines.

The existing overhead backup lines from the TPP to the Spreader Yard are not energized. These lines would only become energized in the event of a failure of the underground transmission line system from the dam to the Spreader Yard. Therefore associated electric and magnetic fields and corona effects are could be produced by these backup lines happen only under emergency conditions. These backup lines will be removed during construction of the proposed lines.

There are a few homes and businesses (including the Visitors' Center) in proximity to the proposed transmission line route. Transmission lines, like all electric devices and equipment, produce electric fields and magnetic fields (EMF). Electrical current (the flow of electric charge in a wire) produces the magnetic field. Voltage (the force that drives the current) is the source of the electric field. The strength of electric and magnetic fields depends on the design of the line and on the distance from the line. Field strength decreases rapidly with distance.

Electric fields from high-voltage transmission lines can cause nuisance shocks when a grounded person touches an ungrounded object under a line or when an ungrounded person touches a grounded object. Transmission lines are designed so that the electric field will be below levels where shock could occur should any metallic enter under the electric field (i.e., a vehicle parked under the overhead line).

Electric and magnetic fields are found around any electrical wiring, including household wiring and electrical appliances and equipment. Throughout a home, the electric field strength from wiring and appliances is typically less than 0.01-kVs per meter (kV/m). However, fields of 0.1-kV/m and higher can be found very close to electrical appliances.

There are no national guidelines or standards for electric fields from transmission lines except for the 5-milliampere criterion for maximum permissible shock current from vehicles. Washington does not have any specific guidelines for electric field strength. BPA designs new transmission lines to meet its electric-field guideline of 9-kV/m maximum on the ROW and 5-kV/m

maximum at the edge of the ROW. Average magnetic field strength in most homes (away from electrical appliances and home wiring, etc.) is typically less than 2-milligauss (mG). When an individual stand too close to appliances carrying high current, fields of tens or hundreds of milligauss are present. Typical magnetic field strengths for some common electrical appliances found in the home are given in Table 3-21. Unlike electric fields, magnetic fields from outside power lines are not reduced in strength by trees and building materials. Transmission lines and distribution lines (the lines feeding a neighborhood or home) can be a major source of magnetic field exposure throughout a home located close to the line.

There are no national guidelines or standards for magnetic fields. The state of Washington does not have magnetic field limits. BPA does not have a guideline for magnetic field exposures, but a more detailed analysis of EMF can be found in Appendix A.

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Table 3-21. Typical Magnetic Field Strengths (1 foot from common appliances)

Appliance	Magnetic Fields (mG)[a]
Coffee maker	1–1.5
Electric range	4–40
Hair dryer	0.1–70
Television	0.4–20
Vacuum cleaner	20–200
Electric blanket[b]	15–100

mG = milligauss

[a] The magnetic field from appliances usually decreases to less than 1 mG at 3 to 5 feet from appliances.

[b] Values are for distance from blanket in normal use (less than 1 foot away).

Source: Miler 1974; Gauger 1985

3.14.1.3 Intentional Destructive Acts

Intentional destructive acts (that is, acts of sabotage, terrorism, vandalism, and theft) sometimes occur at power utility facilities. Vandalism and thefts are most common, and recent increases in the prices of metal and other materials have accelerated thefts and destruction of federal, state, and local utility property. BPA has seen a significant increase in metal theft from its facilities over the past several months due in large part to the high price of metals on the salvage market. There were more than 50 burglaries at BPA substations in 2006. The conservative estimate of damages for these crimes is $150,000, but the actual amount is likely much higher since this number does not factor in all the labor-related costs associated with repairing the damage.

The Proposed Action is comprised of many components. Overhead transmission conductors and the structures that carry them are mostly on unfenced utility rights-of-way. The conductors use the surrounding air as insulation. The structures and tension between conductors make sure they are high enough aboveground to meet safety standards. Structures are constructed on footings in the ground and are difficult to dislodge. The TPP and Grand Coulee substations, which may

need to be upgraded in the future, are both fenced to restrict access to authorized workers. Security cameras and other specialized equipment are in place to safeguard the areas.

Federal and other utilities use physical deterrents, such as fencing, cameras, warning signs, and rewards, to help prevent theft, vandalism, and unauthorized access to facilities. In addition, through its Crime Witness Program, BPA offers up to $25,000 for information that leads to the arrest and conviction of individuals committing crimes against BPA facilities. Anyone having such information can call BPA's Crime Witness Hotline at (800) 437-2744. The line is confidential and rewards are issued in such a way that the caller's identity remains confidential.

3.14.2 Environmental Consequences – Preferred Alternative

3.14.2.1 Vehicle Travel and Aircraft

Potential health and safety impacts of the Proposed Action would include the following:

- Construction activity hazards
- Heavy equipment safety
- Potential fuel spills
- Traffic entering and traveling along State Route 155
- Potential aircraft hazards

The risk of fire and injury is associated with the use of heavy equipment, working near high-voltage lines, and hazardous materials such as fuels during access road construction, and replacement of structures and conductors. Fuel spills may occur where vehicles that are not highway authorized are fueled.

There would be potential safety issues with more traffic on the highways and roads in the general vicinity of ROW during construction. By far the greatest potential hazard from construction traffic exists along State Route 155 during the summer and early fall. Without mitigation measures, construction trucks and vehicles turning off and onto State Route 155 could cause substantial safety hazards for vehicles and travelers using the road.

The presence of the rebuilt transmission line, like the existing line, could pose a hazard to any low-flying aircraft.

3.14.2.2 Electric and Magnetic Fields

Electric fields for existing and new locations are reported in Table 3-22, with certain values noted, such as maximums and at edges of the ROW. All electric field values along the new edge of ROW for the Preferred Alternative (shaded area on Table 3-22) are equal to less than 1-kV/m—a level at which no nuisance shocks are expected to occur. These levels are far below BPA electric-field guidelines of 9-kV/m maximum on the ROW and 5-kV/m at the edge of the ROW.

Magnetic fields are subject to controversy. After decades of research, the issue of whether there are long-term health effects associated with transmission-line fields remains controversial. Magnetic fields are most in question as possible sources of long-term effects, although studies

sometimes lump the two (electric and magnetic) fields together. For the latest information, BPA defers to the determinations of the National Institute of Environmental Health Science (NIEHS) and to the related web site, *http://www.niehs.nih.gov/emfrapid/home.htm*. Scientific reviews of the research on EMF health effects have found that there is insufficient evidence to conclude that EMF exposures lead to long-term health effects. However, some uncertainties remain for childhood exposures at levels above 4-mG.

An increase in public exposure to magnetic fields could occur if field levels increased or if residences or other structures draw people to these areas. The predicted field levels are only indicators of how the proposed project may affect the magnetic-field environment. They are not measures of risk or impacts on health.

Magnetic fields up to about 10-milligauss can affect the pictures of standard television tubes and computer monitors. Pictures may appear "wavy." Liquid crystal displays (LCDs) are immune to these effects. LCD screens are common in laptop computers and can be obtained to replace desktop computer monitors. Should these effects occur, BPA would investigate them on a case-by-case basis.

Table 3-22. Calculated Electric Field and Magnetic Field from the Proposed Grand Coulee Line Replacement Project by Profile and Design Option.

Profile Number	1			2			3			4		
Profile Description	On Hillside above State Highway 155			Adjacent to or through GC Visitors Center			East of GC Visitors Center			Along Roof of Third Powerhouse		
Alternatives	2	3	4	2	3	4	2	3	4	2	3	4
Electric field, kV/m												
Maximum	2.3	4.1	5.6	1.1	1.7	1.2	1.3	1.7	1.0	2.1	2.1	2.1
300' North of Line 2 CL	0.4	0.7	0.7	0.6	1.3	0.6	1.0	1.3	0.5			
600' North of Line 2 CL	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.3
Magnetic field, mG												
Maximum	23	45	61	12	19	12	16	19	11	39	44	46
300' North of Line 2 CL	10	14	14	11	19	12	16	19	11			
600' North of Line 2 CL	4	4	4	4	4	4	4	4	3	9	8	8

CL = Centerline

3.14.2.3 Intentional Destructive Acts

The impacts from vandalism and theft, though expensive, do not generally cause a disruption of service to the area. Stealing equipment from electrical substations, however, can be extremely dangerous. In fact, nationwide, many would-be thieves have been electrocuted while attempting to steal equipment from energized facilities. On October 11, 2006, a man in La Center, Washington, was electrocuted while apparently attempting to steal copper from an electrical substation.

Acts of sabotage or terrorism on electrical facilities in the Pacific Northwest are rare, though some have occurred. These acts generally focused on attempts to destroy large transmission line steel towers. For example, in 1999, a large transmission line steel tower in Bend, Oregon, was toppled.

Depending on the size and voltage of the line, destroying towers or other equipment could cause electrical service to be disrupted to utility customers and end users. The effects of these acts would be as varied as those from the occasional sudden storm, accident, or blackout and would depend on the particular configuration of the transmission system in the area. While in some situations these acts would have no noticeable effect on electrical service. In other situations, service could be disrupted in the local area, or if the damaged equipment was part of the main transmission system, a much larger area could be left without power.

When a loss of electricity occurs, all services provided by electrical energy cease. Illumination is lost. Lighting used by residential, commercial, industrial, and municipal customers for safe locomotion and security is affected. Residential consumers lose heat. Electricity for cooking and refrigeration is also lost, so residential, commercial, and industrial customers cannot prepare or preserve food and perishables. Residential, commercial, and industrial customers experience comfort/safety and temperature impacts, increases in smoke and pollen, and changes in humidity, resulting from loss of ventilation. Mechanical drives stop, causing impacts as elevators, food preparation machines, and appliances for cleaning, hygiene, and grooming are unavailable to residential customers. Commercial and industrial customers also lose service for elevators, food preparation, cleaning, office equipment, heavy equipment, and fuel pumps. Sewage transportation and treatment can be disrupted. A special problem is the loss of industrial continuous process heat. Electricity loss also affects alarm systems, communication systems, cash registers, and equipment for fire and police departments. Loss of power to hospitals and people on life-support systems can be life-threatening.

While the likelihood for sabotage or terrorist acts on the Proposed Action is difficult to predict given the characteristics of the project, it is unlikely that such acts would occur. Even if such an act did occur, any impacts from sabotage or terrorist acts likely could be quickly isolated. In addition, the Department of Energy, public and private utilities, and energy resource developers include the security measures mentioned above and others to help prevent such acts and to respond quickly if human or natural disasters occur.

3.14.3 Mitigation Measures

The following mitigation measures would help avoid or minimize potential health and safety risks to workers and the public.

- Prior to starting construction, require the contractor to prepare and maintain a safety plan in compliance with State of Washington, Reclamation, and BPA requirements. This plan would detail how to manage hazardous materials such as fuel, and how to respond to emergency situations. It would be kept onsite at all times.
- During construction, require the contractors to hold crew safety meetings at the start of each workday to review potential safety issues and concerns.
- At the end of each workday, require the contractor and subcontractors to secure the site to protect equipment and the general public.

- Train employees as necessary, in structure climbing, cardiopulmonary resuscitation, first aid, rescue techniques, and safety equipment inspection.
- To minimize the risk of fire, fuel all highway-authorized vehicles offsite. Fueling of construction equipment would be done in accordance with regulated construction practices and state and federal laws.
- Comply with all fire safety laws, rules, and regulations of the State of Washington, Reclamation, and BPA standards. The contractor will be required to prepare a Fire Prevention and Suppression Plan that would meet BPA, local authority, and land manager requirements.
- Provide notice to the public of construction activities.
- Remain on established access roads during construction activities.
- Keep vegetation cleared to avoid contact with transmission lines.
- During construction, follow BPA specifications for grounding fences and other objects on and near the ROW.
- Ensure transmission towers minimize EMF, corona and electric field through implementation of standard BPA design and construction practices. All BPA lines are designed and constructed in accordance with the National Electrical Safety Code (NESC). NESC specifies the minimum allowable distance between the lines and the ground or other objects. These requirements determine the edge of the ROW and the height of the line, that is, the closest point that houses, other buildings, and vehicles are allowed to the line.
- Ground fences and other metal structures on and near the ROW during construction to limit the potential for nuisance shocks. BPA provides a free booklet that describes safety precautions for people who live or work near transmission lines.

Potential unavoidable public health and safety risks include accidental release of fuels or oils, accidental injury to construction workers, and possible collisions between construction vehicles and vehicles driven by the public. Nuisance shocks may occur infrequently under the proposed line.

3.14.4 Unavoidable Impacts Remaining After Mitigation

Potential unavoidable public health and safety risks include accidental release of fuels or oils, accidental injury to construction workers, and possible collisions between construction vehicles and vehicles driven by the public. Nuisance shocks may occur infrequently under the proposed line.

3.14.5 Cumulative Impacts

Health and safety in the area is affected by the existing transmission lines, existing traffic, and new construction that occur periodically in the area. The Proposed Action would contribute to those potential impacts. Likely population growth focused at both ends of the ROW, but especially at the west end, would add traffic to the area and likely increase accident rates.

3.14.6 Environmental Consequences - Alternatives

Under the No Action Alternative, the proposed transmission line would not be constructed, the current inactive lines would remain in places, and the potential health and safety risks associated with construction traffic would not occur. A failed structure, which is an unplanned event, can cause the line to go out of service, resulting in impacts to residential and commercial customers who depend on this transmission line for power. When a loss of electricity occurs, all services provided by electrical energy cease. Lighting used by residential, commercial, industrial, and municipal customers for safe locomotion and security is affected. Residential and commercial consumers lose electricity used for heat, air conditioning, cooking, and refrigeration.

3.15 Air Quality

3.15.1 Affected Environment

The Grand Coulee Dam area is within attainment of National Air Quality Standards area, as defined by the Washington Department of Ecology. It is primarily rural with no major industrial sources. Ecology monitors ambient air quality in urban areas, with the closest stations in Yakima and Spokane (Ecology 2009a).

Dust and associated fine particulate matter (PM) is the primary air quality concern in rural Washington east of the Cascades (Ecology 2010). Much of the dust can be attributed to human-caused soil erosion related to agriculture and related development. EPA has set health-based limits for six major air pollutants, including fine particulate matter less than 10 microns in diameter (PM_{10}) and less than 2.5 microns in diameter ($PM_{2.5}$), both of which are informally referred to as "dust."

In the past, Spokane has exceeded the health-based limit for PM_{10}, which when inhaled can increase breathing problems, damage lung tissue, and aggravate existing health problems. In addition to health concerns, dust generated from various activities can reduce visibility, resulting in accidents. Dust can also be a nuisance when particulate matter is deposited on the property of others.

Existing local emission sources include traffic (local, commercial trucking, visitors/travelers), construction, agriculture and some light-industrial and manufacturing. Traffic generated dust from both paved and unpaved roads is as important contributing factors to local air pollution as vehicle exhaust emissions.

The project area has an arid to semiarid climate, with dry and windy conditions being common. Most regional winds are from the northeast during the fall and winter, and from the south and southwest during spring and summer.

Three site features raise the need for care in preventing fugitive dust from drifting onto areas regularly used by people. First, the setting includes several land uses within a short distance from proposed, work areas, including State Route 155, a hotel, a gas station, residences and the Visitor's Center and associated park grounds. The second on-site feature that raises concerns is the geologic formation upon which towers and access roads would be constructed, which consists of deep silt and fine sands on steep slopes. The third feature is the climate and weather, which includes prolonged periods of dryness with occasional strong winds. The presence of sensitive land uses, steepness and fineness of the soils, and dry and windy conditions combine to create the need to consider windblown dust as part of project construction and operations. Note that dust control is closely related to erosion control addressed under the topic of *Geology and Soils*.

3.15.2 Environmental Consequences – Preferred Alternative

The scope of air quality impacts evaluated has been defined into three issues:

1. hazardous emissions;
2. fugitive emissions (dust and exhaust); and

3. greenhouse gases.

Hazardous Emissions. Two sources of emissions are relevant to the Proposed Action: (1) transmission lines "corona" effects can create ozone and other gases during certain weather conditions, and (2) herbicide use for vegetation management – including noxious weed control (note: no aerial spraying would be conducted as part of the Proposed Action).

No other project air emissions are directly relevant to decisions. No contaminated soils or other hazards are known or suspected to exist on site.

Corona effects, including ozone generation, are minimized through design and inspection, as a standard practice not only to avoid unwanted effects of corona discharges, but also because they represent wasted energy, so corona is minimized as part of any transmission project, from design through monitoring and repairs during operation.

Construction Dust. Due to the fine-grained nature of soils in areas proposed for construction, dust may be a site-specific issue that needs to be mitigated. Towers would not require on-site painting or other coatings, and other than fuel and lubricants, not hazardous materials would be used for construction.

The presence of nearby sensitive land uses, steepness and fineness of the soils, and dry and windy conditions combine to create the need to consider windblown dust as part of project construction and operations.

The closest point of construction to sensitive off-site properties would be Tower 1-1 of the Proposed Action (Preferred Alternative), which would be located approximately 300 feet from rooms and the swimming pool at the Columbia River Inn. Rooms have a walkway facing the hill upon which Tower 1-1 would be located. Access may also occur along the railroad grade that travels parallel and behind the hotel, approximately 150 feet distant. Both of these locations have the highest potential for fugitive dust impacts

Removal of the existing towers would not require much excavation and would be done on graded, level ground with little risk of erosion. Removal would be expected to be completed within a few days (Hesse pers. com.). The closest resident is 311 feet, and no unique conditions exist that would indicated that dust could not be controlled using standard BMPs.

Once installed, the only source of air pollution would be dust from soils exposed during construction. Traffic would occur only during infrequent monitoring and/or repairs (i.e., less than one trip expected per month).

Reclamation efforts will be important to control dust from exposed soils, particularly since the project area contains fine grained soils on steep slopes. Specific reclamation plans and performance standards would be specified as part of a project- specific Storm Water Pollution Prevention Plan (addressed under the topic Water) to be prepared during final design and monitoring plans.

Ozone. Transmission lines would emit ozone and nitrogen oxides as a result of the corona effect. Reviews of EISs conducted for other transmission project have found that ozone levels at high voltage lines do not exceed safe levels. (BPA 2002a).

The most recent study found regarding ozone and transmission lines was conducted in Europe (Valuntait and Girgdiene 2009). That study found ozone concentration close to the high voltage lines in rural areas was on average by 2% higher than the background ozone concentration, and

up to 38% in some cases. Concentrations near the lines were highest when the air was calm. Absolute concentration levels were reported in the range of 40 parts per billion (ppb) near the lines, falling to below 34 ppb approximately 50 meters from the lines.

Greenhouse gases are not directly relevant to the proposed line replacement project. Greenhouse gases usually come into play for transmission lines only when new lines are associated with a new source of energy that may change the balance between gas or coal fired plants and hydroelectric, wind or solar. Replacing transmission systems at Grand Coulee Dam is intended to transmit existing generation capacity and would have no direct effect on energy generation.

No other project air emissions are directly relevant to decisions. No contaminated soils or other hazards are known or suspected to exist on site.

A study on the effects of ozone on people found that levels above 70 ppb can result in stresses to the human cardio vascular system (American Thoracic Society 2009). The National Ambient Air Quality Standard (NAAQS) for ozone is 75 ppb for 8 hour exposure and 112 ppb for one hour exposure. These levels are approximately 75% and 125% higher than the highest readings presented in the European study.

3.15.3 Mitigation Measures

Hazardous Emissions. Because ozone levels would be well below hazardous levels, no additional mitigation has been identified.

Dust. Apply 2004 Storm water Management Manual for Eastern Washington (Ecology 2004) BMP C140: Dust Control. Consider preparing a site-specific Dust Control Plan to be included in construction contracts.

Ozone. Standard emission requirements and BMPs for air quality would address this issue.

3.15.4 Unavoidable Impacts Remaining After Mitigation

Hazardous Emissions. Elevated ozone levels near transmission lines would be unavoidable during calm, foggy weather. During calm and foggy conditions, corona effect could create elevated ozone levels in the vicinity of transmission lines. The increased separation between adjacent private lands under the Proposed Action, when compared to Alternative 1, serves to offset concerns related to ozone or other corona effects.

Because corona results from "leaking" electricity, lines are designed to minimize corona and repairs are quickly made when excessive corona effects are seen, since these typically indicate frays or other damage to the conductors.

Dust. While many standard BMPs address dust, the fine nature of the soils indicates that without additional efforts, dust from construction traffic and/or construction of towers could drift north onto adjacent properties, including the Columbia River Inn, the gas station, and the residential area of Grand Coulee Dam. Dust could also be present at road intersections, where construction equipment would enter and leave the roadway.

Ozone. Construction equipment would emit greenhouse gasses.

3.15.5 Cumulative Impacts

The Proposed Action would not contribute dust at levels meaningful to the significant cumulative impact of dust across eastern Washington. At the local level, dust from the project could add to existing dust and fine-grained particulate matter (PM_{10}, $PM_{2.5}$) within the immediate vicinity of Grand Coulee Dam. The addition, however, would not be sufficient to create total particulate loads greater than allowed by National Ambient Air Quality Standards.

3.15.6 Environmental Consequences – Alternatives

Hazardous Emissions. The primary difference between all alternatives relative to air quality impacts is the distance of conductors and the first tower to sensitive land uses. Under the Preferred Alternative, conductors would be 55 feet south of the hotel, compared to just 3 feet away as proposed in Alternative 1. Closest distance to the nearest resident would be 480 feet with the Preferred Alternative, compared to 275 feet under Alternative 1.

For tower distances, under the Preferred Alternative, the first tower would be 1,040 feet from the closest residence, compared to 310 feet under Alternative 1, 400 feet under Alternative 3 and 440 feet under Alternative 4.

Under the Preferred Alternative, the fist tower would be closer (310 feet) to the hotel than originally proposed (490 feet) or under Alternatives 3 and 4, (620 and 540 feet respectively).

Dust. The primary difference again is distance to adjacent sensitive land uses, with the first tower (Tower 1-1) under Preferred Alternative being closer to the hotel, but farther from the closest residence, than Alternative 1.

Ozone. Alternative 1, 2, 3, 4, and 5 would not differ in their green house gas emissions. Under the No Action alternative, the risk of system failure could result in temporary shift of power to non-hydro sources.

3.16 Traffic and Transportation

3.16.1 Affected Environment

State Route 155 is the main north-south route through the Town of Coulee Dam. Approaching from the south, SR 155 descends from the west side of the dam to the Visitor's Center and the Town of Coulee Dam. A clearly-marked turn lane leads visitors to the approximate 155 parking spaces within the upper parking area at the Visitor's Center. Immediately past the Visitor's Center, a left turn lane accesses Lincoln Road and the Mini-Mart and Columbia River Inn. A paved center strip separates lands near the Visitor's Center. A crosswalk provides pedestrian access to the Visitor's Center from the hotel area.

SR 155 continues through the Town of Coulee Dam, crossing the Columbia River about 1/2 mile downstream of the dam via the Columbia River Bridge, the original bridge constructed in the 1930s during the building of Grand Coulee Dam. Vehicles crossing the bridge are limited to 20,000 pounds per axle on 3 or 4 axle single units; also known as tri-axles. Six or more axle combination units are also limited to 20,000 pounds per axle. The bridge has a restricted height of 14 feet 3 inches. Traffic becomes congested on the east and west approaches to the bridge when large trucks are crossing. The bridge provides access to the TPP and public tour via Roosevelt Way in east Coulee Dam. The Reclamation road across Grand Coulee Dam is located off SR 155 between Grand Coulee and the Town of Coulee Dam. Security restrictions prohibit public access to the road atop the dam (USBR 2009). SR 155 continues north, through Nespelem and eventually crosses in to the Okanogan Valley at Omak.

3.16.2 Environmental Consequences – Preferred Alternative

Possible traffic impacts would be limited to construction. Once constructed, the project would generate no direct traffic other than occasional inspection/maintenance vehicles. Construction traffic would be limited to short periods and few vehicles. Towers would arrive in small sections via flatbed truck delivery to staging areas. Delivery would not require trucks making sharp turns in or out of construction areas. Construction traffic would pass by the Columbia River Inn and behind the Town of Coulee Dam City Hall to access the proposed lower tower locations. A sharp turn behind City Hall could require the parking area to be temporarily closed.

Removal of the existing back up towers within the lower Visitor's Center grounds could require the lower grounds to be closed for one or two days. Installation (or "stringing") of conductors over the Visitor's Center and SR 155 would require traffic stoppages and/or guard structures to be placed over SR 155 during the time when the proposed transmission lines will be strung.

3.16.3 Mitigation Measures

A Construction Traffic Management Plan is typically prepared prior to construction that would occur on or near public roads. Such a plan could be developed in consultation with the WSDOT, Grand Coulee Dam and Grant County to minimize delays and safety hazards. The plan could also include specific times when construction would not occur (e.g., during the Festival of America celebration on the Fourth of July). Public announcements regarding construction should inform the public but also should be worded to avoid discouraging potential visitors from visiting Grand Coulee Dam.

3.16.4 Cumulative Impacts

The primary concern for cumulative traffic impacts would be combined traffic from construction of the proposed act and from the Third Powerplant Overhaul Project. However, the EA prepared for the Overhaul Project identified neither adverse workforce related traffic impacts nor permanent increase in traffic with the TPP's return to service.

3.16.5 Unavoidable Impacts Remaining After Mitigation

Traffic could be temporarily disrupted during construction from:

1. Trucks delivering tower sections, conductors, heavy equipment and other project materials could delay vehicles by slow speeds and stops required to make turns.
2. Removal of towers from the lower grounds could block vehicle access to the lower grounds for up to two days. Visitors may be inconvenienced.
3. Traffic on SR 155 would need to be stopped as conductors are installed (work may involve helicopters).

3.16.6 Environmental Consequences – Alternatives

3.16.6.1 Overhead Alternatives

Alternatives 1, 3 and 4 would involve construction of towers below the Visitor's Center, resulting in more construction traffic disruptions in this area and less or no construction traffic behind City Hall.

3.16.6.2 Rebuild Alternative

Under the Rebuild Alternative, delivery traffic would be limited to transmission lines and other construction materials but would not include trucks with tower components.

3.16.6.3 No Action Alternative

Under the No Action Alternative, no traffic disruptions would occur until a failure. With a line failure, traffic could be disrupted for emergency repairs and possibly temporary overhead replacement lines.

Chapter 4 Consultation, Review, and Permit Requirements

This chapter addresses federal statutes, implementation of regulations, and Executive Orders potentially applicable to the proposed project. This EA is being sent to Tribes, federal agencies, and state and local governments as part of the environmental review process for this project. A summary of agency consultation and coordination is provided in Table 4-1 below.

Table 4-1. Summary of Agency Consultation and Coordination

Agency	Law	Compliance Documentation	Element(s) of Environment	Where/When addressed
Confederated Tribes of the Colville Reservation	Colville Tribal Law and Order Code , Title 4 Natural Resources and the Environment. (See also Washing DAHP) Archaeological Data Preservation Act (ADPA) • Archaeological Resources Protection Act (ARPA) • Native American Graves Protection and Repatriation Act • Executive Order 13007 Indian Sacred Sites	Documented in NEPA EA	3.3 Wildlife 3.5 Water Resources, Wetlands, and Fisheries 3.10 Cultural Resources 3.11 Indian Trust Assets 3.12 Indian Sacred Sites 3.13 Socioeconomics and Environmental Justice	Consultation concurrent with EA/FONSI
Ecology	Clean Air Act	EA/FONSI	3.16 Air Quality	Addressed in EA/FONSI (no consultation required)
Ecology	CWA Section 401 certification	Water Quality Certification	3.5 Water Resources, Wetlands, and Fisheries	Design-level permit review
EPA	CWA Section 402: National Pollutant Discharge Elimination System (NPDES)	NPDES permit or EPA concurrence that none required.	3.5 Water Resources, Wetlands, and Fisheries	Design-level permit review
EPA	Spill Prevention, Control and Countermeasures Act (SPCCA), Resource Conservation and Recovery Act (RCRA)	Determine applicability to quantities and types of hazardous materials related to existing oil-filled lines.	3.5 Water Resources, Wetlands, and Fisheries	Design-level permit review

Agency	Law	Compliance Documentation	Element(s) of Environment	Where/When addressed
Federal Aviation Administration (FAA)	FAR Part 77: Objects affecting navigable airspace specifies criteria for determining whether "Notice of Proposed Construction or Alteration" is required for potential obstruction hazards. Advisory Circular 70/7460-1 AC70/7460-1K, Obstruction Marking and Lighting.	Concurrence letter	3.15 Public Health and Safety	Design-level permit review
Federal Communications Commission (FCC)	Communications Act	Documented in NEPA EA/FONSI	3.15 Public Health and Safety	Addressed in EA/FONSI (no consultation required)
Grant and Okanogan Counties	Local Land Use Consistency	Documented in NEPA EA/FONSI	3.6 Land Use and Transportation	Consultation concurrent with EA/FONSI
National Oceanic and Atmospheric Administration (NOAA Fisheries) for salmon	Endangered Species Act Section (7a) Consultation	Concurrence letter	3.3 Wildlife and 3.5 Water Resources, Wetlands, and Fisheries	Consultation concurrent with EA/FONSI
Reclamation	Executive Order 12898, on Environmental Justice in Minority and Low-Income Populations.	Documented in NEPA EA/FONSI	3.13 Socioeconomics and Environmental Justice	Addressed in EA/FONSI (no consultation required)
US Army Corps of Engineers	Section 10, Rivers and Harbors Act	Confirmation from Corps of Engineers that transmission lines and other proposed project component exempt.	3.6 Land Use and Transportation	Consultation concurrent with EA/FONSI
US Army Corps of Engineers	CLEAN WATER ACT SECTION 404	Jurisdictional determination (letter). 404 Permit, if required.	3.5 Water Resources, Wetlands, and Fisheries	Consultation concurrent with EA/FONSI
US Army Corps of Engineers	Executive Orders 11988 and 11990 Floodplain/Wetlands Environmental Review Requirements	Documented in NEPA EA/FONSI	3.5 Water Resources, Wetlands, and Fisheries	Consultation concurrent with EA/FONSI
US Fish and Wildlife Service	Endangered Species Act Section (7a) Consultation	Concurrence letter	3.2 Vegetation 3.3 Wildlife and 3.5 Water Resources, Wetlands, and Fisheries	Consultation concurrent with EA/FONSI

Agency	Law	Compliance Documentation	Element(s) of Environment	Where/When addressed
US Fish and Wildlife Service	Migratory Birds: Executive Order 13186	Avian Protection Plan (APP)	3.5 Wildlife	Consultation concurrent with EA/FONSI
US Fish and Wildlife Service	Bald and Golden Eagle Protection Act (Eagle Act).	Eagle Permit and/or APP	3.5 Wildlife	Consultation concurrent with EA/FONSI
US Fish and Wildlife Service	Migratory Bird Treaty Act	Avian Protection Plan	3.5 Wildlife	Consultation concurrent with EA/FONSI
US Fish and Wildlife Service	Fish and Wildlife Conservation Act	Documented in NEPA EA/FONSI	3.5 Wildlife	Consultation concurrent with EA/FONSI
Washington Department of Archaeology and Historic Preservation (DAHP)	Cultural and Historic Preservation Antiquities Act of 1906 • Historic Sites Act of 1935 • Section 106 of the National Historic Preservation Act (NHPA) • Archaeological Data Preservation Act (ADPA) • Archaeological Resources Protection Act (ARPA) • Native American Graves Protection and Repatriation Act • Executive Order 13007 Indian Sacred Sites	Memorandum of Agreement per 36 C.F.R. 800.6(b)(iv)	3.10 Cultural Resources 3.11 Indian Trust Assets 3.12 Indian Sacred Sites 3.13	Consultation concurrent with EA/FONSI
Washington Department of Fish and Wildlife	Washington Hydraulic Code, Chapter 77.55 RCW	Hydraulic Project Approval (HPA)	3.5 Water Resources, Wetlands, and Fisheries	Design-level permit review

4.1 National Environmental Policy Act

This EA has been prepared by BPA in accordance with regulations implementing the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.), which requires federal agencies to assess the impacts that their actions may have on the environment. NEPA requires preparation of an environmental impact statement (EIS) for major federal actions significantly affecting the quality of the human environment. BPA prepared this Preliminary EA to determine whether the Proposed Action would create any significant environmental impacts that would warrant preparing an EIS, or if a Finding of No Significant Impact (FONSI) is justified.

4.2 Vegetation and Wildlife

The Endangered Species Act of 1973 (16 U.S.C. 1536), as amended in 1988, establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants, and the preservation of the ecosystems on which they depend. The Act is administered by the USFWS and, for salmon and other marine species, by the National Oceanic and Atmospheric Administration (NOAA). Section (7a) requires federal agencies to ensure that the actions they

authorize, fund, and carry out do not jeopardize endangered or threatened species or their critical habitats.

The USFWS maintains on-line lists of ESA species and critical habitats by county (USFWS 2010). The project begins in Okanogan County at the TPP, and then crosses the Columbia River into Grant County, where lines would meet the proposed transmission towers leading across the developed and upland action areas. Two other counties are close. Douglas County begins a few hundred feet north of proposed towers; and Ferry County is located on the north side of Lake Roosevelt, behind (up river of) the dam. Lincoln County is over one mile southeast of the proposed project.

Due to the location of the project, a list was compiled using USFWS lists for all four counties. In addition, BPA data from the Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) Program was reviewed for known location of listed wildlife and/or possible habitats.

Table 4-1 presents the species lists for Grant, Okanogan, and Douglas counties. A No Effect Determination Memorandum was then prepared with the determinations presented in Table 4-1.

Potential impacts to threatened and endangered plant and animal species are discussed in Chapter 3 in the Vegetation and Wildlife sections (no threatened or endangered fish species are present in the vicinity of the project area).

Table 4-2. Wildlife and Vegetation Species Determinations

Species	Status	Determination
Bull trout (*Salvelinus confluentus*)	Threatened	No Effect
Pygmy rabbit (*Brachylagus idahoensis*)	Endangered	No Effect
Ute ladies'-tresses (*Spiranthes diluvialis*)	Threatened	No Effect
Canada lynx (*Lynx canadensis*)	Threatened; MIS	No Effect
Grizzly bear (*Ursus actors horribilis*)	Threatened	No Effect
Northern spotted owl (*Strix occidentalis caurina*)	Threatened	No Effect

The Fish and Wildlife Conservation Act of 1980 (16 U.S.C. 2901 et seq.) encourages federal agencies to conserve and promote the conservation of nongame fish and wildlife species and their habitats. Mitigation measures designed to conserve wildlife and their habitat are listed in Chapter 3 in the Vegetation and Wildlife sections.

The Migratory Bird Treaty Act implements various treaties and conventions between the United States and other countries, including Canada, Japan, Mexico, and the former Soviet Union, for the protection of migratory birds (16 U.S.C. 703 712, July 3, 1918, as amended 1936, 1960, 1968, 1969, 1974, 1978, 1986, and 1989). Under the Act, taking, killing, or possessing migratory birds or their eggs or nests is unlawful. Most species of birds are classified as migratory under the Act, except for upland and nonnative birds.

The proposed project could potentially impact birds through collisions with power lines and habitat removal. Potential impacts to migratory birds are discussed in the Wildlife Section in Chapter 3.

Executive Order 13186 was issued on January 17, 2001. It directs each federal agency that is taking action that may negatively impact migratory bird populations to work with the USFWS to develop an agreement to conserve those birds. The protocols developed by this consultation are intended to guide future agency regulatory actions and policy decisions; renewal of permits, contracts, or other agreements; and the creation of or revisions to land management plans. This order also requires that the environmental analysis process include effects of federal actions on migratory birds. On August 3, 2006, the USFWS and the U.S. Department of Energy signed a Memorandum of Understanding (MOU) to complement the Executive Order. BPA, as part of the Department of Energy, would work cooperatively in accordance with the protocols of the MOU.

4.3 Water Resources, Wetlands, and Fisheries

The Clean Water Act (33 U.S.C. 1251 et seq.) regulates discharges into Waters of the U.S. The ROW includes both wetlands and Waters of the U.S.

Section 402 of the Clean Water Act authorizes storm water discharges associated with industrial activities under the National Pollutant Discharge Elimination System (NPDES). For Washington, EPA has a Construction General Permit (CGP) authorizing federal facilities to discharge storm water from construction activities disturbing land of 1 acre or more into Waters of the U.S., in accordance with various set conditions. BPA and Reclamation would comply with the appropriate conditions for this project, such as issuing a Notice of Intent (NOI) to obtain coverage under the EPA CGP, and preparing and implementing a Storm Water Pollution Prevention (SWPP) plan.

Clean Water Act Section 401 certification is required for any permit or license issued by a federal agency for any activity that may result in a discharge into waters of the state to ensure that the proposed project will not violate state water quality standards. This water quality certification is part of the 1974 Clean Water Act, which allows each state to have input into projects that may affect its waters (rivers, streams, lakes, and wetlands). This not only protects the public at large, but also protects lands adjacent to projects from damage (thereby also protecting landowners' rights and investments). The Washington Department of Ecology is responsible for issuing Section 401 certifications in Washington. Any Section 401 certification in Washington also ensures that the project will comply with water quality improvement plans developed for affected water bodies and that the project will not adversely impact water quality impaired streams (streams that already do not meet water quality standards).

Section 404 of the Clean Water Act establishes programs to regulate the discharge of dredged and fill material into Waters of the U.S. The basic premise of Section 404 is that dredged or fill material cannot be discharged into water if the nation's waters would be significantly degraded or if a feasible alternative exists that is less damaging to the aquatic environment.

Dredge and fill activities are controlled by a permit process administered by the U.S. Army Corps of Engineers. Activities that are regulated under this program include fills for development, water resource projects (such as, dams), infrastructure development (such as, highways), and other water related construction activities.

4.4 Cultural Resources

Regulations established for the management of cultural resources include the following:

- Antiquities Act of 1906 (16 U.S.C. 431-433)
- Historic Sites Act of 1935 (16 U.S.C. 461-467)
- Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. 470 et seq.), as amended
- Archaeological Data Preservation Act (ADPA) of 1974 (16 U.S.C. 469 a-c)
- Archaeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. 470 et seq.), as amended
- Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. 3001 et seq.)
- Executive Order 13007 Indian Sacred Sites

For this project, BPA has undertaken the Section 106 consultation process with the Washington Department of Archaeology and Historic Preservation, the Advisory Council on Historic Preservation, and the affected Native American Tribes. For this project, the Colville Confederated Tribes were consulted. Letters were sent to all of the Tribes on August 7, 2009, initiating consultation under Section 106 as well as introducing the project and notifying the Tribes of public meetings. On February 22, 2010 a letter was sent to the Tribes and DAHP containing updates about the project's progress. On May 2, 2011, the cultural resource survey report was sent to the SHPO for review and concurrence and the Tribes for review. The Cultural Resources Section in Chapter 3 describes historic and cultural resources that were found along the new and existing ROW and access roads. It also includes BPA's determinations of effect for each site and recommendations for treatment of several sites. Determinations were coordinated with Reclamation's archaeologist before the report was sent to DAHP and the Tribes for review. No comments were received from the Tribes.

The DAHP concurred with all of BPA's determination of eligibility findings for the cultural resources documented for this project. Consultation on NRHP eligibility for this site continues. BPA's project Determination of Effect for NHRP-eligible sites is found in Section 3.10. The DAHP recommends complete avoidance of all sites eligible or potentially eligible for listing on the NRHP. Since complete avoidance is not possible for all sites, mitigation measures would be implemented for affected sites.

4.5 Environmental Justice

In February 1994, Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations, was released to federal agencies. This order states that federal agencies shall identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. Minority populations are considered members of the following groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic if the minority population of the affected area exceeds 50 percent,

or is meaningfully greater than the minority population in the general vicinity of project. The proposed project has been evaluated for potential disproportionately high environmental effects on minority and low-income populations and none were identified (see the Socioeconomics Section in Chapter 3).

4.6 Air Quality

The Clean Air Act as revised in 1990 (PL 101-542, 42 U.S.C. 7401) requires EPA and states to carry out programs intended to ensure attainment of National Ambient Air Quality Standards (NSAAQS). Air quality impacts of the proposed project would be very low, localized, and temporary, as discussed in the Air Quality Section in Chapter 3.

4.7 Noise

The Noise Control Act of 1972, as amended (42 U.S.C. 4901 et seq.), declares that it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes their health or welfare. The Act further states that federal agencies are authorized and directed, to the fullest extent consistent with their authority under federal laws administered by them, to carry out the programs within their control in such a manner as to further this policy. As described in Section 3.14, Noise, the proposed project would have low to moderate noise impacts primarily of a temporary nature, and mitigation measures are identified to further reduce noise impacts.

4.8 Health and Safety

As part of the transmission line design, BPA seeks to comply with Federal Aviation Administration (FAA) procedures. Final locations, types, and heights of structure would be submitted to the FAA for the project. The information includes identifying structures taller than 200 feet aboveground (three structures would be above 200 feet) and listing all structures within prescribed distances of airports listed in the FAA airport directory. General BPA policy is to follow FAA recommendations for airway marking and lighting.

Federal Communications Commission (FCC) regulations require that transmission lines be operated so that radio and television reception would not be seriously degraded or repeatedly interrupted and that interference is mitigated. While neither the Proposed Action or the No Action Alternative are expected to increase electromagnetic interference above existing levels, complaints about electromagnetic interference would be investigated.

The Spill Prevention, Control and Countermeasures Act (SPCCA), Title III of the Superfund Amendments and Reauthorization Act, and the Resource Conservation and Recovery Act (RCRA) Program potentially apply to the proposed project, depending on the exact quantities and types of hazardous materials stored onsite. Regulations would be enforced by Washington Department of Environmental Quality (DEQ). In addition, development of a Hazardous Materials Management Plan in accordance with the Uniform Fire Code (UFC) may be required by the local fire district. Small amounts of hazardous waste may be generated (paint products, motor and lubricating oils, herbicides, solvents, etc.) during construction, operation, and/or maintenance. These materials would be disposed of according to state law and RCRA requirements.

The Safe Drinking Water Act (42 U.S.C. Section 200f et seq.) protects the quality of public drinking water and its source. It does not cover private drinking water sources such as the Papoose Creek Spring. The proposed project would not affect any sole source aquifers or other critical aquifers, or adversely affect any surface water supplies.

Chapter 5
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Chapter 6
Acronyms and Abbreviations

ADPA	Archaeological Data Preservation Act
APE	Area of Potential Effect
APLIC	Avian Power Line Interaction Committee
APP	Avian Protection Plan
ARPA	Archaeological Resources Protection Act
asl	above sea level
BGEPA	Bald and Golden Eagle Protection Act
BLM	Bureau of Land Management
BMP	Best Management Practices
BPA	Bonneville Power Administration
CGP	Construction General Permit
CORPS	U.S. Army Corps Engineers
CRP	Conservation Reserve Program
dBA	decibels on the A-weighted scale
dbh	diameter at breast height
DEQ	Department of Environmental Quality
E.O.	Executive Order
EA	Environmental Assessment
EDRR	Early Detection and Rapid Response
EIS	environmental impact statement
EMF	electric and magnetic fields
FCC	Federal Communications Commission
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
GIS	geographic information system
GPS	geographic positioning system
HPA	Hydraulic Project Approval
HRV	historical ranges of variability

IFIM	Instream Flow Incremental Methodology
IPM	integrated pest management
kV	kilovolt
kV/m	kilovolts per meter
LCD	Liquid Crystal Display
LLC	Limited Liability Company
LWD	Large Wood Debris
MBTA	Migratory Bird Treaty Act
mG	milligauss
MIS	Management Indicator Species
mph	miles per hour
MVA	Megavolt Ampere
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NFMA	National Forest Management Act
NHPA	National Historic Preservation Act
NIEHS	National Institute of Environmental Health Science
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRA	National Recreation Area
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NWCC	National Wind Coordinating Collaborative
O&M	Operation and Maintenance
OBL	obligate
OFM	Office of Financial Management
OHV	off-highway vehicle
OSHA	Occupational Safety and Health Act
PEM	Palustrine emergent
PHB	Pioneer Historic Byway

PHS	Priority Habitat Species
PI	point of inflection
PM	Particulate Matter
PSS	Palustrine scrub-shrub
RCRA	Resource Conservation and Recovery Act
RFP	Revised Forest Plan
ROD	Record of Decision
ROS	Recreation Opportunity Spectrum
ROW	right-of-way
RPP	Right Powerplant
RPW	Relatively Permanent Water
SHPO	State Historic Preservation Office
SIO	Scenic Integrity Objective
SMA	Shoreline Management Act
SMS	Scenery Management System
SPCCA	Spill Prevention, Control, and Countermeasures Act
SR	State Route
SRMA	Special Recreation Management Area
SWPP	Storm Water Pollution Prevention
TDG	Total Dissolved Gas
TMDL	Total Maximum Daily Load
TNW	Traditional Navigable Water
TPP	Third Powerplant
UDC	Unified Development Code
UFC	Uniform Fire Code
USBR	United States Bureau of Reclamation
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
VMS	Visual Resource Management System
VQO	Visual Quality Objectives
WAC	Washington Administrative Code

WDFW	Washington Department of Fish and Wildlife
WDOT	Washington Department of Transportation
WECC5	Western Electric Coordinating Council
WMA	Wildlife Management Area
WSNWB	Washington State Noxious Weed Board
YTC	Yakima Training Center

APPENDIX A

ELECTRICAL EFFECTS

GRAND COULEE 500-KV TRANSMISSION LINE REPLACEMENT PROJECT

ELECTRICAL EFFECTS

February 2011

Prepared by
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for

Bonneville Power Administration

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Electrical Effects from the Proposed Grand Coulee Transmission 500-kV Line Replacement Project

1.0 Introduction

The Bureau of Reclamation proposes to build approximately 1.1-miles of 500-kilovolt (kV) transmission lines from the existing Grand Coulee Switching Station to the Third Powerhouse at the Grand Coulee Dam. The three proposed transmission lines would replace existing 500-kV underground cables. The proposed project is located almost entirely on US Government land in Grant and Okanogan Counties, Washington. A narrow section of privately owned land, 60 to 20 feet wide and just west of State Highway 155, would be crossed. There is also a parcel just to the north of potential tower locations that is owned by the Town of Coulee Dam, as described in the Land Use/Human Environment technical report.

The proposed Grand Coulee Line Replacement Project would consist of six three-phase circuits that are placed on three double-circuit transmission lines. The towers for the three lines would be separated by about 200 feet (ft.) or 61 meters (m). The proposed transmission lines would cross the Columbia River from west to east just downstream from the dam. The conductors would start at an existing substation located on a hill approximately 800 ft. (244 m) above the level of the river and extend to the wall of the dam above the Third Powerhouse. The proposed lines would cross over the Grand Coulee Visitors Center and State Highway 155 on the west side of the river. From the wall of the dam the conductors drop down to attach to the east wall of the powerhouse before attachment to the 500-kV transformers at between the powerhouse and the dam. Some of these conductors would pass near the inclined elevator that serves the powerhouse from the top of the dam. The Bonneville Power Administration (BPA) has agreed to provide engineering and environmental support for this project. This report is part of that effort by BPA.

The purpose of this report is to describe and quantify the electrical effects of the proposed Grand Coulee Replacement 500-kV Transmission Line project. These effects include the following:

- the levels of 60-hertz (Hz; cycles per second) electric and magnetic fields (EMF) at 3.28 ft. or 1 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 those 500-kV lines already present in the area of the proposed route for the Grand Coulee Line Replacement Project. Therefore, the levels of these quantities for the proposed lines are computed and compared with those from existing 500-kV lines in Washington and elsewhere.

Four design options are under consideration for the proposed transmission line. Each option would consist of three approximately parallel double-circuit 500-kV lines. The principal differences between options are the north-south location of their towers with respect to the main dam and the number of towers placed between the powerhouse and the substation. The tower placements for all four options are shown in Figure 1.

Option 1 has the most northerly line location. The northern most circuits of this option would pass over an existing swimming pool, which would be in violation of BPA design practices. Therefore this option was not included in the detailed analyses of electrical effects reported here. The swimming pool is located approximately 300 ft. (91 m) from the centerline of the other design options and this appears to be the nearest structure to the proposed lines. Therefore 300 ft. (91 m) was used as a surrogate for an edge-of-right-of-way distance.

Each double-circuit line in **Option 2** would consist of two structures between the substation and powerhouse. Because of the distances and elevation gains required, this option would require a custom designed tower structure located on the hillside west of the existing road and visitor center. There would be no towers between the visitor center and the river. In this case the centerline for the corridor would pass just to the south of the existing Grand Coulee Visitors Center.

For **Option 3** three towers would be used for each double-circuit line between the substation and powerhouse. In this case standard BPA tower designs would be used with three structures (one for each double-circuit line) located in the area between the Visitors Center and the river. In this case the centerline for the corridor would pass just over the south end of the existing Visitors Center.

Option 4 would be very similar to Option 3 except that the towers between the Visitors Center and the river would be about 100 ft. (30 m) closer to the Visitors Center and its parking lot. The centerline for the corridor would pass just over the south end of the existing visitor center.

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. (1.0 m) above the ground.

The 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 usually measured or calculated at a height of 3.28 ft. (1 m) above the ground.

The 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 visible light.

To quantify EMF levels along the route, the electric and magnetic fields from the proposed and existing lines were calculated using the BPA Corona and Field Effects Program (USDOE, undated). 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.

In the computer model the transmission-line conductors are assumed to be straight, parallel to each other, and located above and parallel to an infinite flat ground plane at a specific distance above the ground. 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. Because maximum voltage, maximum

current, and minimum conductor height above-ground are used, ***the calculated 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.

This calculation method was used to estimate fields for the proposed Project Replacement lines, where minimum clearances were assumed to provide worst-case (highest) estimates for the fields. Minimum clearances above ground for each line were used in the calculation to estimate the maximum field under that line in the profile. Since the distance above ground is one of the principal determinants of field strength at ground level, this assumption produces realistic estimates of maximum fields on the ground. The contribution of fields from adjacent lines to maximum levels is not significant because of the approximately 200-foot spacing between lines.

The conductors of the three double-circuit lines are not quite parallel in the areas of primary interest on the west side of the river. However, the two lines on each double-circuit tower are parallel or close to parallel except near the powerhouse end of the line. Because the lines on a double-circuit tower are essentially parallel and because the spacing between the three circuits is several hundred feet, the field calculation method was deemed sufficiently accurate to assess field levels and electrical effects.

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 currents are assumed for each three-phase circuit and the contribution of induced image currents in the conductive earth is not included. Peak current and power flow direction for the proposed lines were provided by BPA and are based on the maximum capacity of the generators.

The total magnetic field is calculated from the vector summation of the fields from currents in all the transmission-line conductors. Balanced currents are assumed for each three-phase circuit and the contribution of induced image currents in the conductive earth is not included. Peak current and power flow direction for the proposed lines were provided by BPA and are based on the maximum capacity of the generators.

Computation of the magnetic fields in the vicinity of the inclined elevator on the face of the dam also used a vector summation of fields from the nearby transmission line conductors. However, in this case it was necessary to use a three-dimensional model with conductors of finite lengths to describe the overhead lines attaching to the dam and the cables dropping down to the transformers at the powerhouse.

The corona performance of the proposed lines was also predicted using the BPA Corona and Field Effects Program (USDOE, undated). Corona performance is calculated using empirical equations that have been developed over several years from the results of measurements on numerous high-voltage lines (Chartier and Stearns, 1981; Chartier, 1983). The validity of this approach for corona-generated audible noise has been demonstrated through comparisons with measurements on other lines all over the United States (IEEE Committee Report, 1982). The accuracy of this method for predicting corona-generated radio and television interference from transmission lines has also been established (Olsen et al., 1992). Important input parameters to

the computer program are voltage, current, conductor size, and geometric configuration of the line.

Due to its dependence on weather and conductor surface condition, corona is a highly variable phenomenon that depends on conditions along a length of line. Therefore predictions of the levels of corona effects are reported in statistical terms rather than a maximum value that might be exceeded only under worst case conditions. Typically corona effects are reported as L_{50} values, where L_{50} refers to the level that is exceeded 50 percent during a lengthy time period (say, annually).

Levels of audible noise, radio interference, and television interference were predicted for both fair and foul weather; however, corona is basically a foul-weather phenomenon. Wet conductors can occur during periods of rain, fog, snow, or icing. At the location of the Grand Coulee Line Replacement Project, such conditions are expected to occur about 6.5 percent of the time during a year, based on hourly precipitation records during years with complete records for Ephrata, WA (2005-2009) (NOAA, 2010). Corona activity also increases with altitude. For purposes of evaluating corona effects from the proposed line, an altitude of 1000 ft. (305 m) was assumed.

2.0 Physical Description

2.1 Proposed Line

The proposed project includes three 500-kV double-circuit transmission lines. Each line would consist of two three-phase, single-circuit lines for a total of six single circuits. Each phase of a line is carried on a separate set of conductors (wires). For the 500-kV line, each phase actually is carried on a bundle of three conductors (wires) and there are three bundles per circuit as shown in Figure 2. The lines would be aligned in an east-west direction and the six circuits arranged in a north-south direction.

The voltage and current waves on each phase are displaced by 120° in time (one-third of a cycle) from the waves on the other phases. The proposed lines would be placed on double-circuit towers with three conductor bundles arranged vertically on either side of the tower (Figure 2). Four design options were identified for the project based on tower type and physical location. One option (Option 1) was eliminated from consideration because of its proximity to a swimming pool.

BPA provided the physical and operating characteristics of proposed Options 2, 3 and 4. The electrical characteristics and physical dimensions for the towers and conductors of each option are shown in Table 1.

The maximum phase-to-phase voltage for the proposed lines would be 550-kV and the average voltage would be 540 kV. The maximum electrical current on the lines would be 845 amperes (A) per phase for the three northern-most circuits and 730 A for the three southern-most circuits. These currents are based on peak ratings for the generators feeding each circuit. The individual generators, and consequently the lines connected to them, are operated at peak load when in service. Although all generators are unlikely to be in service at the same time, field and corona effects calculations were performed at peak load with all generators operating to produce an estimate of the maximum field and corona levels anticipated for the project. Only the maximum values for fields corresponding to all generators in operation are reported here. Periods of

reduced or no generation would necessarily reduce these levels either in extent or magnitude at all locations.

Option 2 would utilize three 1.382-inch diameter conductors for each phase. These conductors would be arranged in an inverted triangle configuration with approximately 17-in. (43.3 cm) spacing between conductors. There would be three bundles per three-phase circuit and six three-phase circuits in all (18 total conductor bundles). Options 3 and 4 would utilize slightly smaller 1.300-inch conductors in bundles of the same dimensions. The smaller conductors would result in a small increase in corona-generated audible noise and electromagnetic interference, but not in electric or magnetic field levels.

The double-circuit towers used for the three options would employ different horizontal and vertical spacings between conductor bundles depending on the location of the tower (Table 1). The horizontal spacing between the top and bottom pairs of conductor bundles is generally less than the spacing between the middle pair of conductor bundles. The conductors would all attach to the face of the dam at the same height requiring a transition of each circuit from a vertical to a horizontal configuration.

At each profile location the horizontal and vertical spacings for each line were estimated, to account for slight changes along each span. The minimum clearance above ground for each line was used for field computations along a profile. Using the lowest clearance for each line results in conservative (high) estimates for the fields expected along a profile.

Minimum conductor-to-ground clearance for 500-kV lines over flat terrain normally would be about 35 ft. (10.7 m) at a conductor temperature of 122°F (50°C). This temperature represents operating conditions with high currents and high ambient air temperatures. However, for this project the minimum clearances would be greater than 50 ft. (15 m) because of steep terrain and the river crossing. These larger minimum clearances would result in lower fields than found under similar lines over flat terrain.

The larger than 50-foot clearance ensures that the BPA criteria for maximum electric field at ground level (9 kV/m on the right-of-way and 5 kV/m at road crossings) would be met along the entire project. The land in the vicinity of the proposed lines is federally owned well beyond the distance normally designated as right-of-way.

Electric and magnetic fields for the proposed lines were calculated at the standard height (3.28 ft. or 1 m) above the ground (IEEE, 1994). Calculations were performed out to 600 ft. (182 m) north and 800 ft. (244 m) south of the of the corridor centerline. The corridor centerline is defined as the centerline of Line 2 which is the middle of the three double circuit lines.

Electric and magnetic fields were computed along four north-south profiles roughly perpendicular to the lines. The profiles were chosen to pass through relatively flat areas where the conductors were closest to the ground. The locations of the four profiles are described in Table 2. **Profile 1** was located on the hillside between the substation and State Highway 155. **Profile 2** was located on a transect passing through the Visitors Center and parking lot. **Profile 3** was located along the flat area between the Visitors Center and the river, approximately 150 ft. (46 m) east of the Visitors Center. **Profile 4** was located along the center of the powerhouse roof. The general public is expected to access only the areas of Profiles 2 and 3 on a regular basis. Calculated levels at 300 ft north of the corridor centerline were considered surrogates for edge of right-of-way values on the west side of the river. For Profile 4 on the powerhouse roof

levels at 600 ft. (182 m) north of the Line 2 centerline, corresponding to the end of the roof, were reported.

Magnetic fields were calculated at a height of 6.56 ft (2 m) along the centerline of the inclined elevator route from the top of the dam to the floor level of the power house. The electric fields in this area were not calculated because they would be mostly shielded from the interior of the inclined elevator.

Calculations of audible noise and electromagnetic interference levels were made under conditions of an estimated average operating voltage (540 kV for the proposed lines) and with the average minimum height of Line 1 at Profiles 2 and 3 for each option. These profiles were chosen to predict noise levels at the swimming pool location 300 ft. (91 m) north of the corridor and in areas most regularly visited by the public.

2.2 Existing Lines

The existing overhead transmission lines from the Third Powerhouse to the substation are energized only in the event of a failure of the underground cable system from the dam to the substation. Therefore electric and magnetic fields and corona effects are produced by these lines only under emergency conditions. These lines will be removed during construction of the proposed lines. Consequently, the No-action Alternative does not produce any electric fields, magnetic fields or corona effects to be compared with those from the proposed project options and would result in a continued absence of such effects at this location.

3.0 Electric Field

3.1 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 the unbalanced electrical charges associated with voltage on the conductors. 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 (1 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 in the air is perpendicular to the conductor surface and 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.

3.2 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. (1 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, local 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 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 120°F (50°C), and at a maximum voltage (IEEE, 2002). BPA has supplied the needed information for calculating electric and magnetic fields from the proposed transmission lines: 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 or where conductors are closest to the ground (minimum clearance). As the location of an electric-field profile approaches a tower, the conductor clearance increases, and the peak field decreases. A grounded tower will reduce the electric field considerably by shielding.

For traditional transmission lines in flat terrain, where the right-of-way extends laterally well beyond the conductors, electric fields at the edge of the right-of-way are not as sensitive as the peak field to conductor height. However for the Grand Coulee Line Replacement Project with its much increased clearances, the computed values at normal edge-of-right-of-way distances are relatively low compared to fields at the same distance from more traditional lines.

3.3 Calculated Values of Electric Fields

Table 3 shows the calculated values of electric field at 3.28 ft. (1 m) above ground for the four profiles under the proposed 500-kV transmission-lines by option. The peak value under the conductors and at 300 (91 m) and 600 ft. (182 m) north from the center of the corridor are given for Profiles 1, 2, and 3 and only at 600 ft. (182 m) for Profile 4 of the proposed lines. The maximum fields were computed with all circuits operating at the maximum voltage of 550 kV. The electric fields along each of the four profiles for the three design options are shown in Figures 3-6.

The calculated maximum electric fields under the lines range from 1.0 to 5.6 kV/m, depending on the profile and option. The largest peak values occur for Profile 1 on the hillside above the Visitors Center. The peak fields along profiles 2 and 3 near the Visitors Center are 1.0 to 1.7 kV/m. The electric fields expected at 300 ft. (182 m) from the centerline of the corridor on the west side of the river are 1.3 kV/m or less. The fields at 600 ft. (182 m) north of the corridor on the west side of the river (Profiles 1, 2, and 3) would be about 0.1 kV/m. On the roof of the powerhouse the field at 600 ft. (182 m) would be about 0.3 kV/m.

The peak values would be present only at locations very close to or directly under the lines, where the conductors are at the minimum clearance along a profile. The calculated peak levels are rarely reached under ordinary 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 towers, vegetation and other objects above ground tend to shield the field at ground level.

3.4 Environmental Electric Fields

The electric fields associated with the proposed Line Replacement Project 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 the 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 500 kV or higher. 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. 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, electrical 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 than other appliances. 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 with the average field at the chest equivalent to a 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 (IIT Research Institute, 1984). 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. Existing 500-kV lines in the Pacific Northwest typically have maximum fields of about 9 kV/m. Although these peak levels are considerably higher than the levels found in other public areas, they are present only in limited areas directly under the conductors. Electric fields at the edge of the rights-of-way for existing 500-kV lines are typically 2 to 3 kV/m.

The calculated electric fields along profiles 2 and 3 of the proposed project would be 1.7 kV/m or less (Table 3; Figures 4, 5 and 6). Thus, the fields along Profiles 2 and 3 near the Visitors Center are at or below levels typically found at the edge of the right-of-way of existing long-distance 500-kV transmission lines. The electric fields at the Visitors Center (Profile 2, Figure 4) would be between 1 and 1.6 kV/m depending on the option. Electric fields from the overhead lines would be shielded and not present inside the Visitors Center. Electric fields along Profile 1 on the steep hillside above State Highway 155 would be higher, up to 5.6 kV/m for Option 4 (Figure 3). Maximum electric fields along the roof of the Third Powerhouse would be about 2.1 kV/m. The calculated electric fields of 0.4 to 1.3 kV/m at 300 ft. from the center of the corridor would be below fields typically found at the edges of existing 500-kV transmission line rights-of-way.

4.0 Magnetic Field

4.1 Basic Concepts

Magnetic fields can be characterized by the force they exert on a moving charge or on an electrical current. As with electric field, 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 tesla (T) is the unit of magnetic flux density preferred in scientific publications, where 1.0 gauss equals one ten-thousandth of a tesla (0.1 mT) and 1.0 mG equals 0.1 microtesla [μT]).

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 (1 meter) 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 fields 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 as well as its area.

4.2 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 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 right-of-way. 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 clearances for magnetic-field calculations for the proposed lines were 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 at midspan, where the conductors are usually the lowest. The magnetic field at the edge of the right-of-way is not very dependent on line height. If more than one line is present, the peak field will depend on the relative electrical phasing of the conductors and the relative direction of power flow in the lines.

4.3 Calculated Values for Magnetic Fields

Table 3 gives the calculated values of the magnetic field at 3.28 ft. (1 m) height for the four profiles under the proposed 500-kV transmission-lines. Peak fields under the lines and at 300 (91 m) and 600 ft. (182 m) from the corridor centerline (only at 600 ft. (182 m) for Profile 4) are given, These values were computed for projected maximum currents and minimum clearance at a conductor temperature of 50° C. The maximum currents are based on the rated maximum power output for the existing generators and all generators are assumed to be operating. The projected maximum currents are 845 A on the three northernmost lines and 730 A on the three

southernmost lines. It is not possible to estimate an average current over the year, since the generators are either operating or not and it is not evident which generators will be operating and for how long.

Figures 7 to 10 show lateral profiles of magnetic fields under maximum current and minimum clearance conditions for the proposed 500-kV transmission lines. The magnetic field levels shown in the figures represent the highest magnetic fields expected under the proposed 500-kV lines. The actual day-to-day magnetic-field levels would be lower. They would vary as currents change daily and seasonally and as clearances change with ambient temperature.

The maximum calculated 60-Hz magnetic fields expected at 3.28 ft. (1 m) above ground for the proposed lines range from 11 to 61 mG for the four profiles. The highest fields would occur for Profile 1 on the hillside above the Visitors Center. The lowest maximum fields would occur along Profile 2 that passes through or very close to the Visitors Center, where maximum fields would range from 12 to 19 mG depending on which option is chosen. The maximum field on the roof of the Powerhouse would range from 39 to 46 mG depending on the option.

The maximum magnetic fields in the areas that are regularly accessed by the public (Profiles 2 and 3) would range up to 19 mG. In these area somewhat higher fields would occur for Option 3 than for Options 2 or 4.

With all circuits from the Third Powerhouse energized, the inclined elevator would pass through magnetic fields ranging from 14 to 66 mG while going between the top of the dam and the transformer area. These fields represent the highest possible levels, because they do not account for shielding of the magnetic field provided by ferromagnetic materials in the elevator. The fields along the elevator route would also be reduced if one or more of the adjacent circuits was not in service. For example, with the closest circuit to the elevator (Circuit 20) de-energized, the peak magnetic fields during transit of the elevator would be reduced from 66 mG to 22 mG.

The fields present in the elevator traveling along the face of the dam would be less than those found on the rights-of-way of existing 500-kV transmission lines and exposures during ascent or descent of the elevator would be less than a minute. The highest magnetic fields along the elevator route would likely occur at and below the level of the transformers, where higher current (lower voltage) conductors are present. These fields already exist, would not be affected by the proposed overhead 500-kV lines, and were not calculated.

The magnetic field falls off as distance from the lines increases. At 300 ft north from the centerline of the corridor the magnetic fields for Profiles 2 and 3 would be about the same as the range of maximums: between 11 and 19 mG. At 600 ft north of the centerline the maximum fields would be about 4 mG for Profiles 1, 2 and 3, and would be 9 mG or less on the roof of the Powerhouse.

4.4 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 500 kV lines 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 large 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 largest “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 percent 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. New "low-field" blankets 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 a 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. The technology of newer energy-efficient and battery-powered appliances and tools is likely to reduce fields from such devises considerably compared to the examples given above.

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:

(1) 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.

(2) Homes with overhead electrical service appear to have higher average fields than those with underground service.

(3) 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 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, computers, and office equipment. 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.

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 right-of-way. 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 lines would be comparable to or less than those from existing 500-kV lines in Washington and elsewhere. Under or directly adjacent to the proposed lines, magnetic fields would be above average residential levels. However, the fields from the lines would decrease rapidly and approach common ambient levels at distances greater than 600 ft. (182 m) from the corridor centerline. Furthermore, the fields at 300 ft. (91 m) from the centerline would not be above those encountered during normal activities near common sources such as hand-held appliances.

5.0 Electric and Magnetic Field (EMF) Effects

Possible effects associated with the interaction of EMF from transmission lines with people on and near a right-of-way fall into two categories: short-term effects that can be perceived and may represent a nuisance, and possible long-term health effects. Only short-term effects are discussed here. The issue of whether there are long-term health effects 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 (Exponent, 2009).

5.1 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 would occur infrequently, if at all, because of the relatively low field levels (less than 1.7 kV/m) in areas frequented by the public.

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 lines will 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 will not be possible from induced currents under the proposed lines, because the clearances above ground 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 500-kV lines when making contact with ungrounded conducting objects such as large vehicles or equipment. However, such occurrences are anticipated to be very infrequent. Shocks, if and when they occur under the 500-kV lines, are most likely to be below the nuisance level. Induced currents are extremely unlikely to be perceived beyond 300 ft. (91 m) from the proposed corridor centerline.

Induced currents are always present in electric fields under transmission lines and will be present near the proposed line. However, during initial construction, BPA routinely grounds metal objects that are located on or near a right-of-way. The grounding eliminates these objects as sources of induced current and voltage shocks. Multiple grounding points are used to provide redundant paths for induced current flow. After construction, BPA would respond to any complaints and install or repair grounding to 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 lines to 5 milliamperes (mA) or less. This can be accomplished by limiting access or by increasing conductor clearances in areas where large vehicles could be present. BPA and other utilities design and operate lines to be in compliance with the NESC.

For the proposed line, conductor clearances at 50°C conductor temperature would be sufficient to limit the maximum field to 1.7 kV/m or less over the road crossing and parking lots. This level ensures that the NESC short-circuit current limit for large vehicles will not be exceeded met and that the BPA electric-field criteria for road crossings and parking lots will be met.

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. The relatively low electric field (≤1.7 kV/m) under the proposed lines will significantly reduce the possibility of nuisance shocks compared to that under more convention long distance lines where the maximum field can approach 9 kV/m. It is unlikely that nuisance shocks will occur under the proposed lines.

In electric fields higher than will 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 to occur for ignition is extremely remote. The large clearances of conductors provided at the road crossing and parking lots would reduce the electric field in areas where vehicles are prevalent and significantly reduce the chances for such events. Even so, BPA recommends that vehicles should not be refueled under the proposed 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 percent could perceive fields of 2 kV/m or less (Deno and Zaffanella, 1982). In areas under the conductors along Profiles 2 and 3, the electric field at ground level would be below levels where field perception normally occurs. Therefore it is unlikely that persons in these areas would be able to perceive the electric field.

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 500-kV lines would be less than those from existing 500-kV lines in the project area and elsewhere. Potential impacts of electric fields can be mitigated through grounding policies, adherence to the NESC, and increased clearances above the minimums specified by 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 towers, vehicles and vegetation, also reduces the potential for electric-field effects. Recommended safety practices and restricted activities on BPA transmission line rights-of-way are described in the BPA booklet “Living and Working Safely Around High-Voltage Transmission Lines” (USDOE, 2007).

5.2 Magnetic Field: 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 several factors, including 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).

For the proposed transmission lines, the contributing factors tend to be considerably reduced from those present with longer lines with higher fields. At only one mile in length including a river crossing and a large elevation change, there will belittle opportunity for long parallel conductors. Also the fields are lower than those present under longer lines where procedures have been developed to mitigate for induced voltages on pipelines, irrigation pipes, and fences. Grounding policies employed by utilities for long fences also reduce the potential magnitude of induced voltage.

Knowledge of the phenomenon, grounding practices, and the availability of mitigation measures mean that magnetic-induction effects from the proposed 500-kV transmission lines will be minimal.

Magnetic fields from transmission and distribution facilities can interfere with certain electronic equipment. Magnetic fields as low as 10 mG can cause distortion of the image on older VDTs and computer monitors that employ cathode ray tubes (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. Contemporary display devices using flat-panel technologies, such as liquid-crystal or plasma displays are not affected. Consequently, this type of magnetic interference is not expected near the proposed lines.

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 500-kV transmission lines.

The magnetic fields under and adjacent to the proposed transmission lines will be less than those under and at the edge of the rights-of-way from existing 500-kV lines in the area of the proposed lines.

6.0 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 might cause health effects. In no case has a limit or standard been established because of a known or demonstrated health effect.

The proposed lines would be designed to meet the 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. In addition, as a matter of safety, the NESC specifies that electric-field-induced currents from transmission lines to vehicles must be below the 5 mA ("let go") threshold deemed a lower limit for primary shock. BPA publishes and distributes a booklet that describes safe practices to protect against shock hazards around power lines (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. The limits established by three such guidelines are described in Table 4.

The American Conference of Governmental Industrial Hygienists (ACGIH) sets guidelines (Threshold Limit Values or TLVs) 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).

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).

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, 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. The state of Washington does not have guidelines for electric or magnetic fields from transmission lines. However, several states have been active in establishing mandatory or suggested limits on 60-Hz electric and (in two cases) magnetic fields. Six states have specific electric-field limits that apply to transmission lines: Florida, Minnesota, Montana, New Jersey, New York, and Oregon. Florida and New York have established regulations for magnetic fields. These regulations are summarized in Table 5.

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 right-of-way, 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. The latter 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.

The electric fields from the proposed 500-kV lines would meet the ACGIH standards, provided wearers of pacemakers and similar medical-assist devices are discouraged from unshielded right-of-way use. (A passenger in an automobile under the lines would be shielded from the electric field, as would a person in the visitor center.) The electric fields in a small area on the steep hillside above the Visitors Center (Profile 1 could exceed the ICNIRP guideline for public exposure. However all areas in the vicinity of Profiles 2 and 3 would have electric fields less than the limits established by both ICNIRP and IEEE. The electric fields in all areas would be less than the occupational limits set by all three agencies. The magnetic fields from the proposed lines would be below the ACGIH, ICNIRP, and IEEE limits for occupational and public exposure in all areas.

The estimated peak electric and magnetic fields under and near the proposed transmission lines would meet limits set in all states that have established limits. (see Table 5). The BPA maximum allowable electric field limits for on and off the right-of-way, for road crossings and for parking lots would be met for all options of the proposed lines.

7.0 Audible Noise

7.1 Basic Concepts

Audible noise (AN), as defined here, represents an unwanted sound, as from a transmission line, transformer, airport, or vehicle traffic. Sound is a pressure wave caused by a sound source vibrating or displacing air. The ear converts the pressure fluctuations into auditory sensations. AN from a source is superimposed on the background or ambient noise that is present before the source is introduced.

The amplitude of a sound wave is the incremental pressure resulting from sound above atmospheric pressure. The sound-pressure level is the fundamental measure of AN; it is generally measured on a logarithmic scale with respect to a reference pressure. The sound-pressure level (SPL) in decibels (dB) is given by:

$$SPL = 20 \log (P/P_o)dB$$

where P is the effective rms (root-mean-square) sound pressure, Po is the reference pressure, and the logarithm (log) is to the base 10. The reference pressure for measurements concerned with hearing is usually taken as 20 micropascals (Pa), which is the approximate threshold of hearing for the human ear. A logarithmic scale is used to encompass the wide range of sound levels present in the environment. The range of human hearing is from 0 dB up to about 140 dB, a ratio of 10 million in pressure (EPA, 1978).

Logarithmic scales, such as the decibel scale, are not directly additive: to combine decibel levels, the dB values must be converted back to their respective equivalent pressure values, the total rms pressure level found, and the dB value of the total recalculated. For example, adding two sounds of equal level on the dB scale results in a 3 dB increase in sound level. Such an increase in sound pressure level of 3 dB, which corresponds to a doubling of the energy in the sound wave, is barely discernible by the human ear. It requires an increase of about 10 dB in SPL to produce a subjective doubling of sound level for humans. The upper range of hearing for humans (140 dB) corresponds to a sharply painful response (EPA, 1978).

Humans respond to sounds in the frequency range of 16 to 20,000 Hz. The human response depends on frequency, with the most sensitive range roughly between 2000 and 4000 Hz. The frequency-dependent sensitivity is reflected in various weighting scales for measuring audible noise. The A-weighted scale weights the various frequency components of a noise in approximately the same way that the human ear responds. This scale is generally used to measure and describe levels of environmental sounds such as those from vehicles or occupational sources. The A-weighted scale is also used to characterize transmission-line noise. Sound levels measured on the A-scale are expressed in units of dB(A) or dBA.

AN levels and, in particular, corona-generated audible noise (see below) vary in time. In order to account for fluctuating sound levels, statistical descriptors have been developed for environmental noise. Exceedence levels (L levels) refer to the A-weighted sound level that is exceeded for a specified percentage of the time. Thus, the L_5 level refers to the noise level that is exceeded only 5 percent of the time. L_{50} refers to the sound level exceeded 50 percent of the time. Sound-level measurements and predictions for transmission lines are often expressed in terms of exceedence levels, with the L_5 level representing the maximum level and the L_{50} level representing a median level.

Table 6 shows AN levels from various common sources. Clearly, there is wide variation. Noise exposure depends on how much time an individual spends in different locations. Outdoor noise generally does not contribute to indoor levels (EPA, 1974). Activities in a building or residence generally dominate interior AN levels.

BPA has established a transmission-line design criterion for corona-generated audible noise (L_{50}, foul weather) of 50 dBA at the edge of the right-of-way (USDOE, 2006). This criterion applies to new line construction and is under typical conditions of foul weather, altitude, and system voltage for the line. It is generally only of concern for 500-kV lines.

The Washington Administrative Code provides noise limitations by class of property, residential, commercial or industrial (Washington State, 1975). Transmission lines are classified as industrial and may cause a maximum permissible noise level of 60 dBA to intrude into residential property. During nighttime hours (10:00 pm to 7:00 am), the maximum permissible limit for noise from industrial to residential areas is reduced to 50 dBA. This latter level applies to transmission lines that operate continuously. The state of Washington Department of Ecology accepts the 50 dBA level at the edge of the right-of-way for transmission lines, but encouraged BPA to design lines with lower audible noise levels (WDOE, 1981).

The EPA has established a guideline of 55 dBA for the annual average day-night level (L_{dn}) in outdoor areas (EPA, 1978). In computing this value, a 10 dB correction (penalty) is added to night-time noise between the hours of 10 p.m. and 7 a.m.

The area under and immediately adjacent to the proposed transmission lines is federally owned and there is no distinct edge of right-of-way distance for the corridor. Therefore the 300-foot distance from the corridor centerline to nearby swimming pool was used as a surrogate edge-of-right-of-way distance. This location is about 55 ft. (17 m) from the outside conductors of Line 1.

7.2 Transmission-line Audible Noise

Corona is the partial electrical breakdown of the insulating properties of air around the conductors of a transmission line. In a small volume near the surface of the conductors, energy and heat are dissipated. Part of this energy is in the form of small local pressure changes that result in audible noise. Corona-generated audible noise can be characterized as a hissing, crackling sound that, under certain conditions, is accompanied by a 120-Hz hum. Corona-generated audible noise is of concern primarily for contemporary lines operating at voltages of 345 kV and higher during foul weather. The proposed 500-kV lines will produce some noise under foul weather conditions.

The conductors of high-voltage transmission lines are designed to be corona-free under ideal conditions. However, protrusions on the conductor surface—particularly water droplets on or dripping off the conductors—cause electric fields near the conductor surface to exceed corona onset levels, and corona occurs. Therefore, audible noise from transmission lines is generally a foul-weather (wet-conductor) phenomenon. Wet conductors can occur during periods of rain, fog, snow, or icing. Based on hourly meteorologic records over several years (2005-2009) from Ephrata, WA, such conditions are expected to occur about 6.5 percent of the time during the year in the vicinity of the proposed line.

For a few months after line construction, residual grease or oil on the conductors can cause water to bead up on the surface. This results in more corona sources and slightly higher levels of audible noise and electromagnetic interference if the line is energized. However, the new conductors "age" in a few months, and the level of corona activity decreases to the predicted equilibrium value. During fair weather, insects and dust on the conductor can also serve as sources of corona.

Option 2 would use three 1.38-inch diameter conductors per phase arranged in an inverted triangle with a 17-inch diameter. Options 3 and 4 would use smaller conductors (1.30-inch diameter) in the same bundle configuration. The smaller conductors produce slightly more audible noise.

7.3 Predicted Audible Noise Levels

To characterize audible noise in areas regularly accessed by the public, fair and foul weather audible noise levels were calculated for average voltage of 540 kV and average minimum conductor heights for Profiles 2 and 3. The predicted levels of corona-generated audible noise under the lines and at 300 ft. (91 m) north from the centerline of the corridor for the proposed lines are given in Table 6. The L_{50} foul-weather levels directly under the proposed lines in this area range from 48 to 51 dBA. The lowest levels would occur for Option 2 because of the slightly larger conductors employed in this option. At 300 ft. (91 m) from the centerline, noise levels for the three options would range from 47 to 50 dBA. A difference of 3 dBA is barely discernible. During fair-weather conditions, which occur about 93 percent of the time, audible noise levels would be about 20 dBA lower (if corona were present).

7.4 Discussion

There would be increases in the perceived noise above ambient levels during foul weather under and away from the lines. However, the corona-generated noise during foul weather would be masked to some extent by naturally occurring sounds such as rain hitting surfaces, wind and water being spilled over the dam. The lower levels present during fair weather would also be masked by ambient noise and would be barely perceptible. Beyond 300 ft. (91 m) the lower levels during fair weather will likely be masked by ambient level noise. For all options the audible noise at 300 ft. (91 m) from the corridor centerline would be comparable to or lower than audible noise from existing 500-kV lines in Washington.

Beyond the 300-foot distance, foul-weather levels of audible noise from the proposed lines would be well below the 55 dBA level that can produce interference with speech outdoors. Residential buildings provide significant sound attenuation (-12 dBA with windows open; -24 dBA with windows closed). Therefore indoor noise levels would be well below the 45 dBA level where interference with speech indoors can occur and below the 35 dBA level where sleep interference can occur (EPA, 1973; EPA, 1978).

The highest noise level of 50 dBA for the design options would meet the BPA design criterion for edge-of-right-of-way noise levels and, hence, the statutory limits established in both Oregon and Washington. The computed annual L_{dn} level for transmission lines operating in areas with 6 to 7 percent foul weather is about $L_{dn} = L_{50} - 3$ dB (Bracken, 1987). Therefore, assuming such conditions in the Grand Coulee area, the estimated worst case L_{dn} at 300 ft. (91 m) from corridor centerline would be approximately 47 dBA, which is below the EPA L_{dn} guideline of 55 dBA.

Thus all applicable federal, state, and local regulations will be met by the proposed transmission line and substation addition and modification.

8.0 Electromagnetic Interference

8.1 Basic Concepts

Corona on transmission-line conductors can also generate electromagnetic noise in the frequency bands used for radio and television signals. The noise can cause radio and television interference (RI and TVI). In certain circumstances, corona-generated electromagnetic interference (EMI) can also affect communications systems and other sensitive receivers. Interference with electromagnetic signals by corona-generated noise is generally associated with lines operating at

voltages of 345 kV or higher. This is especially true of interference with television signals. The bundle of three 1.3-inch (or 1.6-inch) diameter conductors used in the design of the proposed 500-kV lines will mitigate corona generation and thus keep radio and television interference levels at acceptable levels.

Spark gaps on distribution lines and on low-voltage wood-pole transmission lines are a more common source of RI/TVI than is corona from high-voltage electrical systems. This gap-type interference is primarily a fair-weather phenomenon caused by loose hardware and wires. The proposed transmission lines would be constructed with modern hardware that eliminates such problems and therefore minimizes gap noise. Consequently, this source of EMI is not anticipated for the proposed line.

No state has limits for either RI or TVI. In the United States, electromagnetic interference from power transmission systems is governed by the Federal Communications Commission (FCC) Rules and Regulations presently in existence (Federal Communications Commission, 1988). A power transmission system falls into the FCC category of "incidental radiation device," which is defined as "a device that radiates radio frequency energy during the course of its operation although the device is not intentionally designed to generate radio frequency energy." Such a device "shall be operated so that the radio frequency energy that is emitted does not cause harmful interference. In the event that harmful interference is caused, the operator of the device shall promptly take steps to eliminate the harmful interference." For purposes of these regulations, harmful interference is defined as: "any emission, radiation or induction which endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radio communication service operating in accordance with this chapter" (Federal Communications Commission, 1988: Vol II, part 15. 47CFR, Ch. 1).

Electric power companies have been able to work quite well under the present FCC rule because harmful interference can generally be eliminated. It has been estimated that more than 95 percent of power-line sources that caused interference were due to gap-type discharges. These can be found and completely eliminated, when required to prevent interference (USDOE, 1980). Complaints related to corona-generated interference occur infrequently. This is especially true due to increased use of FM radio, cable television and satellite television, which are not subject to corona-generated interference. Mitigation of corona-generated interference with conventional broadcast radio and television receivers can be accomplished in several ways, such as use of a directional antenna or relocation of an existing antenna (USDOE, 1977; USDOE, 1980; Loftness et al., 1981).

8.2 Radio Interference (RI)

Radio reception in the AM broadcast band (535 to 1605 kilohertz (kHz)) is most often affected by corona-generated EMI. FM radio reception is rarely affected. Generally, only residences very near to transmission lines can be affected by RI. The IEEE Radio Noise Design Guide identifies an acceptable limit of fair-weather RI as expressed in decibels above 1 microvolt per meter (dBμV/m) of about 40 dB(μV/m) at 1 megahertz (MHz) (IEEE Committee Report, 1971). This limit applies at 100 ft. (30 m) from the outside conductor. As a general rule, average levels during foul weather (when the conductors are wet) are 16 to 22 dBμV/m higher than average fair-weather levels.

8.3 Predicted RI Levels

The L_{50} fair-weather RI levels were predicted at 100 ft. (30 m) from the outside conductors for all options in the vicinity of the Visitors Center. The results are shown in Table 6. The L_{50} levels at 100 ft. (30 m) from the outside conductors for all configurations are at or below the acceptable limit of about 40 dBμV/m and are therefore compliant with the IEEE guideline level.

8.4 Television Interference (TVI)

Corona-caused TVI occurs during foul weather and is generally of concern for transmission lines with voltages of 345 kV or above, and only for conventional receivers within about 600 ft. (183 m) of a line. As is the case for RI, gap sources on distribution and low-voltage transmission lines are the principal observed sources of TVI. The use of modern hardware and construction practices for the proposed lines would minimize such sources.

8.5 Predicted TVI Levels

The predicted foul-weather TVI levels at 75MHz from the proposed configurations operating at 540 kV are shown in Table 6. These levels are given for a location 100 ft. (30 m) from the outside conductor. The levels at these points range from 10 to 17 dB(μV/m) depending on the design option, with Option 2 having the lowest levels. These levels are comparable to or lower than those from existing 500-kV lines in Oregon and Washington. As with RI the largest values occur for the two options with the smaller 1.3 inch conductors.

At the highest predicted levels, there is a potential for interference with television signals at locations very near the proposed lines in fringe reception areas. However, several factors reduce the likelihood of occurrence. Corona-generated TVI occurs only in foul weather; consequently, signals will not be interfered with during the predominant fair weather. Because television antennas are directional, the impact of TVI is related to the location and orientation of the antenna relative to the transmission line. If the antenna were pointed away from the line, then TVI from the lines would affect reception much less than if the antenna were pointed towards the line. Since the level of TVI falls off with distance, the potential for interference becomes minimal at distances greater than several hundred feet from the lines.

Other forms of TVI from transmission lines are signal reflection (ghosting) and signal blocking caused by the relative locations of the transmission structure and the receiving antenna with respect to the incoming television signal. Again only houses within several hundred feet of the proposed lines would possibly be affected.

Television systems that operate at higher frequencies, such as satellite receivers, are not affected by corona-generated TVI. Cable television systems are also not affected.

Interference with television reception can be corrected by any of several approaches: improving the receiving antenna system; installing a remote antenna; installing an antenna for TV stations less vulnerable to interference; connecting to an existing cable system; or installing a translator (cf. USDOE, 1977). BPA has an active program to identify, investigate, and mitigate legitimate RI and TVI complaints. It is anticipated that any instances of TVI caused by the proposed lines could be effectively mitigated.

8.6 Interference with Other Devices

Corona-generated interference can conceivably cause disruption on other communications bands such as the citizen's (CB) and mobile bands. However, mobile-radio communications are not

susceptible to transmission-line interference because they are generally frequency modulated (FM). Similarly, cellular telephones operate at a frequency of about 900 MHz or higher, which is above the frequency where corona-generated interference is prevalent. In the unlikely event that interference occurs with these or other communications, mitigation can be achieved with the same techniques used for television and AM radio interference.

8.7 Conclusion

Predicted EMI levels for the proposed 500-kV transmission lines are comparable to, or lower, than those that already exist near other 500-kV lines and no impacts of corona-generated interference on radio, television, or other reception are anticipated. Whether interference occurs could depend on which option is selected, the nature of the signal being received, as well as the type of television or radio receiver. Furthermore, if interference should occur, there are various methods for correcting it; BPA has a program to respond to legitimate complaints.

9.0 Other Corona Effects

Corona is visible as a bluish glow or as bluish plumes. On the proposed 500-kV lines, corona levels would be very low, so that corona on the conductors would be observable only under the darkest conditions and only with the aid of binoculars, if at all. Without a period of adaptation for the eyes and without intentional looking for the corona, it would probably not be noticeable.

When corona is present, the air surrounding the conductors is ionized and many chemical reactions take place, producing small amounts of ozone and other oxidants. Ozone is approximately 90 percent of the oxidants, while the remaining 10 percent is composed principally of nitrogen oxides. The national primary ambient air quality standard for photochemical oxidants, of which ozone is the principal component, is 147 micrograms/cubic meter) or 75 parts per billion. The maximum incremental ozone levels at ground level produced by corona activity on the proposed transmission lines during foul weather would be much less than 1 part per billion. This level is insignificant when compared with natural levels and fluctuations in natural levels.

10.0 Summary

Electric and magnetic fields from the proposed transmission lines have been characterized using well-known techniques accepted within the scientific and engineering community. The expected maximum electric-field levels from the proposed lines at minimum design clearance would be less than those from existing 500-kV lines in Washington and elsewhere. The expected maximum magnetic-field levels from the proposed lines would be less than those from other 500-kV lines in Washington and elsewhere.

The peak electric field expected under the proposed lines would be from 2.3 to 5.6 kV/m, depending on the design option that is chosen. The peak would occur on the hillside above the Visitors Center. The maximum field in the vicinity of the Visitors Center would be 1 to 1.7 kV/m. The largest values in the area of the Visitors Center would occur for Option 3. The maximum electric fields at 300 ft. (91 m) from the centerline would be about 1.3 kV/m for Option 3 with somewhat lower levels for Options 2 and 4. The conductor clearance over State Highway 155 will ensure that the electric field there will not exceed 5 kV/m for any option.

Under maximum current conditions, the maximum magnetic fields on and at 300 ft. (91 m) from centerline in the vicinity of the Visitors Center are comparable with the highest values (19 mG) for Option 3 and about 12 mG for the other two options. By 600 ft. (182 m) from centerline the magnetic fields drop to about 4 mG under maximum operating conditions. Maximum magnetic fields during an ascent or descent of the inclined elevator would be about 66 mG.

The electric fields from the proposed lines would meet regulatory limits for public exposure in states with such limits and guidelines established by IEEE. However, the electric fields in one location (Option 4, Profile 1) could exceed the guideline for peak field established by ICNIRP.

The magnetic fields from the proposed lines under the lines and in the inclined elevator on the face of the dam would be within the regulatory limits of the two states that have established such limits and below the guidelines for public exposure established by ICNIRP and IEEE. Washington does not have any electric- or magnetic-field regulatory limits or guidelines.

Short-term effects from transmission-line fields are well understood and can be mitigated. Nuisance shocks arising from electric-field induced currents and voltages are very unlikely to be perceivable in the areas near the Visitors Center. To reduce the likelihood of such shocks occurring it is a BPA practice to ground permanent conducting objects during and after construction.

Corona-generated audible noise from the lines could be perceivable during foul weather. The levels would be comparable to or less those near existing 500-kV transmission lines in Washington, would be in compliance with noise regulations in Washington, and would be below levels specified in EPA guidelines.

Corona-generated electromagnetic interference from the proposed line would be comparable to or less than that from existing 500-kV lines in Washington. Radio interference levels would be at or below limits identified as acceptable. Television interference, a foul-weather phenomenon, is anticipated to be comparable to or less than that from existing 500-kV lines in Washington. It is unlikely that radio or television interference will occur. However, if legitimate complaints arise, BPA has a mitigation program.

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Table 1: Electrical and Physical Characteristics of Transmission Lines in the Grand Coulee Line Replacement Project by Option, Line, and Tower.

Characteristic	Option/Profile	Line 1				Line 2				Line 3			
Voltage, kV Max./Ave.[1]	**All**	550/540											
Proposed Peak Current, A	**All**	845				845 (N ckt.); 730 (S ckt.)				730			
Electric Phasing (north to south)	**Profiles 1, 2 & 3**	B A A C C B				B A A C C B				B A A C C B			
	Profile 4	B C A C B A				C B A C B A				C B A C B A			
Tower configuration	**Profiles 1, 2 & 3**	Double Circuit: Vertical											
	Profile 4	All Circuits: Transition Vertical to Flat											
Phase spacing at tower, ft. H = Horizontal, V = Vertical	**Option 2**	Tower 1 (West): 28, 50, 28H; 45V Tower 2 (East): 28, 38, 28H; 36V											
	Option 3 & 4	Tower 1 & 3 (West & East): 28, 38, 28H; 36V Tower 2 (Central): 31.65, 41.65, 31.65H; 38V											
Phase spacing at dam, ft.	**All options**	Ave. spacing 47 ft. except 245 ft. for two northernmost phases of Line 3											
Conductor: # x Dia., in./Bundle Dia., in.	**Option 2**	3 x 1.382/17.04											
	Options 3 & 4	3 x 1.300/17.04											
MinimumClearance, ft. [1]	**Profile**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
	Option 2	149	154	120	91	87	159	149	91	82	144	183	99
	Option 3	115	96	96	87	58	101	101	87	58	106	106	87
	Option 4	111	135	149	82	58	130	149	84	48	135	168	82
Centerline Spacing Between Lines at Towers, ft.	**Tower**	**1**		**2**		**3**		**Dam**	
	Lines	**L1-L2**	**L2-L3**	**L1-L2**	**L2-L3**	**L1-L2**	**L2-L3**	**L1-L2**	**L2-L3**
	Option 2	210	230	210	220	–	–	278	481
	Option 3	235	235	205	205	210	210	278	481
	Option 4	225	225	200	200	190	190	278	481

Notes for Table 1: Maximum voltage and current and minimum clearance used for electric and magnetic field calculations; average voltage and average clearance for Profiles 2 and 3 used for corona calculations

Table 2: Description of Calculation Profiles for the Proposed Grand Coulee Line Replacement Project. Profiles are approximately perpendicular to centerline of Line 2 at location indicated. Towers are numbered west to east towards dam.

Profile No.	General Description	Approximate Location Relative to Towers		
		Option 2 2 Towers	**Option 3 3 Towers**	**Option 4 3 Towers**
1	On hillside above State Highway 155	760 ft. west of Tower 2	440 ft. west of Tower 2	360 ft. west of Tower 2
2	Through west portion of Visitors Center	370 ft. east of Tower 2	500 ft. west of Tower 3	390 ft. west of Tower 3
3	On flat area 300 ft. east of Visitors Center	690 ft. west of Tower 2	170 ft. west of Tower 3	70 ft. west of Tower 3
4	Along center of Third Power-house roof	450 ft. east of dam face	450 ft. east of dam face	450 ft. east of dam face

Table 3: Calculated Electric Field and Magnetic Field from the Proposed Grand Coulee Line Replacement Project by Profile and Design Option.

Profile Number	1			2			3			4		
Profile Description	On Hillside above State Highway 155			Adjacent to or through GC Visitors Center			East of GC Visitors Center			Along roof of Third Powerhouse		
Design Option	2	3	4	2	3	4	2	3	4	2	3	4
Electric field, kV/m												
Maximum	2.3	4.1	5.6	1.1	1.7	1.2	1.3	1.7	1.0	2.1	2.1	2.1
300 ft North of Line 2 Centerline	0.4	0.7	0.7	0.6	1.3	0.6	1.0	1.3	0.5			
600 ft North of Line 2 Centerline	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.3
Magnetic field, mG												
Maximum	23	45	61	12	19	12	16	19	11	39	44	46
300 ft North of Line 2 Centerline	10	14	14	11	19	12	16	19	11			
600 ft North of Line 2 Centerline	4	4	4	4	4	4	4	4	3	9	8	8

Table 4: Electric- and Magnetic-field Exposure Guidelines.

ORGANIZATION	TYPE OF EXPOSURE	ELECTRIC FIELD, kV/m	MAGNETIC FIELD, mG
ACGIH	OCCUPATIONAL	25[1]	10,000
ICNIRP	Occupational	8.3[2]	4,200
	General Public	4.2	833
IEEE	Occupational	20	27,100
	General Public	5[3]	9,040

1 Grounding is recommended above 5 –7 kV/m and conductive clothing is recommended above 15 kV/m.
2 Increased to 16.7 kV/m if nuisance shocks are eliminated.
3 Within power line rights-of-way, the guideline is 10 kV/m.

Sources: ACGIH, 2008; ICNIRP, 1998; ICES, 2002

Table 5: States with Transmission-line Field Limits.

STATE AGENCY	WITHIN RIGHT-OF-WAY	AT EDGE OF RIGHT-OF-WAY	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 Environmental 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[1]	1[2]	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)[3]	1.6	Explicitly implemented in terms of a specified right-of-way 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.

Notes for Table 5:
1 At road crossings
2 Landowner may waive limit
3 At highway and private road crossings, respectively

Source: USDOE, 1996

Table 6: Estimated Corona-generated Audible Noise, Radio Interference, and Television Interference from the Proposed Grand Coulee Line Replacement Project by Design Option.

Profile Description	Area at and to the east of the Visitors Center (Profiles 2 and 3)			
Parameter	**Specific Location**	**Design Option**		
		2	**3**	**4**
Audible noise, dBA L50 foul weather	**Maximum under lines**	48	51	50
	300 ft north of Line 2 Centerline	47	50	49
Radio Interference Level, dB(µV/m) L50 fair weather, at 1 MHz	**100 ft. north of outside conductor**	38	40	40
Television Interference Level, dB(µV/m) Foul weather, at 75 MHz	**100 ft. north of outside conductor**	10	17	13

Table 7: Common Noise Levels.

Sound Level, dBA	Noise Source or Effect
130	Threshold of pain
110	Rock-and-roll band
80	Truck at 50 ft. (15.2 m)
70	Gas lawnmower at 100 ft. (30 m)
60	Normal conversation indoors
50	Moderate rainfall on foliage
49	Highest foul-weather L_{50} at edge of proposed 500-kV right-of-way
40	Refrigerator
25	Bedroom at night
0	Hearing threshold

Adapted from: USDOE, 1986; USDOE, 1996.

Figure 1: Proposed design options for the Grand Coulee Line Replacement Project.

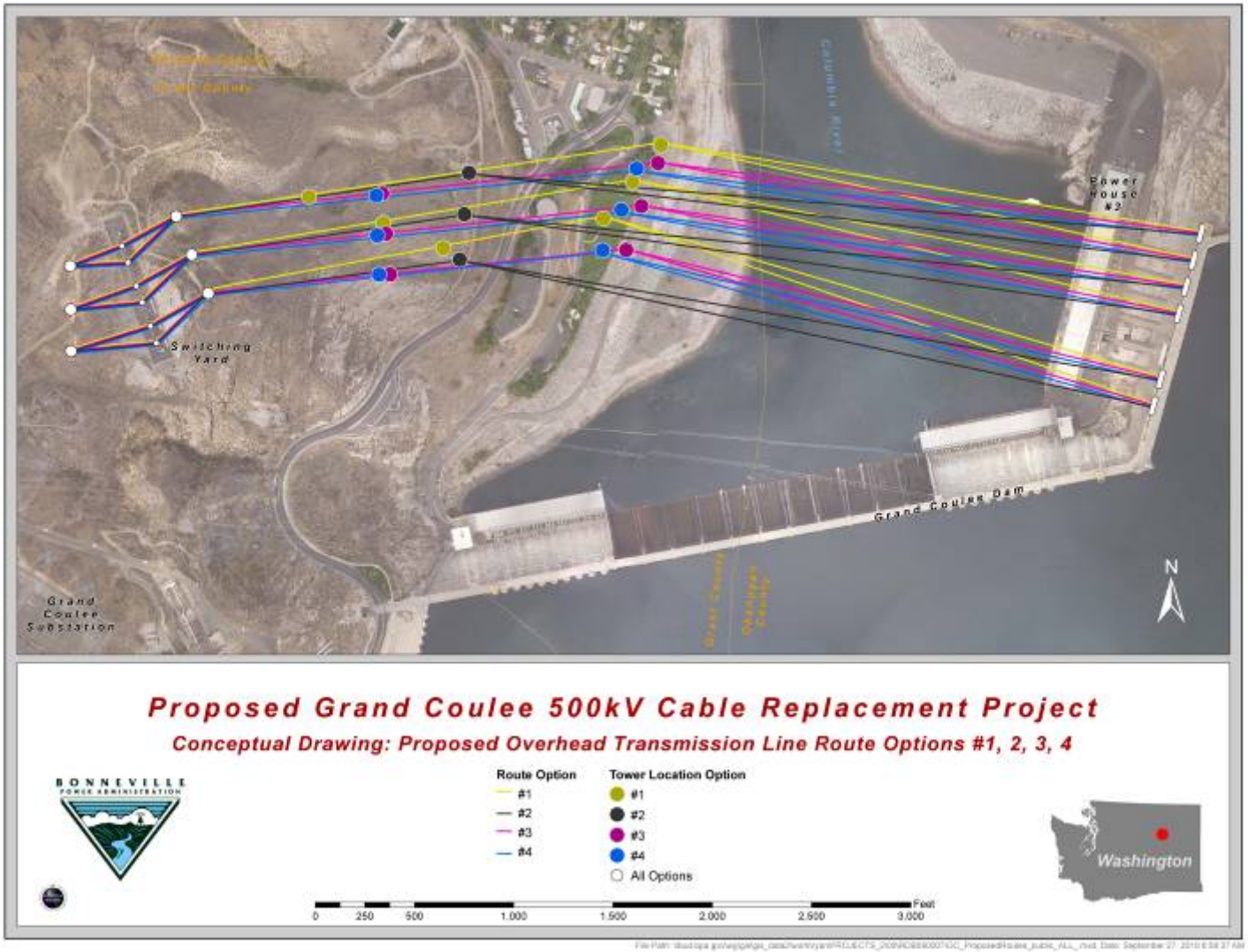


Figure 2: Double-circuit 500-kV towers for the proposed Grand Coulee Line Replacement Project. This is a cross-section of the corridor at Tower 2 of the three parallel lines near the Visitors Center. Options 2, 3 and 4 are similar except for placement of the towers as described in Table 1 and Figure 1.

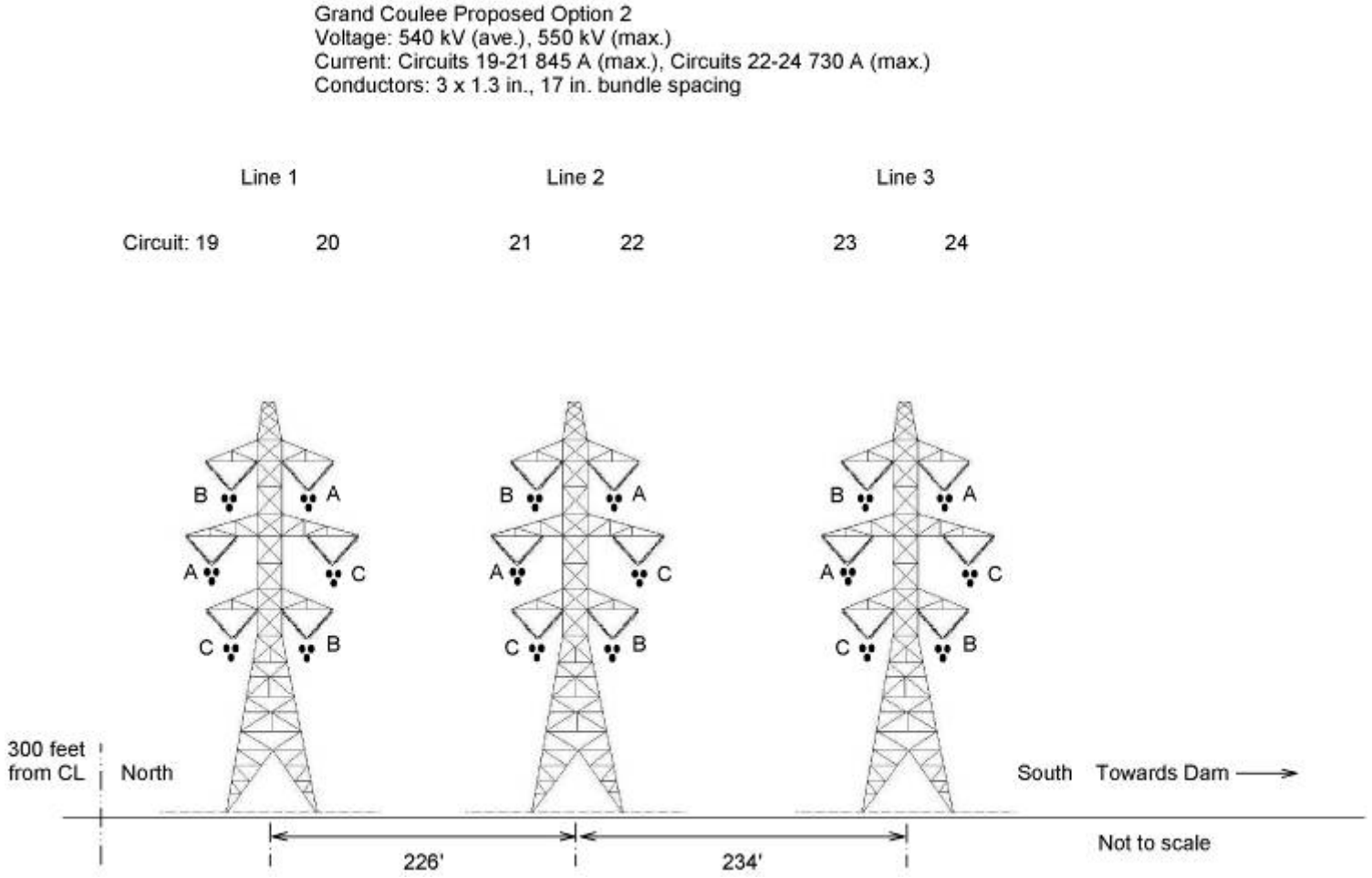


Figure 3: Estimated electric-field Profile 1 on hill above the Visitors Center by design option for the proposed Grand Coulee Line Replacement Project. Fields for maximum voltage and minimum clearances are shown. Configurations are described in Tables 1.

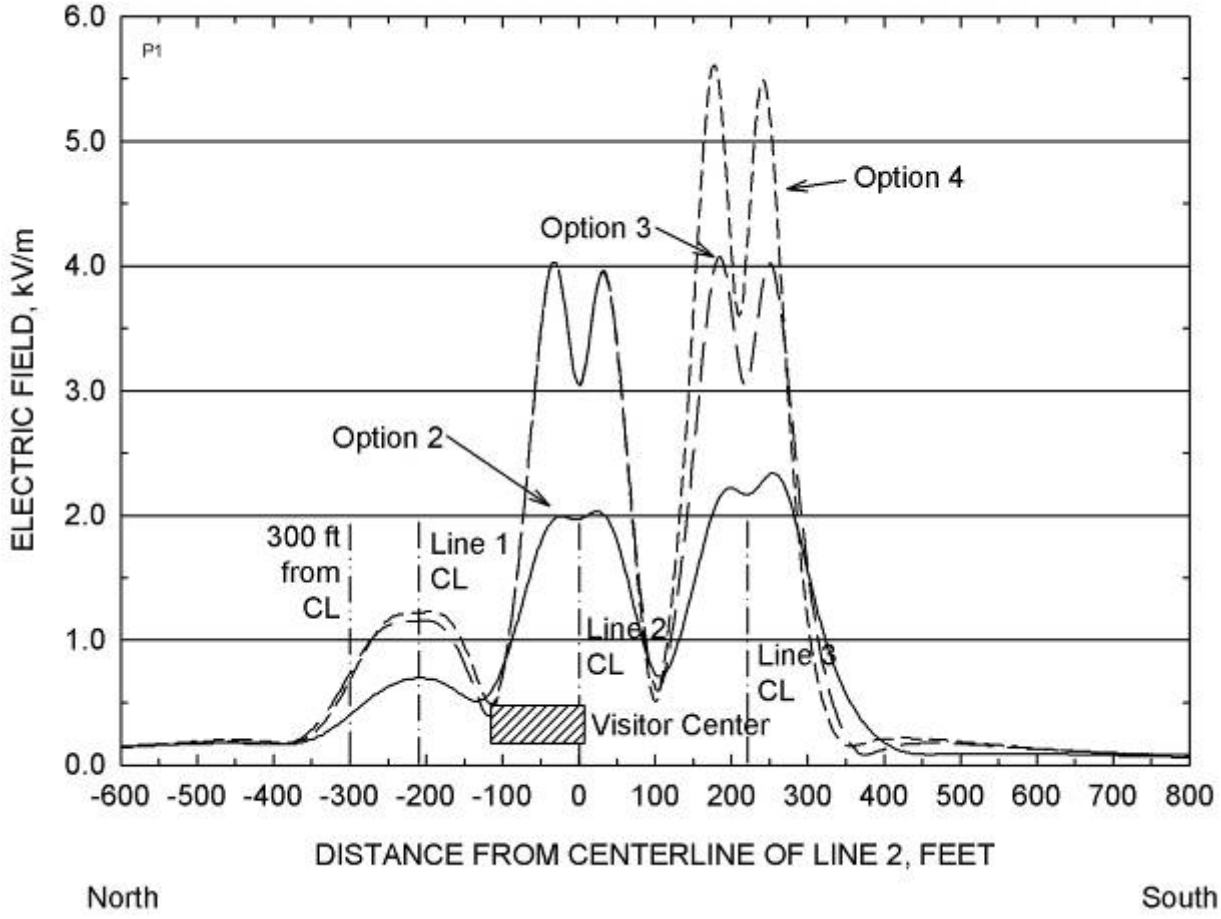


Figure 4: Estimated electric-field Profile 2 near the Visitors Center by design option for the proposed Grand Coulee Line Replacement Project. Fields for maximum voltage and minimum clearances are shown. Configurations are described in Tables 1.

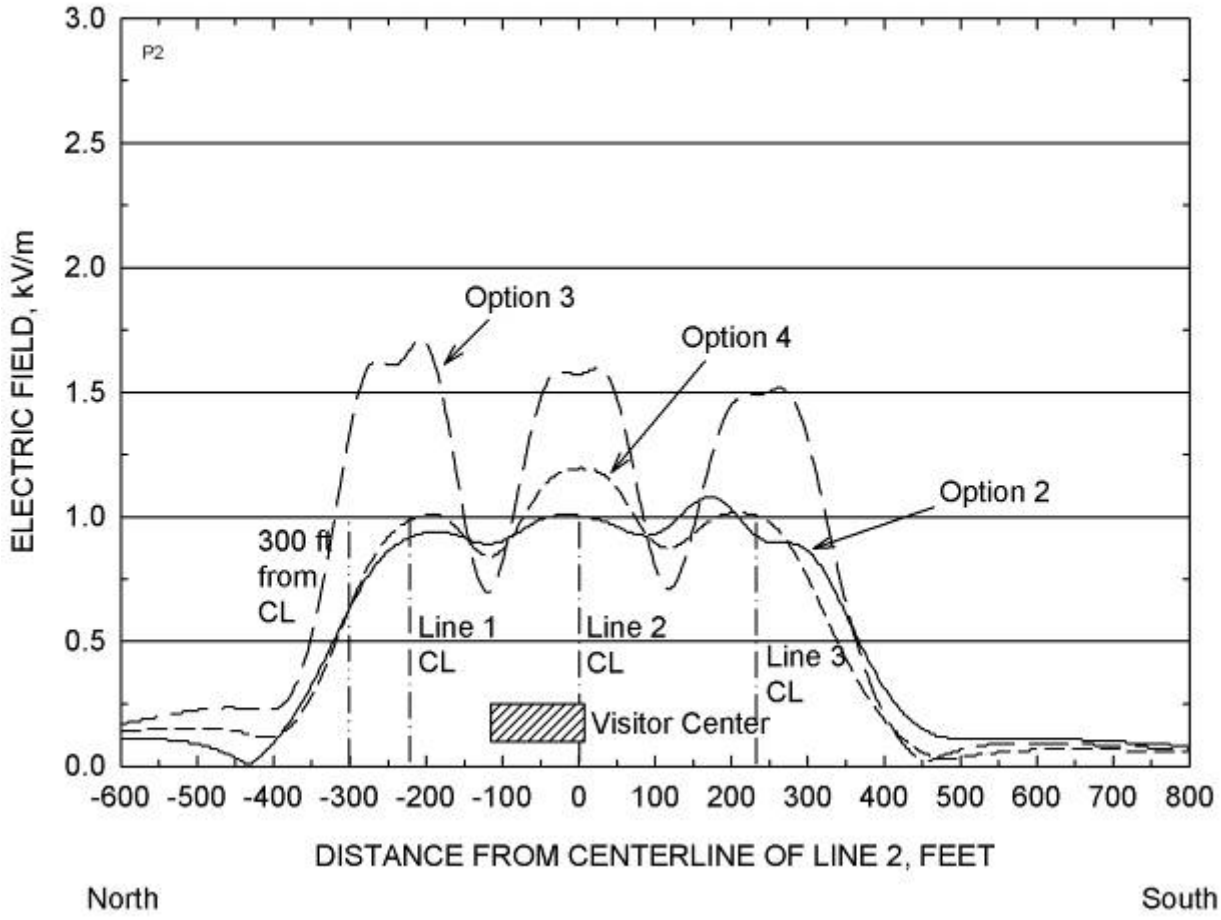


Figure 5: Estimated electric-field Profile 3 east of the Visitors Center by design option for the proposed Grand Coulee Line Replacement Project. Fields for maximum voltage and minimum clearances are shown. Configurations are described in Tables 1.

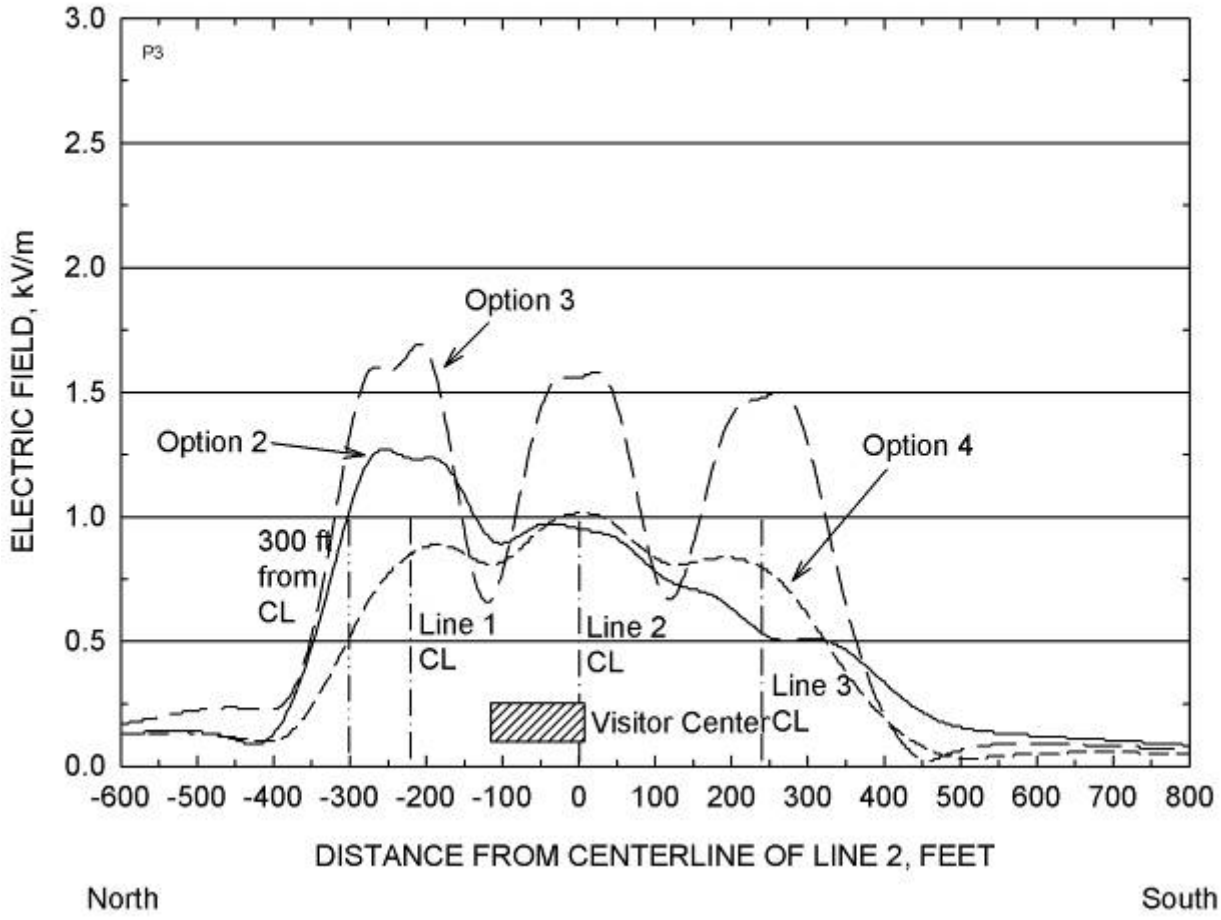


Figure 6: Estimated electric-field Profile 4 on the roof of the Third Powerhouse by design option for the proposed Grand Coulee Line Replacement Project. Fields for maximum voltage and minimum clearances are shown. Configurations are described in Tables 1.

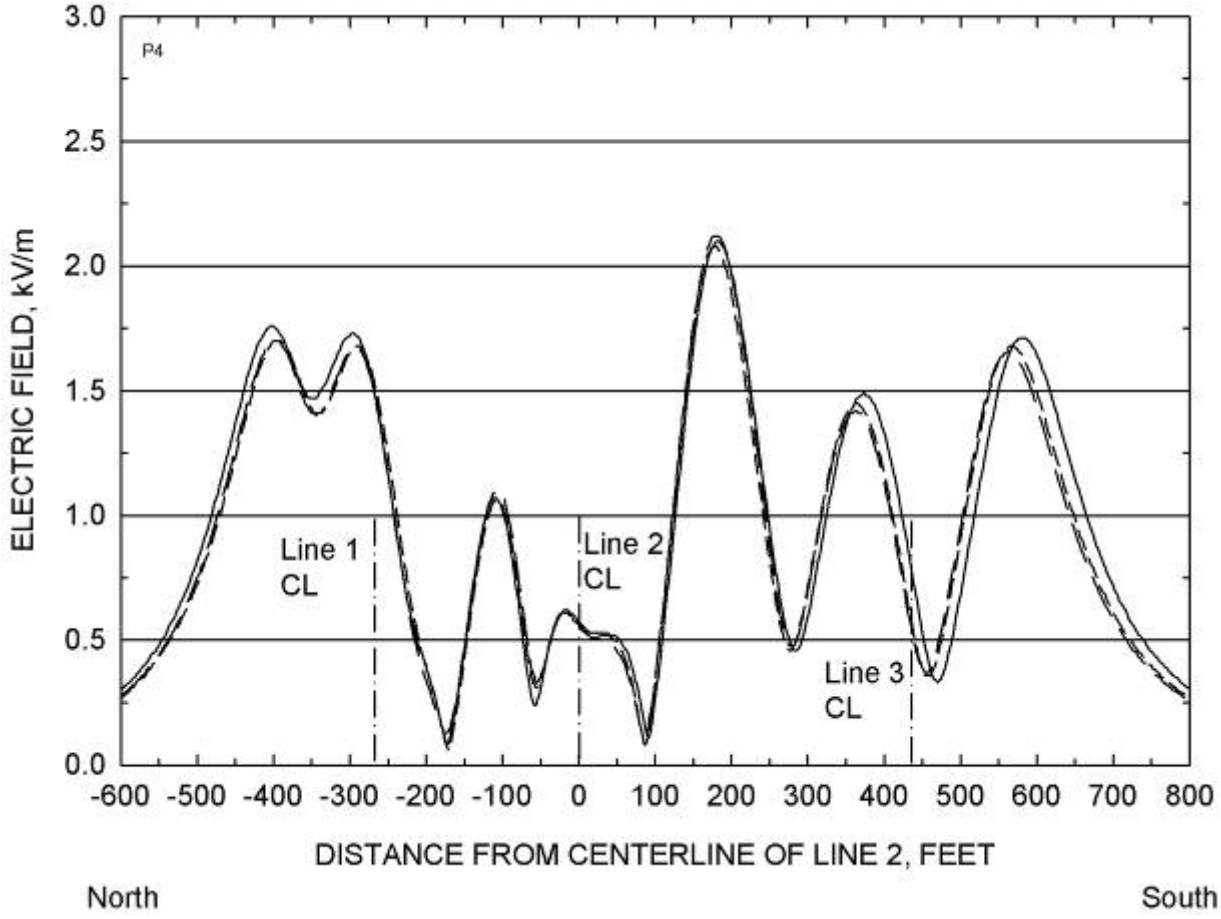


Figure 7: Estimated magnetic-field Profile 1 on the hill west of the Visitors Center by design option for the proposed Grand Coulee Line Replacement Project. Fields for maximum current and minimum clearances are shown. Configurations are described in Tables 1.

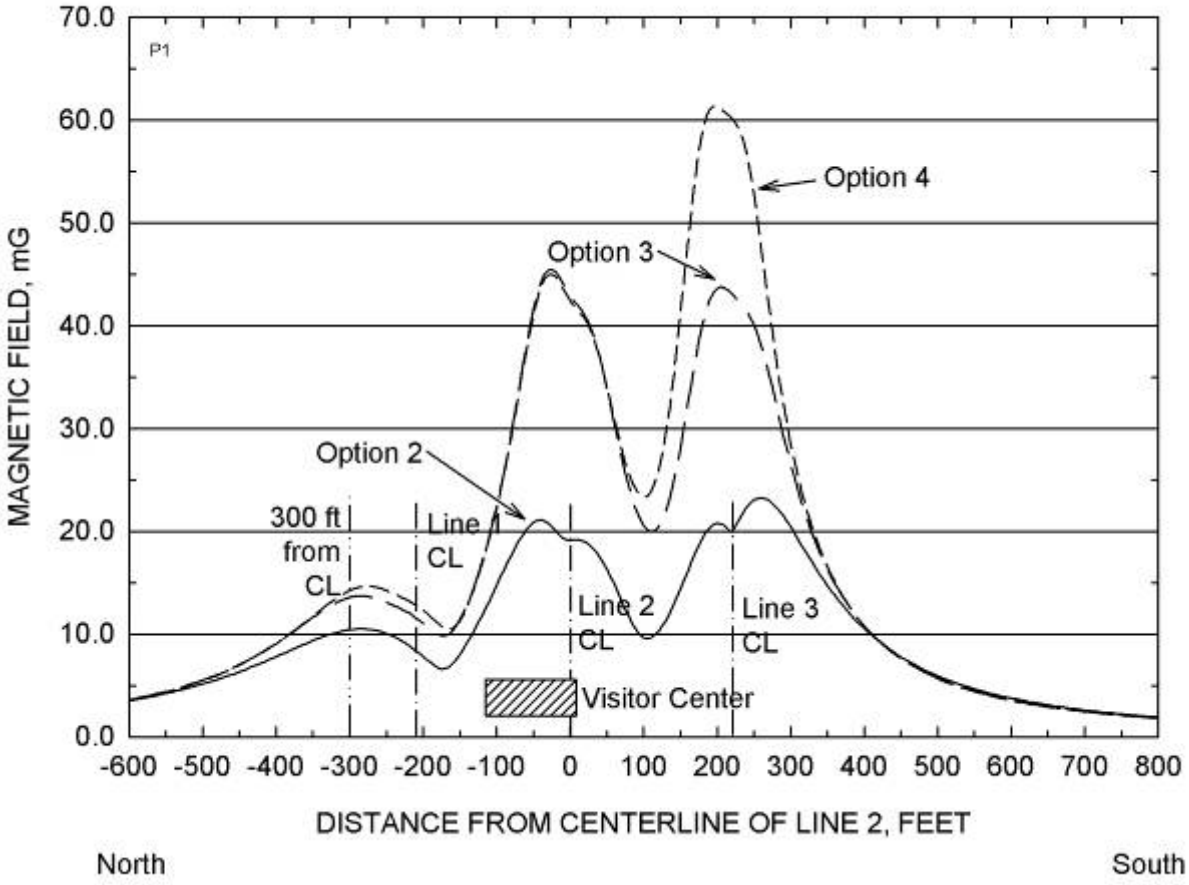


Figure 8: Estimated magnetic-field Profile 2 at the Visitors Center by design option for the proposed Grand Coulee Line Replacement Project. Fields for maximum current and minimum clearances are shown. Configurations are described in Tables 1.

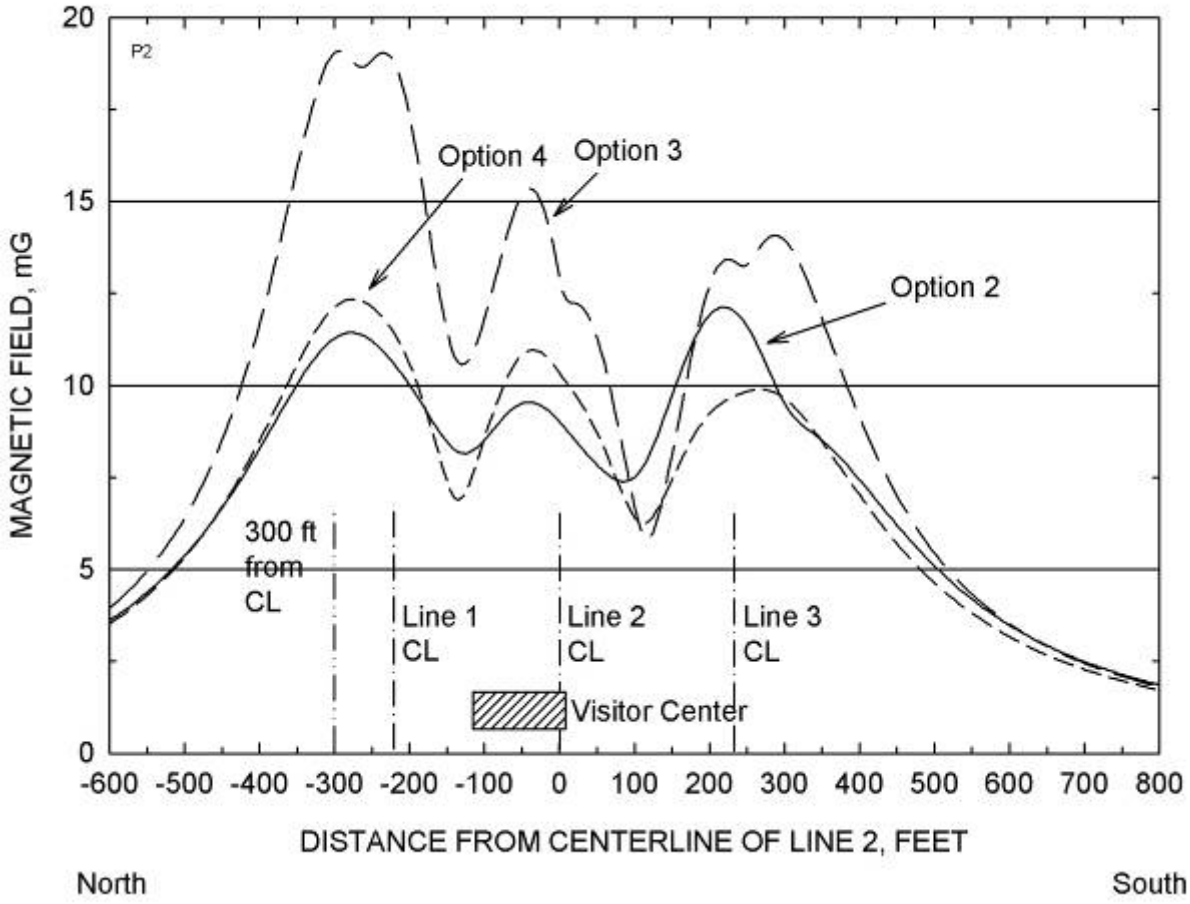


Figure 9: Estimated magnetic-field Profile 3 east of the Visitors Center by design option for the proposed Grand Coulee Line Replacement Project. Fields for maximum current and minimum clearances are shown. Configurations are described in Tables 1.

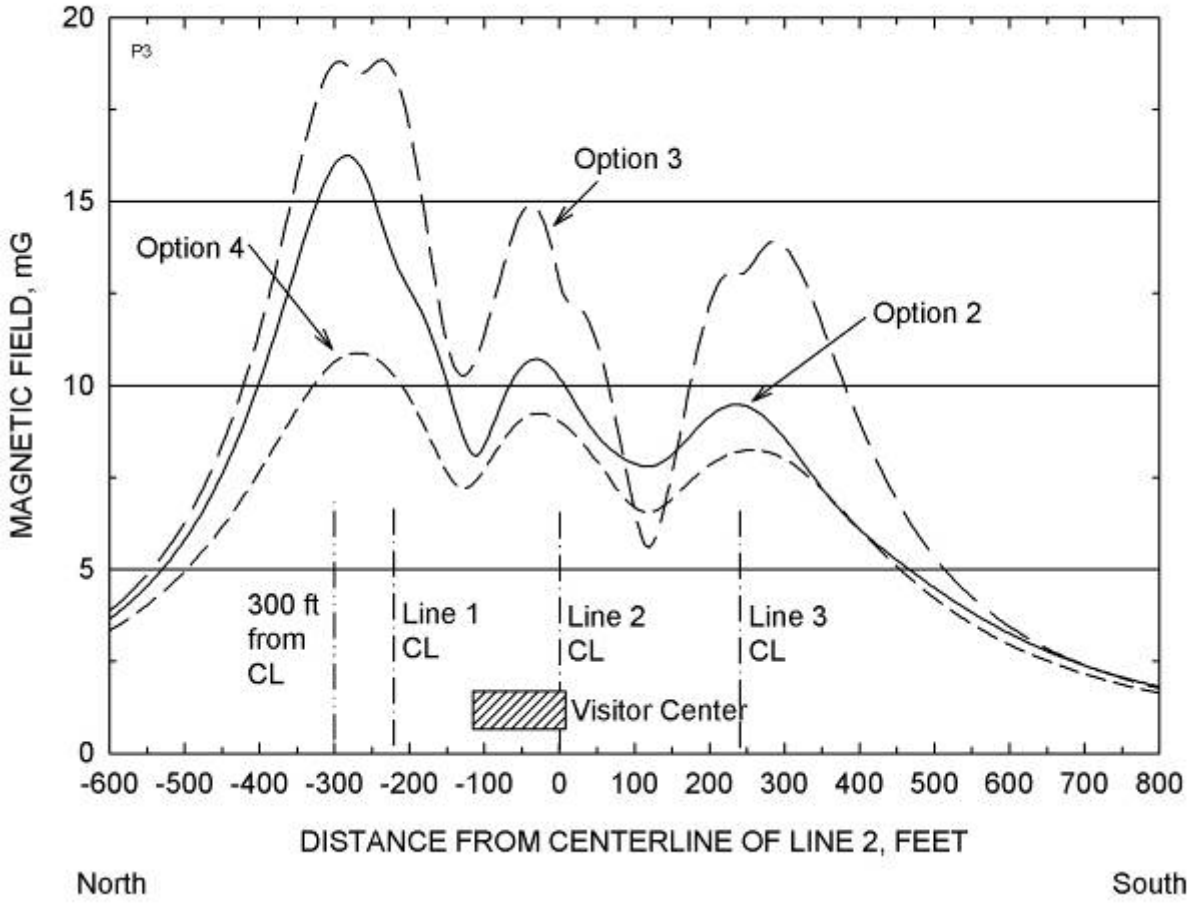


Figure 10: Estimated magnetic-field Profile 4 on the roof of the Third Powerhouse by design option for the proposed Grand Coulee Line Replacement Project. Fields for maximum current and minimum clearances are shown. Configurations are described in Tables 1.

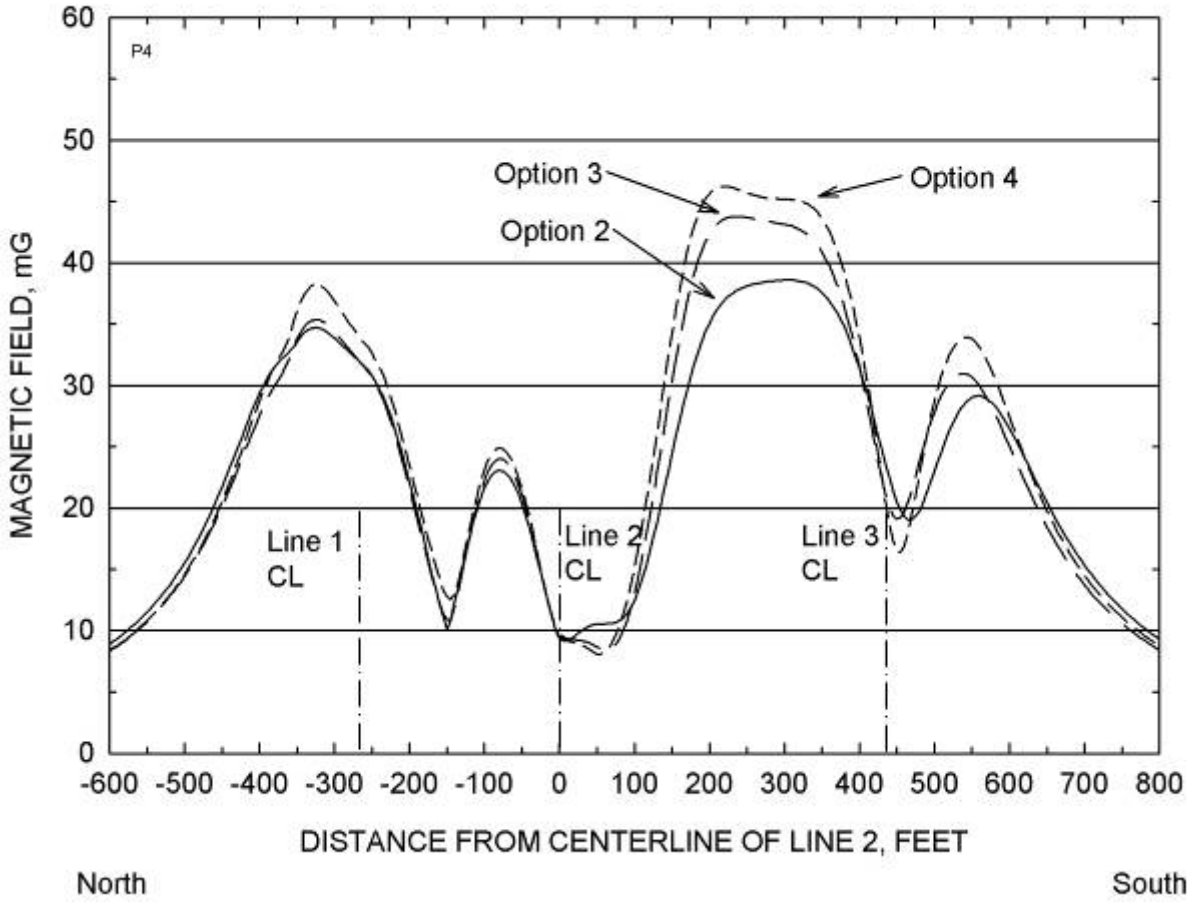
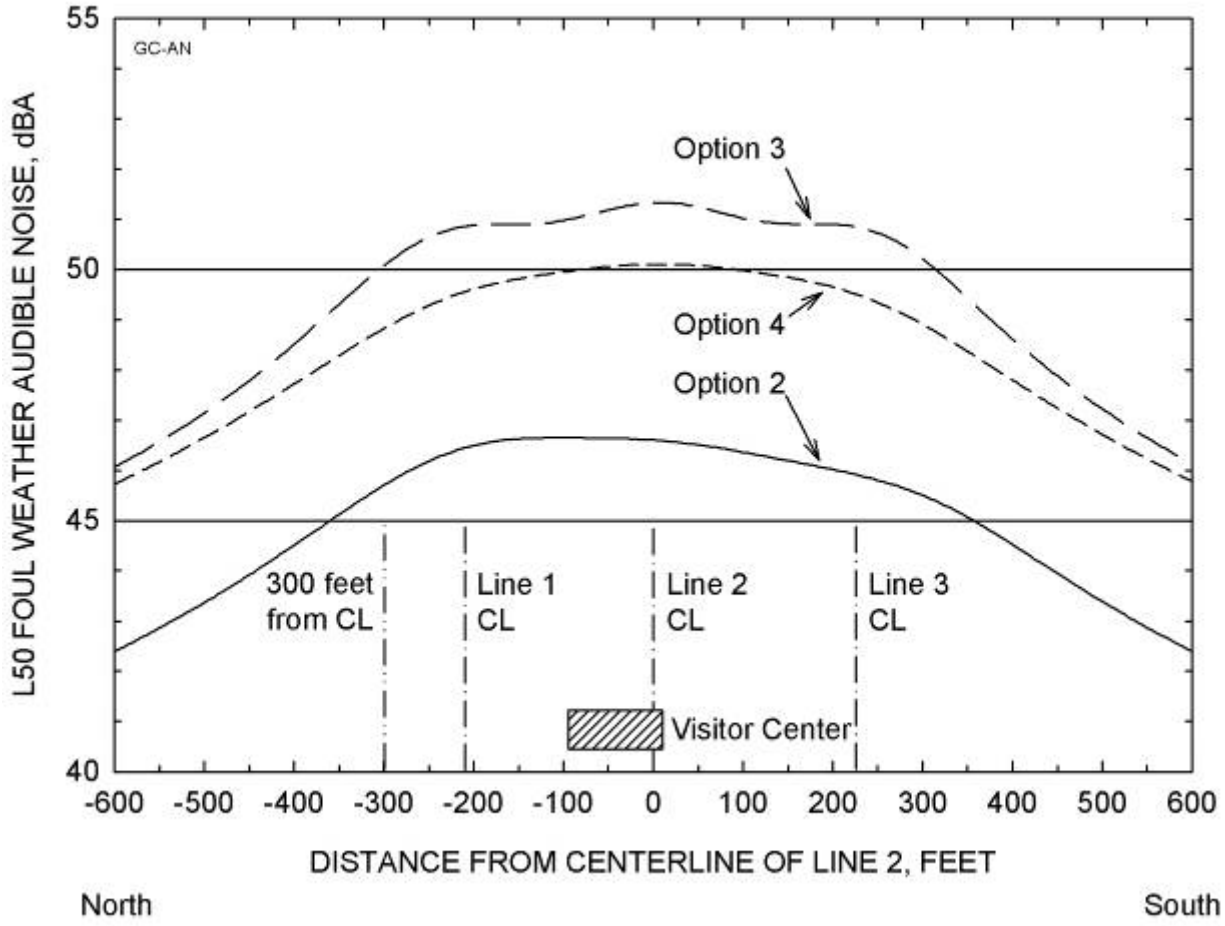


Figure 11: Estimated audible noise levels near the Visitors Center by design option for the proposed Grand Coulee Line Replacement Project. Fields for average voltage and average minimum clearances for Lines 2 and 3 are shown. Configurations are described in Tables 1.



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