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IDAHO PUBLIC
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BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

IN THE MATTER OF IDAHO POWER COMPANY'S APPLICATION FOR A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY TO CONSTRUCT SYSTEM IMPROVEMENTS TO SECURE ADEQUATE AND RELIABLE SERVICE TO CUSTOMERS IN THE WOOD RIVER VALLEY.	CASE NO. IPC-E-16-28

IDAHO POWER COMPANY

DIRECT TESTIMONY

OF

DAVID M. ANGELL

Q. Please state your name and business address.

A. My name is David Angell. My business address is 1221 West Idaho Street, Boise, Idaho 83702.

Q. By whom are you employed and in what capacity?

A. I am employed by Idaho Power Company ("Idaho Power" or "Company") as the Planning Manager in the Customer Operations Engineering and Construction Department.

Q. Please describe your educational background.

A. I graduated in 1984 and 1986 from the University of Idaho, Moscow, Idaho, receiving a Bachelor of Science Degree and Master of Engineering Degree in Electrical Engineering, respectively. I have provided electrical engineering instruction for both the University of Idaho and Boise State University. Most recently, I instructed power system analysis at Boise State University during the 2009 spring semester.

Q. Please describe your work experience with Idaho Power.

A. From 1986 to 1996, I was employed by Idaho Power as an engineer in both communications and protection systems. In 1996, I became the Engineering Leader of System Protection and Communications. I held this position until 2004, when I transferred to Transmission and Distribution Planning. During the fall of 2006, I accepted the positions of System Planning Leader and Manager of Delivery Planning. I have been managing Idaho Power's interconnected-transmission system, subtransmission, and distribution planning and strategies since 2006.

Q. What is the purpose of your testimony in this proceeding?

A. My testimony will provide a detailed description of Idaho Power's need to construct a new transmission line in the Wood River Valley, and provide the background and rationale for the Company coming to this decision. The Company must construct facilities between substations in Hailey and Ketchum to meet its continuing obligation to provide adequate and reliable service to its customers located in the Wood River Valley north of East Fork Road, including the communities of Ketchum and Sun Valley (collectively "North Valley"). Today, beyond the continuing requirement to serve the Wood River Valley's growing load, there are two compelling reasons that now require the construction of such facilities: (1) the increased reliability provided by a redundant source of energy and (2) the need to reconstruct the existing and aging 138 kilovolt ("kV") radial transmission line without long-term disruption of service to the North Valley. There has been significant public outreach, discussion, opposition, as well as support to the proposed line routings. Consequently, the Company is requesting an order from the Idaho Public Utilities Commission ("Commission" or "IPUC") affirming that the public convenience and necessity requires construction of the new 138 kV line.

I. **BACKGROUND**

Q. Please describe the area and conditions that currently exist in the North Valley area.

A. The North Valley contains the resort communities of Ketchum and Sun Valley and the Sun Valley ski resort. Idaho Power serves over 9,100 customers in the North Valley. The peak demand reached 63 megawatts ("MW") during the winter of 2007, with more recent peak demands still exceeding 54 MW. The local population, typical of a resort community, increases during the peak tourist seasons of summer and winter, with high winter peak demand.

The North Valley customers are served by two substations, one located in Ketchum and the other in the Elkhorn Valley within Sun Valley city limits. These two substations are connected to the Idaho Power transmission grid by a single, 12.4 mile, 138 kV transmission line from the Wood River substation in Hailey. The transmission line was built in 1962 with wooden poles. Access to repair the line is impeded by residential development, rough terrain, and aged construction roads in many areas. The mountainous terrain limits vehicle access, impedes equipment set-up and contributes to avalanche threats. This line's access limitations may result in extended outages for line conductor, insulator, or structure failures caused by, among other things, vandalism, inclement weather, wood decay, woodpecker damage, avalanche, fire, and micro-burst wind events (collectively "Line Events"). Power outages caused by avalanche, fire, and other natural events also negatively impact the emergency and life safety response activities that are critical during these events.

II. COMMUNITY OUTREACH AND PUBLIC PARTICIPATION

Q. Has the Company addressed the need for providing a redundant second transmission source into the North Valley with residents of the North Valley?

A. Yes. In fact, Idaho Power and North Valley residents have partnered together for several decades to determine the best approach for meeting the valley's electric demands. One example of that partnership occurred in the mid-1990s. Prior to that partnership, Idaho Power had received a Certificate of Public Convenience and Necessity ("CPCN") from the Commission to construct a second line between Hailey and Ketchum to improve reliability and reduce the risk of extended outages.[1] However, after receiving opposition during the public participation process, Idaho Power agreed to place the

[1] IPUC Case No. U-1006-89, Order No. 11315.

project on hold and reanalyze the need at a later date. The reasons for opposition included the difficulty of finding an acceptable route for the transmission line, aesthetic impacts, health and safety concerns, and the cost of burying part or all of the line.

Q. Has the Company continued its outreach and public participation with its customers in its service territory and in the Wood River Valley region?

A. Yes. First allow me to discuss Idaho Power's process for involving communities in the transmission and substation planning process. In 2004, Idaho Power initiated several Community Advisory Committees ("CAC") and undertook a comprehensive, cooperative transmission planning exercise with the communities and leaders across its service territory, including the Wood River Valley. Idaho Power has completed seven CAC processes across its service territory. These committees were created to provide a cooperative effort between the Company and the communities it serves in developing an outline for prioritized improvements and additions to the Company's transmission and substation infrastructure. Each committee was created from and reviewed a specific geographic region. The committees formed to date have been from the Treasure Valley (three committees), Wood River Valley, Magic Valley, Eastern Idaho, and West Central Mountains (Adams, Boise, and Valley Counties). Each of these committees was composed of elected officials, jurisdictional planners, civic leaders, business leaders/developers, and residents. Each committee met on a monthly basis with each session lasting most of a day. The process included educational sessions that began with a bus tour of Idaho Power facilities. The committees were presented with a view, from production to delivery, of Idaho Power's electrical system, including an introduction to electric generation, substations, transmission, demand-side management, and electric utility regulation. The committees then developed a list of goals and siting criteria that would guide them in their plan development. The committees were presented with growth statistics and anticipated load data of their respective areas based on the planned build-out of their respective communities. Using the information and education gained through these meetings and the knowledge and objectives of local development, the committees laid out proposed transmission line paths and substation sites. The committees then determined a preferred plan by consensus, with some alternatives identified. This process of education and development of the plan took just over a year and was the result of hundreds of hours of involvement from the community.

Q. How was community interaction conducted in the Wood River Valley?

A. In 2007, a CAC was convened which developed the Wood River Valley Electrical Plan ("WREP"), a comprehensive plan for future transmission facilities in the Wood River Valley, including the North Valley area. I have provided a copy of the WREP as my Exhibit No. 2. The WREP is also available publicly on Idaho Power's website. The 19-member CAC included regional transportation and growth planners, various city and county officials, representatives from the Bureau of Land Management, the United States Forest Service, special interest groups, business leaders, and residents. The CAC met monthly to learn about electrical systems, review alternatives to meet the valley's needs, and develop a plan to serve the electrical needs of the valley going forward. The process was thorough and exhaustive. At the conclusion of the review in late 2007, the CAC developed the WREP, which recommended that Idaho Power move forward with a series of projects, including: (1) construction of a North Valley project and (2) construction of a third 138 kV line in the south valley.

Q. With regard to the WREP's recommendation for the construction of a third 138 kV line in the south valley, what is the status of that project?

A. Idaho Power is not able to develop the third 138 kV transmission line in the south valley due to the proposed route residing within core sage grouse habitat as defined in the Idaho Governor's Greater Sage Grouse Conservation Strategy. Without the ability to site this third transmission line, Idaho Power initiated the replacement of the King to Wood River 138 kV transmission line with new larger conductor and steel towers. The construction of this replacement began this summer and will be approximately halfway complete in 2016. The construction activity is going well and the replacement is scheduled to be complete next year. This replacement line, in combination with the prior modification to the Midpoint to Wood River 138 kV line, will provide increased capacity and reliability to the Wood River substation in Hailey.

Q. Did Idaho Power continue to meet with the CAC and/or the North Valley community following the development of the WREP?

A. Yes. The Company has more than 100 documented communications; i.e., meetings and letters with city officials, presentations to committees, open houses, meetings with residents and subdivisions, etc., regarding potential transmission siting in and around the North Valley from 2007 to the present, in addition to the numerous other informal discussions, phone calls, and contacts about this matter.

Q. How was the WREP received by the Wood River Valley residents?

A. In general, support was expressed for the WREP. Improvements to the transmission system south of the Wood River substation (to the "King-Wood River" transmission line and the "Silver" transmission line) received strong support. Support for the proposed redundant 138 kV transmission line between the Wood River substation and Ketchum was mixed, but with a majority in favor. Some individuals remained unconvinced of the need for a redundant transmission line, or suggested that redundancy could be provided through other alternatives.

Q. Based upon feedback from the public presentations, were any changes made to the original WREP?

A. Yes. In 2010 and 2011, the Company reconvened the CAC to further refine the WREP. At those meetings, the Company and the CAC discussed detailed sizing pole heights, reconstruction of existing lines, and alternatives to avoid or reduce potential new visual and physical impacts that may be caused by the development of the proposed redundant 138 kV transmission line between the Wood River substation and Ketchum. Early in 2011, the CAC convened to further discuss alternative line routes for the redundant line;

specifically, options for both overhead and underground installation of the redundant line from the St. Luke's Hospital area to the Ketchum substation.

The CAC was convened again in 2012 to learn new information about the potential impact to core sage grouse habitat that may be caused by recommended improvements in the Burmah area of the southeast section of the existing electrical system. Because sage grouse were currently under federal review for potential listing as an endangered species, Idaho Power informed the CAC that the recommendations for a third 138 kV transmission line in the south valley could not be implemented and that Idaho Power would instead undertake the replacement of the King to Wood River 138 kV line, as I have previously discussed.

Q. Were additional presentations to the public made to present the refined WREP?

A. Yes. While the CAC preferred to have the redundant line buried from the St. Luke's Hospital area to the Ketchum substation, concern was expressed about public support for the local incremental cost of undergrounding any or all of this section. Therefore, subsequent presentations included options for both overhead and underground construction.

Over several months in 2012, members of the planning team conducted more than 40 meetings with individuals, small groups, adjacent neighborhoods, homeowner associations, affected property owners, business owners, and other stakeholders. The purpose of the meetings was to inform them of the WREP, provide high-level cost estimates for the project, review redundant line route alternatives, discuss Local Improvement District ("LID") boundaries for the collection of incremental costs that may result from choosing higher-cost underground alternatives, and to gather input from the public.

Late in 2012, the CAC was reconvened to provide additional input to the planning team regarding the format, content, applicable visual aids, and supporting materials for upcoming public open house events. Three public open house events were held in December 2012; one each in Hailey, Sun Valley, and Ketchum, to present the refined WREP, and to identify the proposed routes and high-level cost estimates. Proposed boundaries and approximate property owner costs for the LID to fund the incremental local cost for the underground portion of a redundant line were included. Reaction to the plan was largely positive; however, some individuals still questioned the need for the redundant line, as well as the potential cost to local property owners. Some individuals expressed opinions that the reliability history of the existing transmission line did not warrant a redundant line or that redundancy could be accomplished using renewable energy resources. Strong opposition was widely expressed for any new overhead transmission lines north of the St. Luke's Hospital area.

Q. What was the Company's response to the suggested alternatives and expressed concerns regarding the visual impacts of overhead transmission lines?

A. The Company's initial response to a number of inquiries from the City of Ketchum and the Ketchum Energy Advisory Committee ("KEAC") was to meet with members of the KEAC and city representatives in late 2013 to further explain the WREP in greater detail, including the proposed redundant line, project cost estimates, and local incremental costs for the underground sections. The KEAC was formed in 2013 to evaluate and provide input to the City of Ketchum regarding concerns for future energy security. The discussions included inquiries from the KEAC, including a request for a cost/benefit analysis, consideration of potential alternatives to the redundant line, and opportunities to bury existing distribution lines in Ketchum in coordination with the proposed redundant line underground construction.

In response to inquiries from both the City of Ketchum and the KEAC, in late 2014, the Company invited representatives from both entities to join the CAC to investigate the possibility of any new alternatives to the proposed redundant line. The "updated" CAC was convened twice in late 2014.

Q. Were there any new alternatives provided to the CAC in 2014?

A. Yes. In response to some of the expressed concerns for a redundant transmission line, the Company did introduce to the CAC a potential new alternative that would provide historical load backup power if the existing transmission line was out of service. The term "historical" here meant the current existing load, and reflected the concept of a distribution alternative to provide redundant electric service, or more specifically, 60 MW of capacity, with additional upgrades required for future growth. The alternative incorporated the use of an additional substation and distribution circuits to tie into the existing distribution system. Although the Company noted that this alternative was not a complete replacement for the redundant line and had limitations, it was developed in response to concerns for the incremental cost for undergrounding a fully redundant transmission line, which would be recovered from the local community.

Q. Were other non-conventional alternatives for providing redundant electric service considered?

A. Although new representation from Ketchum did provide materials that outlined its goals for Ketchum's energy security, including expanded development of local distributed renewable generation and energy conservation, a viable alternative to the redundant line was not provided. However, the Company did provide some additional high-level analysis of other alternatives for redundant electric service.

III. MICROGRID ALTERNATIVES TO REDUNDANT TRANSMISSION

Q. Did the Company conduct any analysis of providing the North Valley with backup electrical supply from locally sited generation?

A. Yes. Individuals in the Wood River Valley have asked whether local electric generation resources combined with the distribution grid (i.e., a microgrid) would be a cost-effective solution to increasing the reliability of service to the North Valley. This prompted a CAC member to ask for updated local backup generation information. I have included as Exhibit No. 3 a cover letter and report which provides a summary of Idaho Power's recent work in this area and an updated analysis of microgrid requirements and capability. Also included in Exhibit No. 3 are two revised and updated appendices, Appendix A and Appendix B, to the October 2016 report. Idaho Power's preliminary and conceptual investigation reveals that the cost to provide a 65 MW microgrid with backup generation for a 24-hour period ranges from approximately $57 million (diesel engine system) to $955 million (photovoltaic plus battery system).

Q. Please briefly describe the report.

A. The report presents the results of a preliminary study to provide the northern Wood River Valley customers served by the Ketchum and Elkhorn substations with backup electrical supply from locally sited generation. The resources considered in the study are diesel reciprocating engine generation, natural gas combustion turbines, photovoltaic plus battery energy storage systems, geothermal generation, and biomass generation.

The analysis was performed using industry-standard energy resource simulation software, HOMER®, which was developed by the National Renewable Energy Laboratory ("NREL"). The capital, operations and maintenance, and fuel cost estimates for the resources identified above were obtained from *Lazard's Levelized Cost of Energy Analysis – Version 9.0.*[2] Idaho Power also compared the Lazard estimates with pre-engineering budgetary quotes from several vendors. Additionally, the Idaho National Laboratory ("INL"), with more than 1,000 MW of hybrid power, solar, and wind energy systems deployed at

[2] Lazard, 2015a. Lazard's Levelized Cost of Energy Analysis - Version 9.0, https://www.lazard.com/perspective/levelized-cost-of-energy-analysis-90/.

Department of Defense and industry/utility sites around the world, provided independent technical review and feedback on the analysis and report.

The analysis demonstrates that the most economical way to provide backup electrical supply from local generation (i.e., a microgrid) is by either diesel engines or gas turbines. With respect to the other resources considered, the study area does not have a geothermal resource suitable for electrical generation and biomass generation costs are significantly higher and the start-up time would be substantially longer than diesel engines or gas turbines. Additionally, the biomass generation would require more investigation into the availability of and cost to extract the local biomass material. Finally, the large winter energy requirement results in a cost prohibitive battery system.

Q. What is the Company's conclusion from this analysis?

A. The report provides a high-level summary of the Company's assessment of local backup generation options. All of the options include higher initial and ongoing maintenance costs compared to a redundant transmission line alternative.

Q. Has the Company reviewed any other microgrid projects?

A. Yes. Most recently, the Ketchum City Council suggested that the Company consider options like the microgrid project in Borrego Springs, California. The Company is familiar with the project and has reviewed the final report prepared for the California Energy Commission ("CEC") by San Diego Gas & Electric ("SDG&E"). The project was a microgrid demonstration project that focused on the design, installation, and operation of a community scale "proof-of-concept" microgrid. The microgrid was an existing utility circuit that had a peak load of 4.6 MW serving 615 customers in Borrego Springs, California. The project was funded through a U.S. Department of Energy ("DOE") and CEC grant and cost share provided by SDG&E and other project team members. The project's partners included Lockheed Martin, IBM, Advanced Energy Storage, Horizon Energy, Oracle, Motorola, Pacific Northwest National Laboratories, and the University of California San Diego. The DOE supported the project with $7.5 million of federal funding, with additional funding coming from SDG&E ($4.1 million), CEC ($2.8 million), and other partners ($0.8 million). Upon completion, the total microgrid installed capacity was expected to be 4 MW, with the main technologies being two 1.8 MW diesel generators, a large 500 kilowatt ("kW")/1500 kilowatt-hour ("kWh") battery at the substation, three smaller 50 kWh batteries, six 4 kW/8 kWh home energy storage units, about 700 kW of rooftop solar photovoltaics, and 125 residential home area network systems.

The final report provided some key lessons learned from the microgrid demonstration project, stating that the project proved to be challenging due to the complexity of integrating new systems into the distribution network that could impact customers, reliance on other projects for integration, the use of newly emerging technologies and systems, and environmental requirements.

Q. What has Idaho Power concluded from its investigation into alternatives for the redundant transmission line?

A. Many of the alternative options suggested by the KEAC or CAC are interesting and innovative; however, they are technologies that are either cost prohibitive or just not viable today. The Borrego Springs microgrid demonstration project is a good example of this. While the project was successful in providing all of the electricity delivered to the Borrego Springs community during a five and a half hour preplanned operation, the Company does not believe that this would be a viable cost-effective option for the North Valley today. A simple extrapolation of the project costs would suggest that if a 4.0 MW microgrid cost $15 million at Borrego Springs, then a 60 MW microgrid for the North Valley would cost $225 million, or more importantly, for the 9,000 customers in the North Valley, would cost approximately $25,000 each. These alternative technologies are just not cost-effective today, would only provide electric backup for a relatively short period of time, and would still not eliminate the need for the redundant transmission system.

IV. PURPOSE AND NEED

Q. When would Idaho Power normally consider the construction of additional facilities to serve customers in a particular area?

A. Idaho Power generally initiates and constructs a second transmission source and transformer when a substation peak load is projected to exceed 40 MW. Recent examples include the additions of second transmission lines and transformers at the Victory substation south of Boise and the McCall substation in McCall, Idaho. Idaho Power is also moving forward with a second transmission project in the Eagle and Star area, which peaks at 71 MW. The area north of Hailey represents the second largest customer base in Idaho Power's service territory served by only a single transmission line. The Ketchum and Elkhorn substations' peak load of about 60 MW, coupled with the winter tourism population in the North Valley, strongly supports the need for a second transmission line.

Q. At what time of year would a significant risk of an outage on the current transmission line be most likely to occur?

A. The most significant risk of an outage on the current single 138 kV transmission line and the resulting economic impact would occur during the winter season when the electric demand and tourism activity are at their highest. Deep snow and steep terrain can make it very difficult to access the susceptible sections of the existing transmission line, resulting in sustained outages (defined as an interruption that lasts more than five minutes). An extended outage could last multiple days and be catastrophic, not only from the economic loss of the area, but the additional damage that may be caused by water pipes freezing. Summers are not immune from risk either, with the potential for a fire to take out the existing line, affecting the ability to pump gas or water, and resulting in economic loss.

Q. Has Idaho Power estimated the potential for future sustained outages in the North Valley?

A. Yes. Historically, this particular line has had a relatively good service record for reliability. This was one of the reasons that the previously issued CPCN was withdrawn in 1995. However, this line, built in 1962, has not aged well and now requires complete reconstruction.

Idaho Power estimates that without any significant changes to the existing North Valley transmission line, the expectation could be that the current configuration will result in an average duration of sustained outages of more than 209 minutes per year.

Q. How has the existing transmission line performed?

A. The line has performed better than average for the 138 kV class of transmission lines. One performance measure is the occurrence of unplanned sustained outages. The existing Hailey to Ketchum 138 kV line has a frequency of 1.23 unplanned sustained outage events per year per 100 miles. Idaho Power's system-wide average for 138 kV lines is 1.89 events per year per 100 miles. However, the line is showing its age. For example, the line was de-energized for seven hours and 45 minutes in 2015 to replace poles that were damaged by woodpeckers.

Q. Has the Company considered the reconstruction of the existing line as one option to mitigate outages and improve the system reliability in the North Valley?

A. Yes, the reconstruction of the existing line would help mitigate outages in the North Valley. Even without considering the need for a redundant transmission line, Idaho Power has determined that the existing transmission line requires reconstruction. The reconstruction would not eliminate the need for a redundant transmission line. Without another source of energy into the valley, the reconstruction of the existing radial line would have its own significant challenges.

Q. What would the reconstruction of the existing transmission line involve?

A. The reconstruction of the existing line involves replacing the wood structures with steel structures in approximately the same locations and replacing the existing conductor. During this reconstruction, it is estimated that 57 out of 93 structure replacements would require as many as 40 eight-hour line outages, or 20 assuming the use of two construction crews. Furthermore, it is estimated that the replacement of the line conductor would require a six to 12 week continuous outage. Replacing the other 35 structures while the line is energized would require much larger construction equipment pads that produce significant environmental and aesthetic impacts, particularly on hillsides.

Q. What is the alternative to replacing the existing line while energized?

A. Considering all the impacts described above, the reconstruction of the existing line while the line is energized is not feasible. A temporary line to the Ketchum substation would be required to serve the customers of the

Ketchum and Elkhorn substations during the reconstruction of the existing line. The temporary line would be placed in road right-of-way, mostly along Highway 75, to minimize private property impact and right-of-way costs. The temporary line would almost assuredly be deemed a visual impact by many North Valley customers. Following the completion of the reconstruction, the majority of temporary line materials (poles and insulators) would be salvaged; however, the conductor cannot be salvaged.

Q. Does construction of the redundant 138 kV line eliminate or change the reconstruction of the existing line?

A. Construction of the redundant 138 kV line does not eliminate the need to reconstruct the existing line. This must be done regardless. However, with the construction of the redundant source the reconstruction of the existing line can be done with little to no disruption of service. The new redundant line can meet the North Valley's electrical needs during the time when the existing line is taken out of service for reconstruction, thus saving the lost investment in the temporary line that would otherwise have been required for reconstruction.

Q. What is the Company's typical construction configuration, or standard practice, for providing redundant electric service to an area in need of redundancy in order to reduce sustained outages and continue providing reliable electric service?

A. The Company's standard practice to reduce the likelihood of sustained outages would be to construct multiple overhead transmission lines (a redundant transmission source) or to implement distribution circuits with tie switches in order to continue providing customers with reliable electric service.

Q. What are the challenges to building redundant electric service in the North Valley area?

A. The North Valley exhibits several transmission siting obstacles for overhead access to the existing Ketchum substation. The North Valley is congested due to numerous residences and businesses sited in a valley less than one mile wide with mountains of steep slope and narrow roadways. This would force an overhead transmission line either through the downtown district or over the top of Dollar Mountain, spanning existing homes near the substation in order to reach the existing Ketchum substation. The valley has ordinances restricting certain development. For example, because of these steep slopes and for aesthetic reasons, Blaine County has an ordinance limiting the development along the mountains (Mountain Overlay District). The cities of Ketchum and Sun Valley prefer new electrical facilities be located underground, and the communities are adamantly against additional visual impacts from overhead lines. Idaho Power representatives have been advised that new overhead lines would not be allowed in Ketchum and Sun Valley.

Q. Has the Company evaluated a number of transmission or distribution routes and alternatives to provide redundant electric service to the North Valley?

A. Yes. The Company has evaluated four construction configuration alternatives for providing redundant electric service to the North Valley, identified as: (1) Overhead Transmission, (2) Underground Transmission, (3) Overhead Distribution, and (4) Underground Distribution.

V. <u>REDUNDANT ELECTRICAL SERVICE OPTIONS</u>

Q. Please describe the four redundant electric service configurations in greater detail.

A. All four of the redundant electric service routes begin with the same basic configuration, defined as the "Common Route." The Common Route is a 138 kV transmission line that would be constructed overhead from the Wood River Transmission Station, east to Buttercup Road, then north along the bike path and Highway 75 to approximately the area near Owl Rock Road. From this point north, each of the various configurations will differ.

Please see my Exhibit No. 4 for an overview map that shows the Common Route.

1. Overhead Transmission.

As discussed above, because of several siting obstacles for overhead access to the existing Ketchum substation, an overhead transmission line route would be forced to run either through the downtown district or over the top of Dollar Mountain. The Overhead Transmission-Dollar Mountain route would begin with the Common Route along Highway 75 and continue north to Elkhorn Road. At that point, the route would follow Elkhorn Road to Larry's Lane (private road) near the existing Elkhorn substation, where the existing transmission line crosses. The remainder of the route would be double circuit to the Ketchum substation, requiring the existing structures to be replaced with structures that can accommodate both transmission circuits. Please see my Exhibit No. 4.

The Overhead Transmission-Downtown District route would also begin with the Common Route along Highway 75 and continue north along Highway 75 into the City of Ketchum to Gem Street. The route then winds its way through downtown Ketchum, taking a right on Gem Street, a left on Leadville Avenue, a right on River Street, a left on East Avenue South, a right on 1st Street, a left on Walnut Avenue, a right on 2nd Street, a left on Spruce Avenue, and, finally, a right on Sun Valley Road. The route then follows Sun Valley Road to the Ketchum substation. Please see my Exhibit No. 4.

2. Underground Transmission.

The Underground Transmission construction configuration would include the Common Route along Highway 75 to one of three possible overhead-to-underground transition points between Owl Rock Road and Elkhorn Road, at which point the transmission line would be constructed underground and proceed along the highway and in road rights-of-way to the Ketchum substation. The three potential transition points are: (1) just before entering the City of Ketchum, near the intersection of Elkhorn Road and Highway 75, (2) further south, near the intersection of Hospital Drive and Highway 75, and (3) prior to the hospital, near the intersection of Owl Rock Road and Highway 75. Each of these alternative routes would provide an independent and fully redundant transmission source. Please see my Exhibit No. 5 for a map of the Underground Transmission construction configuration showing the three transition point options.

3. Overhead Distribution.

The Overhead Distribution construction configuration would include the Common Route to a new substation site on the west side of Highway 75 south of Owl Rock Road. This option would include a new substation with 2 x 44.8 MVA 138/12.5 kV transformers, two 4-bay metalclad sections, five feeder getaways, a control building, 10 foot decorative walls, and sound barriers around the transformers. Five overhead distribution circuits would connect with the existing Ketchum and Elkhorn substation distribution circuits. Eight sets of padmount switchgear and optical fiber from the new substation for Supervisory Control and Data Acquisition (SCADA) control will be installed to effectuate the load transfers during outages of any transmission line or substation. Unlike the Underground Transmission option, this option (and the next) only provides 60 MW of additional service capacity on five distribution circuits. Additional circuits would need to be constructed if the area peak load increases. Please see my Exhibit No. 6 for a map showing the Overhead Distribution construction configuration.

4. Underground Distribution.

The Underground Distribution construction configuration would also include the Common Route to a new substation site on the west side of Highway 75 south of Owl Rock Road. From this point on, the option is substantially the same as the Overhead Distribution option with the 12.5 kV distribution circuits installed underground requiring boring, asphalt, and landscape work.

Q. Has the Company concluded that all of these alternatives and routes provide viable options for redundant electric service to the North Valley?

A. No. While the Overhead Transmission construction configuration may reflect the Company's typical construction configuration, or standard practice, for providing redundant electric service to an area in need of redundancy, the Company has concluded that the Overhead Transmission construction configuration is not a viable option based on the transmission siting obstacles described above. With regard to the Dollar Mountain overhead option, the North Valley section of an overhead line would be limited to a double circuit option on a common tower configuration from the Elkhorn substation to the Ketchum substation across the top of Dollar Mountain. This common tower construction has a high probability of simultaneous loss of both transmission circuits and North Valley customer outages for the Line Events, thereby not truly providing redundant reliable service and not meeting the required purpose and need for a redundant line. Additionally, condemnation of private property may be required to enter the Ketchum substation overhead from Dollar Mountain. Finally, the Company believes that North Valley customers would likely strongly oppose this option due to the visual impacts.

Q. Does the Overhead Transmission construction configuration through the downtown district of Ketchum provide a viable option?

A. No. While the Overhead Transmission route through the Ketchum downtown district may be theoretically possible to construct from an engineering perspective, it has several insurmountable problems. First, it would be vigorously opposed and likely not permitted by the City of Ketchum. The Downtown District overhead option has additional challenges, including the fact that the City of Ketchum consists of a grid of streets, sidewalks, and zero setback buildings that provides little to no room for transmission tower structures and line clearances. Options that exist for construction of overhead transmission include placing the poles in the sidewalks, the edge of streets, overhanging the wires over the streets, utilizing side streets, and constructing tall enough structures to span the wires over the tops of buildings. Because of the very tight geographical constraints, this option would likely be dependent upon and require significant condemnation of private property in order to pass through downtown Ketchum with an overhead line to the Ketchum substation.

Ultimately, the Company has concluded that neither of the two possible route options for an Overhead

Transmission construction configuration provides a viable solution for redundant electric service to the North Valley.

Q. Do the three remaining construction configurations provide potential viable solutions for redundant electric service to the North Valley?

A. Yes. The three remaining construction configurations would all provide viable solutions for redundant electric service to the North Valley, each with their own set of costs and varying degrees of benefits and detriments. The remaining three construction configurations: (1) Underground Transmission, (2) Overhead Distribution, and (3) Underground Distribution are the three construction configurations that were provided to Company witness Ryan Adelman for further analysis and evaluation.

Q. Does this conclude your testimony?

A. Yes.

ATTESTATION OF TESTIMONY

STATE OF IDAHO)
) ss.
County of Ada)

I, David M. Angell, having been duly sworn to testify truthfully, and based upon my personal knowledge, state the following:

I am employed by Idaho Power Company as the Planning Manager in the Customer Operations Engineering and Construction Department and am competent to be a witness in this proceeding.

I declare under penalty of perjury of the laws of the state of Idaho that the foregoing pre-filed testimony and exhibits are true and correct to the best of my information and belief.

DATED this 8th day of November 2016.

David M. Angell

SUBSCRIBED AND SWORN to before me this 8th day of November 2016.

CHRISTA S. BEARRY
NOTARY
PUBLIC
STATE OF IDAHO

Notary Public for Idaho
Residing at: Boise, Idaho
My commission expires: 02/04/2021

BEFORE THE

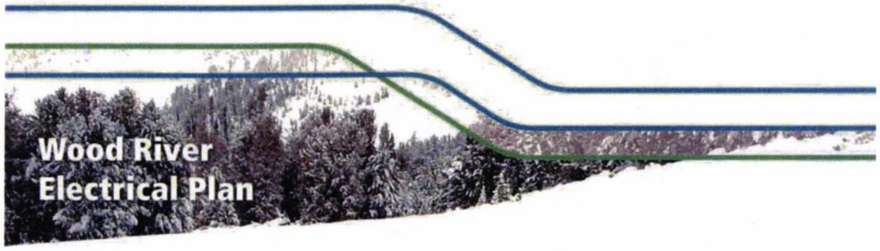
IDAHO PUBLIC UTILITIES COMMISSION

CASE NO. IPC-E-16-28

IDAHO POWER COMPANY

ANGELL, DI
TESTIMONY

EXHIBIT NO. 2



Planning for the Future

IDAHO POWER®
An IDACORP Company

Wood River Electrical Plan

Executive Summary

Updated May 2011

To view entire plan document, please visit

http://www.idahopower.com/aboutus/planningforfuture/regionalelectricalplans/woodriver/

Acronyms/Definitions

BLM – U.S. Bureau of Land Management

CAC – Community Advisory Committee

KING – King Transmission Station, located in Hagerman

kV – kilovolts (thousands of volts). 1,000 volts = 1 kV; 138 kV = 138,000 volts

kW – kilowatts (thousands of watts). 1,000 watts = 1 kW

MPSN – Midpoint Substation, located south of Shoshone

MW – megawatt (millions of watts). 1,000,000 watts = 1 MW

Station – A facility that provides transmission line switching *without* electrical transformation (voltage reduction) to distribution voltages that serve local area loads.

Substation – A facility that provides transmission line switching *with* electrical transformation (voltage reduction) to distribution voltages that serve local area loads.

USFS – U.S. Forest Service

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WREP – Wood River Electrical Plan

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Current Conditions

The Wood River Valley (the Valley) is a vibrant year-round recreation and resort community that depends on a full-time, reliable electric power system. The tourism-based economy focuses on making the Valley a highly desirable place to live, work, play and visit. Electricity is a vital component required to maintain and enhance the unique experience of living in and visiting the Valley. Whether it is powering the furnace fan and lights in your home, the high-speed chairlifts and snowmaking on the mountain, or your computer or internet-based small business, electricity has become a necessity of life in today's modern society. Additionally, as residents and visitors become more and more dependent on electricity charge-based technology such as smart phones, tablets, and computers any interruption in electrical service has negative consequences for the desirability and future of the Valley. This is especially true in the cold winter months when a power outage could create a public safety emergency as residents have difficulty heating their homes and water pipes freeze.

Today's maximum electrical demand in the Wood River Valley occurs in the coldest part of the winter months each year during the height of tourist season. Cold temperatures drive up heating demands and the peak of the ski and tourism season creates a surge in population and user-related power needs. Also, as population in the Valley and the resort community continues to grow over time, the corresponding electrical demand will increase. Recent major emergency events in the area including the summer 2007 Castle Rock fire and the 2009 Christmas Eve power outage emphasize the need for a reliable power system. Idaho Power is proactive in working with the community to plan for reliable new infrastructure to serve the electrical needs of the Wood River Valley today and into the future.

The Need

The primary need for any power system improvements in the Wood River Valley is to provide a reliable electric service to all customers. The existing power transmission system does not adequately meet the Valley's current need for reliable power.

<u>The transmission system lacks sufficient reliability</u> due to these factors:

- The electrical system serving the North Valley (from Hailey to Sun Valley and Ketchum) has only one transmission line which provides no redundancy should an outage occur on that line.
- The transmission line between Hailey and Sun Valley/Ketchum is 49 years old, having been built in 1962. While this line has been relatively dependable in the past, the risk of a major outage continues to increase due to its age.
- The remote location of large portions of the line between Hailey and Sun Valley/Ketchum makes access very difficult, especially in the winter. A failure on the line in the coldest part of winter could result in a long term outage. It could potentially be days before the line could be repaired and power restored to the Sun Valley/Ketchum resort area.

- The electrical system south of Hailey has two transmission lines, but neither line has the capability to provide 100% of the electricity needed for extreme peak loads in the Wood River Valley without rotational power outages. The Christmas 2009 outage was a dramatic reminder of the limitations of the existing system.

In the future, the system will lack sufficient capacity to satisfy projected electricity needs:

- Current power demands in the Wood River Valley at peak load are approximately 100 MW and future demands at build-out are projected to be approximately 320 MW, using current usage patterns to project future use.
- The current system capacity is about 120 MW.
- The system will need 200 MW of increased capacity and delivery infrastructure to serve the Wood River Valley's build-out needs. Any growth-related system upgrades will be built only when required by increased system demands.

Purpose of the Wood River Electrical Plan

The purpose of the Wood River Electrical Plan (WREP) is to outline and prioritize improvements and additions to the high voltage transmission and substation infrastructure to address the Valley's power needs from now through build-out. The development of the Plan was accomplished through a cooperative effort with the Community Advisory Committee (CAC). The CAC consisted of 19 members representing Blaine County, the cities of Sun Valley, Ketchum, Hailey, Bellevue, Picabo and Carey, Blaine County planning administrators, Lincoln County, private business/developers, area residents, the BLM, USFS and the Nature Conservancy. The Plan specifies locations for major transmission lines serving the Valley for many years to come and provides direction for the location of a new distribution/transmission substation to serve the southern part of the Valley. Individual projects resulting from this Plan will still require jurisdictional approval and will be subject to a public siting process. This plan gives the jurisdictions and citizens a "heads-up" as to where high-voltage transmission equipment may be located and allows them to plan accordingly.

In preparing the WREP, Idaho Power and the CAC considered the effect that demand-side management could have on future load in the Wood River Valley. Demand-side management includes energy efficiency efforts that reduce total energy consumption and peak response programs that reduce the maximum demand on the power system. Idaho Power is committed to reducing electrical load through the use of demand-side management at all customer levels. In conjunction with activities outside Idaho Power's control – such as expected improvements in Idaho building standards, customer involvement, and energy efficiency technology advancements – Idaho Power expects new electrical load can be reduced by 20 to 30 percent. Actual reduction in power consumption will be taken into account as infrastructure improvements are implemented. However, even if new electrical load is reduced by 30 percent, new electrical infrastructure is still required to reliably and dependably serve existing and new load.

Renewable power sources are an important component of the total resource portfolio that provides energy to the Wood River Valley. Small scale development of renewable resources (mostly solar) has occurred throughout the Valley while much larger wind, solar and geothermal resources have been and continue to be developed in the region around the Wood River Valley. The power system infrastructure, including transmission lines and substations, enables access to these regional resources for the residents of the Valley. Once brought in to the Valley, the electrical power from renewable resources still require transmission lines, substations and distribution lines to bring the energy to the consumer. A dependable transmission system that serves as the primary full-time power source will continue to be required to reliably meet the power demands of the Wood River Valley.

Because of the high cost, limited potential, significant space requirements, visual impacts and intermittent nature of any large scale renewable resources, it is impractical to assume the transmission system could be replaced by renewable resources in the Valley. Significant additional energy resource development in the Valley could mitigate the need for some of the growth related upgrades outlined in the Plan. However, the need for reliability driven projects such as the second transmission line into Ketchum does not change with more renewable development.

The Committee's Recommendations (see recommendations map; Figure 1)
Through the consensus agreement of the CAC, the WREP recommends the following infrastructure improvements and additions: *(Items are labeled on the map in Figure 1 by letter)*

<u>South Valley – South of Timmerman</u>

(A) Develop a new substation along Highway 75 near Burmah Road to serve the south Valley load and to act as a switching station for new transmission.
(B) Construct a new 138 kV transmission line from Midpoint Station (near Shoshone) to the new Burmah substation. This line would be installed in parallel with Highway 75.
(C) Construct a new 138 kV transmission line from the new Burmah substation to Moonstone Substation (located east of Fairfield).
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(E) Upgrade the existing King (near Hagerman) to Moonstone 138 kV transmission line to 230 kV.

<u>Mid Valley – Timmerman to Hailey</u>

(F) Improve the capability of the existing transmission lines from Silver Substation and Moonstone Substation into the Wood River Transmission Station in Hailey using higher capacity wire while maintaining the current 138 kV operating voltage.

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(G) Construct an additional 138 kV transmission line between Wood River Transmission Station and Ketchum Substation to improve the reliability to the north end of the Valley. The CAC recommended that the new line run parallel with and adjacent to Highway 75. This route was considered the most sensible option because it follows the Valley's main transportation corridor.

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The Idaho Public Utilities Commission requires the costs of underground transmission lines that exceed the cost of the overhead line be paid by entities other than Idaho Power and its customers in general. For any underground transmission line between Hailey and Sun Valley / Ketchum, the local community must pay the difference in cost between the underground line and the equivalent overhead transmission line. Preliminary funding options are currently being developed. This funding issue is expected to be a significant part of the public siting and permitting process in the near future for the new line between Hailey and Sun Valley/Ketchum.

Idaho Power extends a heartfelt thank you to every member of the CAC. The time and effort the committee gave to this project was tremendous. Their work has provided Idaho Power and the affected communities with a framework from which to begin the public siting process to build the power system that corrects the present deficiencies and addresses future requirements of the power system serving the Wood River Valley.

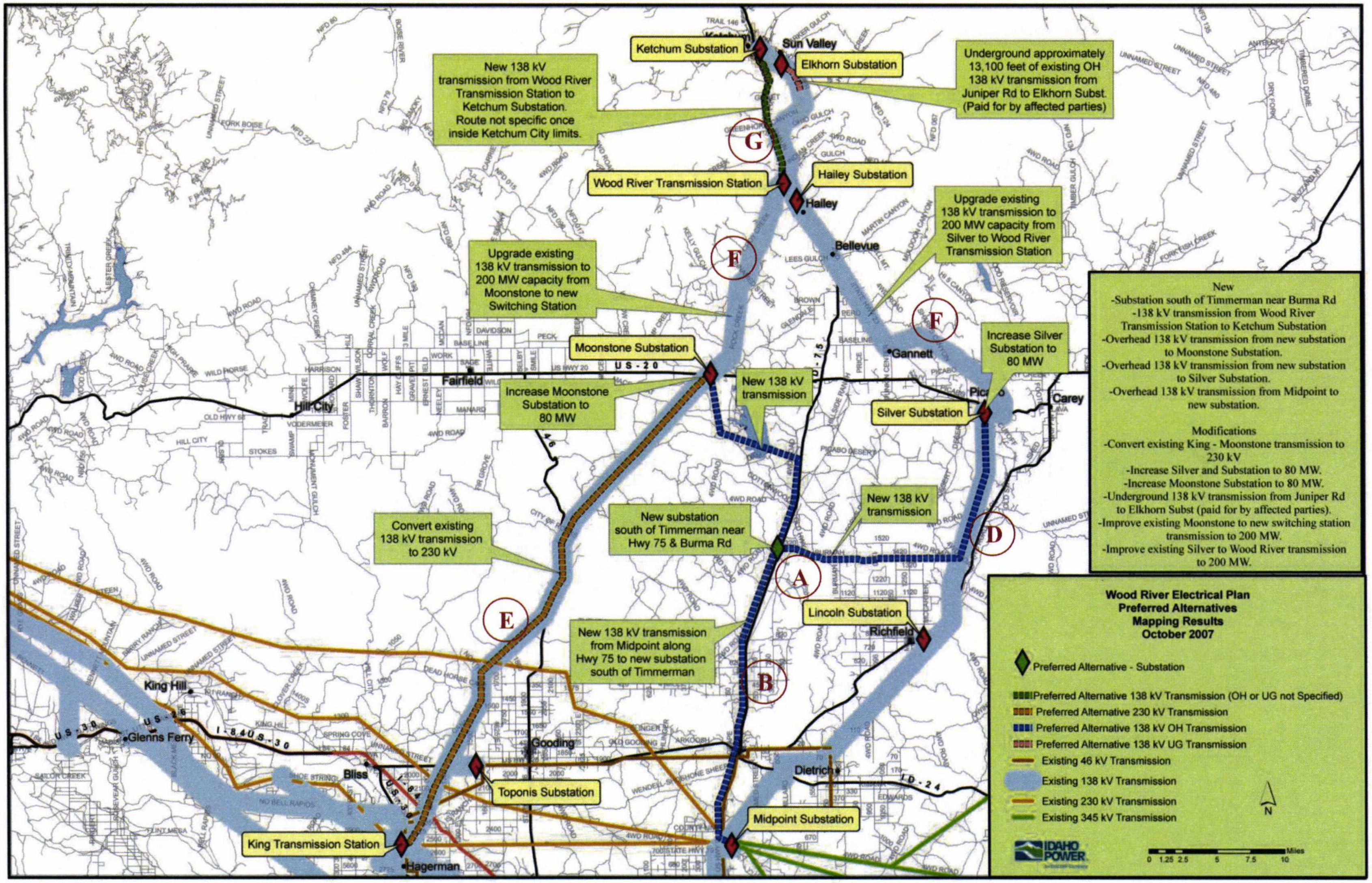

Figure 1. Committee Recommendations Map

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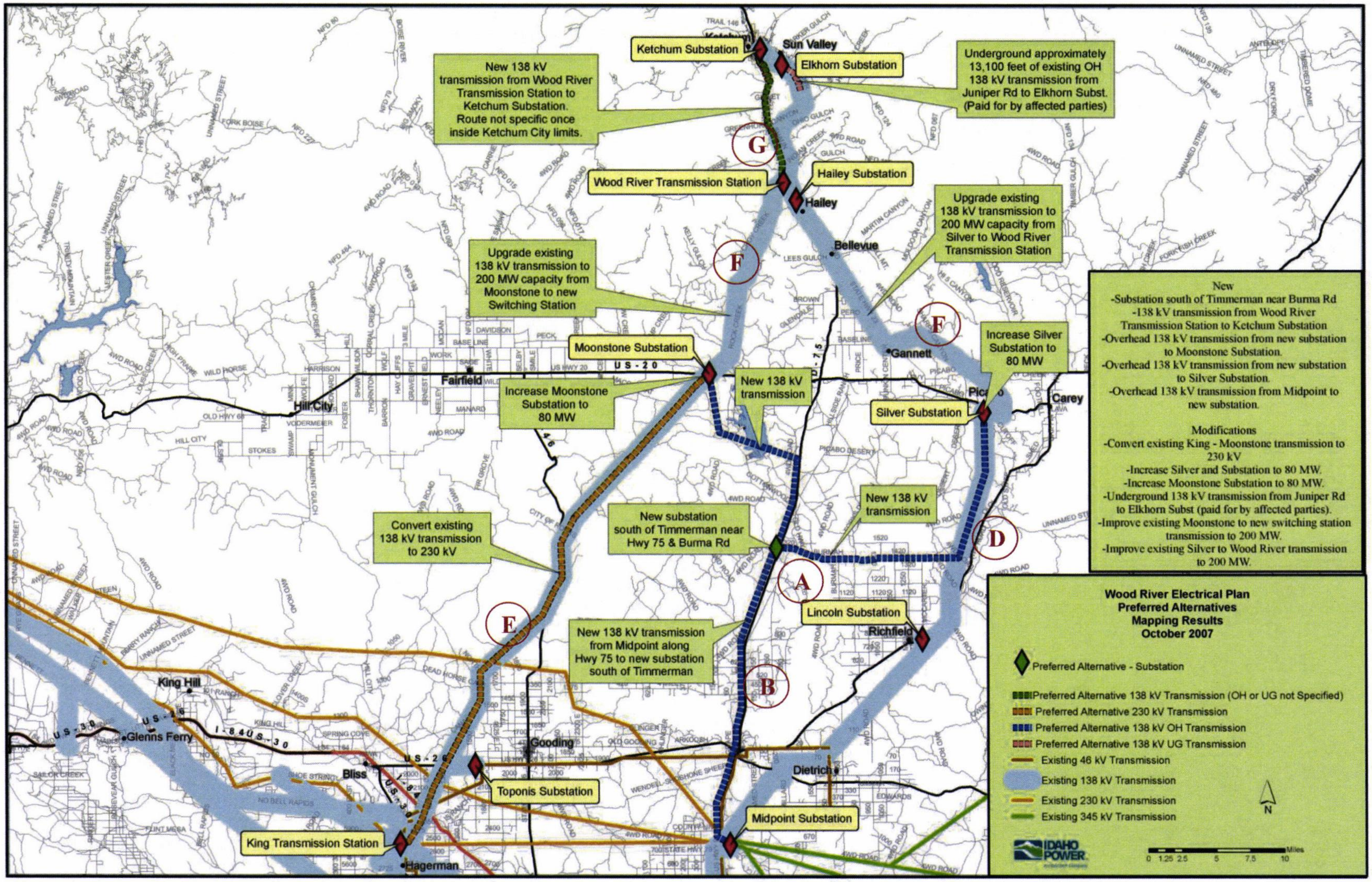

Figure 1. Committee Recommendations Map

Introduction

Located in South-central Idaho, the Wood River Valley is a vibrant area that includes the cities of Ketchum, Sun Valley, Hailey and Bellevue. The economy of these communities has become more and more dependent upon electricity as both businesses and residents install increasing amounts of electrical technology. The Valley's increasing reliance on electricity makes it important that Idaho Power improve its infrastructure serving the Valley to provide reliable and dependable electrical service throughout the Valley. Future growth in electricity demand also makes it important that plans be made for additional power system capacity to the Valley prior to the existing transmission lines reaching their full capability.

The electrical needs of the Wood River Valley can be described using two separate, though interrelated concepts: *dependability* and *adequacy*. In the first case, the electrical system must be dependable. When you flip a light switch, you expect it to turn on a light. When you push the power button on your computer, you expect it to turn-on. And you expect that to happen every time you flip the switch or push the button. To maximize its dependability, an electrical system must be redundant. That is, it must have more than one transmission line serving an area so that if one transmission line is damaged, the other can still provide the electricity. This is not the case in the north end of the Wood River Valley today. To date, the single transmission line that serves Sun Valley and Ketchum has been very dependable, but it was built in 1962 and needs more and more maintenance to maintain that dependability. And to a great extent, this line's dependability is reliant upon the forces of nature. A major winter storm or summer brush fire could damage the line to the extent that the north end of the Valley could be without power for a day or more.

The second concept is adequacy. As the electrical load in the Wood River Valley grows, the two transmission lines feeding into Hailey from the south will soon not have the capability to serve the Valley adequately while maintaining the dependability of the Valley's electrical supply. While the Valley doesn't need more transmission lines feeding into Hailey from the south, the existing capability of the two transmission lines will have to be increased. A new transmission line and upgrades to existing transmission lines are also planned from the Magic Valley up to the Wood River Valley to improve reliability and provide additional capacity to the Valley.

Idaho Power invited members of the Wood River Valley community to be involved in a Community Advisory Committee (CAC) to help layout the Wood River Electrical Plan to address the dependability and adequacy of the Wood River Valley's electrical supply. The Plan specifically outlines the electrical infrastructure needs of the Valley from today through the Valley's population and load buildout. The committee was made up of city and county planning representatives, local politicians, environmental interest groups, Forest Service and BLM representatives, major land-owners and community activists. Idaho Power also invited representation from Lincoln County because any new transmission infrastructure built into the Wood River Valley would likely cross through Lincoln County. A complete list of members can be found in Appendix A. This report documents the study process and the committee's consensus recommendations pertaining to the power system serving the Wood River Valley.

Background

Population and Electrical Load Projections

Idaho Power uses future population to estimate the long-term power needs for the Wood River Valley. For the area of Blaine County from Timmerman Hill to SNRA Headquarters north of Ketchum, Idaho Power estimates the 2006 population to be 21,600. During the winter of 2006, this population consumed 99.5 megawatts (99,500,000 watts) of electricity at peak. The peak electricity demand in the winter of 2010-2011 was about 102 MW for the Wood River Valley.

Using two different methods to determine the population at Valley buildout, the projected population will be nearly 76,000 people and the electrical power requirements will be around 320 megawatts, or about 320% of what is used today. That is, when the Valley has reached population saturation, it will require 3 times as much power as it uses today. Of course this is assuming that present consumption is representative of future consumption. Idaho Power, along with the Community Advisory Committee hopes that consumption will decrease as energy efficiency measures become more effective but the present trends are not positive. While new appliances, lighting and equipment continually become more efficient, individual homes and businesses have more of them and people are finding new ways to use electricity.

Existing Wood River Valley Electrical Supply System

The Wood River Valley is served entirely by transmission lines. There are no electrical generation facilities located within the Valley. Figure 3 shows the transmission system feeding the Valley.

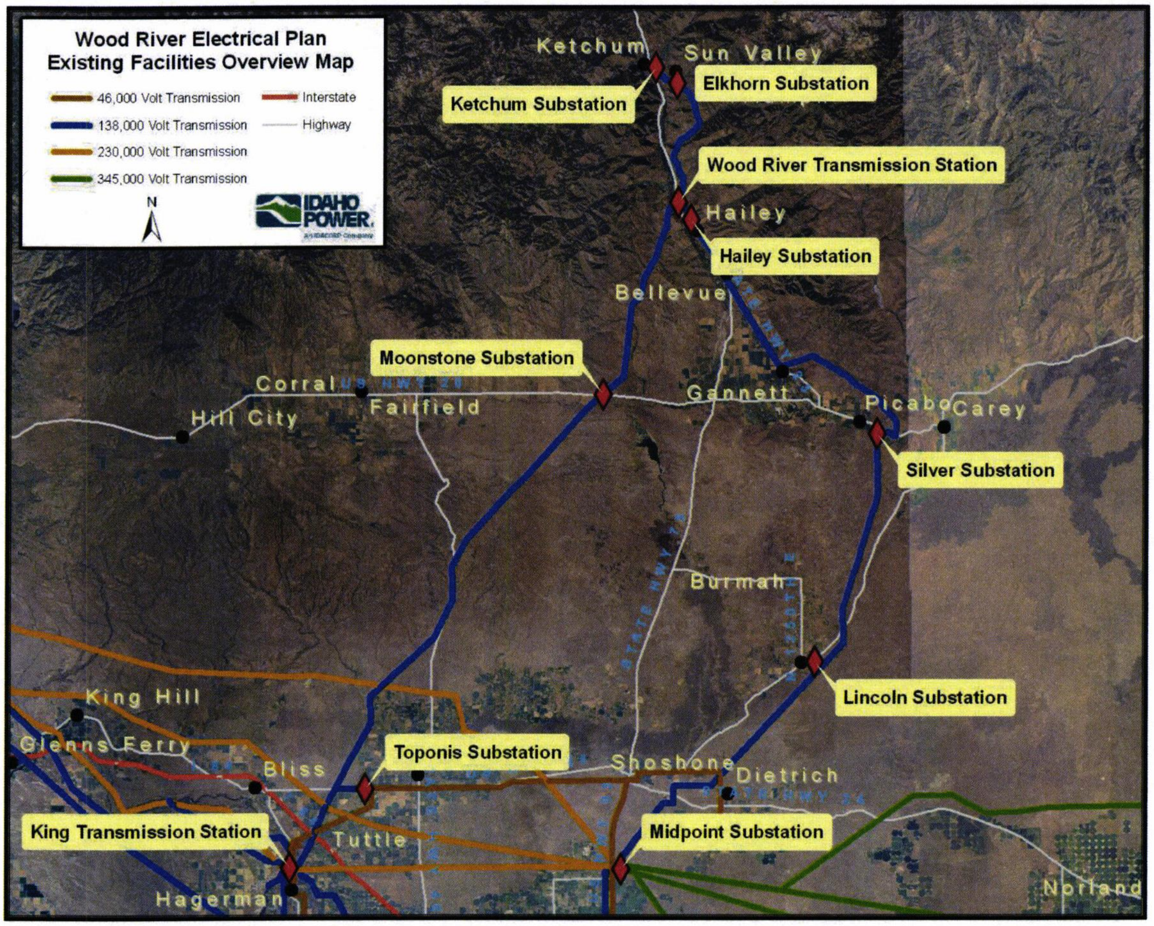

Figure 3. Wood River Valley Electrical Supply Overview Map.

There are two 138 kV transmission lines serving the Valley up to Hailey (blue lines running north on the drawing),

- King Transmission Station to Wood River Transmission Station
- Midpoint Substation to Wood River Transmission Station

The King to Wood River transmission line was built in 1962 and enters the Valley northwest of Hailey. The Midpoint to Wood River transmission line was built in 1989 and has the higher capacity of the two lines; its wires are larger so it can carry more power. It enters the Valley east of Picabo. Idaho Power refers to these two lines combined as the *Wood River loop.*

From the Wood River Transmission Station in Hailey to the Ketchum/Sun Valley area, there is one transmission line. This line was built in 1962.

There are five substations within the Wood River Valley that reduce the transmission voltage to a lower distribution voltage and route the power onto smaller lines for delivery to end users. These substations are:

- Ketchum Substation – Located in Ketchum on Sun Valley Road
- Elkhorn Substation – Located in Sun Valley near the intersection of Elkhorn and Juniper
- Hailey Substation – Located in Hailey on Carbonate Road
- Moonstone Substation – Located along Highway 20 about 18 miles east of Fairfield
- Silver Substation – Located just east of Picabo

Note the Wood River Transmission Station in Hailey does not reduce voltage to directly serve customers; it is only used to control the transmission lines feeding into the Valley from the south and the transmission line feeding north from Hailey toward Ketchum/Sun Valley.

Existing Dependability

The southern half of the Wood River Valley, from Hailey south, is served by two transmission lines, giving it redundant power service a majority of the year. However, the northern part of the Valley is served by a single transmission line. When a storm, accident or brush fire damages the line, there is no alternative way to provide power to the Ketchum/Sun Valley area. Idaho Power maintains and patrols this single line to a higher standard than most other transmission lines in its service territory for just this reason. The line is, however, over 49 years old and will require even greater care in the future.

The two transmission lines serving as far north as Hailey provide better dependability than would a single transmission line. Presently, the combination of these two lines can serve the most extreme peak usage in the Valley at any time. However, the lines individually do not have the capability to serve the entire valley load at winter peak. This means that if one of the lines was to be taken out-of-service during the winter when Valley loads are the highest, the remaining line would not be able to carry the entire Valley load. The load would have to be reduced through the use of rotational outages for the duration of the outage. Depending on the cause and extent of the damage that caused the line to go out-of-service, the rotational outages could extend for several days.

Obviously, if the transmission line serving from the Wood River Transmission Station north to Ketchum/Sun Valley is taken out-of-service at any time of year, there would be no way to serve most of the load in the north end of the Valley. As mentioned before, because of the potential hardships an outage of this line could cause to the citizens and businesses of the north Valley, Idaho Power maintains and patrols this line to a significantly higher degree than it does most other transmission lines in the Idaho Power system. But as this line ages, it will become more and more difficult to maintain its dependability. The line was built in 1962 and as the years go by, it can be expected that more failures will occur. And no matter how much maintenance is done on this line, forces of nature can cause it to fail.

Committee Process and Input

Idaho Power engaged KMP Planning of Twin Falls to facilitate the Community Advisory Committee meetings. The meetings started in January 2007 with a bus tour of Idaho Power facilities, beginning a series of primarily educational meetings that were held monthly through March 2007. Through these educational sessions, the CAC was introduced to electrical generation, substations, transmission, demand-side management, and regulatory affairs. Additionally, the CAC was presented with a view, from production to delivery, of Idaho Power's electrical system. Using the education gained from the meetings held from January through March, the CAC set to work in April and May to lay out proposed Wood River Valley transmission line routes and substation sites.

Alternative Energy Generating Technologies

During the initial committee meeting, a presentation was given by Idaho Power that outlined various alternative energy generation technologies that could deliver energy to the Wood River Valley and thus decrease the need for additional power lines. The technologies discussed included wind turbines, geothermal generators, photovoltaic (solar), combustion turbines and fuel cells. A number of small-scale solar (roof mounted photovoltaic) have been installed by private citizens and businesses in the Wood River Valley. These small scale projects and others such as residential sized fuel cells could offset some of the power demands of the Wood River Valley and potentially delay the need for growth driven power system upgrades. A detailed description and discussion concerning alternative energy generating technologies can be found in Appendix C.

The amount of energy produced by renewable resources and delivered into Idaho is increasing at a rapid pace. Idaho Power is currently contracting for all the energy from the wind turbines currently operational in the Magic Valley, a large scale wind facility in eastern Oregon and all the energy from the Raft River geothermal project in eastern Idaho. Additional small to mid-sized wind turbine facilities are proposed for the Magic Valley and construction on some of them should start soon. Idaho Power, in a joint venture with PacifiCorp, is planning 500,000-volt transmission coming into Idaho from Wyoming which will enable the wind resources in Wyoming to be developed. However, all these resources will still require transmission infrastructure and equipment in order to deliver energy to end users.

Energy Efficiency

Another way to reduce the need for additional transmission resources in the Wood River Valley would be to aggressively pursue energy efficiency technologies or in utility terms, demand-side management (DSM). Idaho Power is currently providing many programs funded by a Customer Conservation Charge to customer bills that promote the use of DSM to reduce electricity usage. Idaho Power's 2004 Integrated Resource Plan (IRP) called for an average of 41 megawatts of energy savings due to DSM by 2014. The 2006 IRP calls for an average of 90 megawatts of energy savings due to DSM by 2024. Table 1 shows the current Idaho Power programs. The Idaho Power Website at www.idahopower.com contains full descriptions of these programs.

Residential	*Commercial/Industrial/Irrigation*
A/C Cool Credit	Irrigation Peak Rewards
Weatherization Assistance	Irrigation Efficiency
Rebate Advantage	Building Efficiency
Energy Star® Homes	Easy Upgrades
Energy Star® Lighting	Customer Efficiency
Energy House Calls	

Table 1. Idaho Power Demand Side Management Programs

Additionally, Idaho Power currently has rates that vary by season, with summer electricity rates being higher than winter rates in order to encourage lower energy use in the summer when the overall electricity usage on the Idaho Power system is highest. In the Wood River Valley, these seasonally varying rates do nothing to reduce power usage when the reduction is needed most…in the winter.

Idaho Power is also investigating using time-of-day pricing and critical peak pricing that would encourage customers to use less energy during the peak times (such as late afternoon and early evening).

Idaho Power Company Energy Efficiency activity and Programs in the Wood River Valley
Idaho Power offers ten distinct Energy Efficiency programs in the Wood River Valley as well as throughout most of its service territory. A listing of each program follows with a brief description of each. More information of each of the programs can be found at www.idahopower.com/energycenter.

Residential Programs:

- **ENERGY STAR® Homes Northwest**
  A $750 incentive is paid to builders for each home built to the ENERGY STAR® standards. These standards are 30 percent more efficient than one built to the Idaho building code.
- **Energy House Calls**
  This program offers a free package of services (inc. duct sealing) designed to help save energy for residents of manufactured homes heated by an electric furnace or heat pump.
- **Rebate Advantage**
  This program offers $500 payment to Idaho Power customers who purchase a new ENERGY STAR® manufactured home.
- **Weatherization Assistance for Qualified Customers**
  This program offers free weatherization measures for electrically heated homes of qualified customers to help them maintain a comfortable and efficient home environment.
- **ENERGY STAR® Lighting**
  This program is a specialty bulb promotion offered in conjunction with BPA (Change a Light, Change the World) to provide a buy-down of bulbs at large retailers. Future programs offer promotions of other bulbs at various retailers.

- **Heating and Cooling Efficiency Program**
  This program provides cash incentives to residential customers (and HVAC contractors) for choosing and installing qualified energy-efficient heating and cooling equipment and services through approved HVAC contractors

Commercial and Industrial Programs:

- **Custom Efficiency**
  This program offers financial incentives for large commercial and industrial energy users with large and complex projects to improve the efficiency of their electrical systems or process.
- **Building Efficiency**
  This program offers incentives of up to $100,000 designed to offset part of the additional capital expenses for more efficient lighting and cooling designs in small and mid-size commercial construction projects
- **Easy Upgrades**
  This program offers Incentives of up to $100,000 for a menu of simple commercial, industrial building retrofit projects. Incentives are available for lighting, HVAC, motors, building shell, plug loads and grocery refrigeration and are based on each measure's assumed energy savings.

Agricultural Programs:

- **Irrigation Efficiency Rewards**
  This program offers an incentive which pays up to 75 percent of the cost for irrigation customers who improve the energy efficiency of an existing pump system or up to 10 percent when installing a new efficient system.

- **Irrigation Peak Rewards**
  This program offers a demand credit for specific irrigation customers who allow Idaho Power to use electric timers to turn off their pumps for a few hours on selected summer days reducing afternoon peak demand and lowering the customer's electric bills.

Wood River Valley projects:

Although Idaho Power doesn't commonly track Energy Efficiency programs specifically by area or city, a manual examination of the Energy Efficiency incentive records show that from 2005 to October 2007 Idaho Power has identified 24 individual projects completed in the Wood River Valley area. These projects were completed in Ketchum, Bellevue, Hailey, Sun Valley, Fairfield, Carey, and Picabo. Four projects were under the Custom Efficiency Program. One project was completed under each of the Building Efficiency, Easy Upgrades and Rebate Advantage programs and seventeen projects were completed under the Irrigation Efficiency Rewards program. Idaho Power paid a total of $130,290 dollars in incentives for an annual energy savings of approximately 1,342,602 kilowatt hours (kWh) and 155 kilowatts (KW) in demand savings for the non-irrigation programs. Under the Irrigation Efficiency Rewards program, Idaho Power paid $28,637 in incentives for an annual savings of approximately 205,717 kWh and about 57 savings in KW.

There are many other activities in addition to those sponsored by Idaho Power that customers could undertake to reduce their energy use and, like the alternative generating resources discussed previously, it will be up to the local residents, businesses and governments to make them a reality.

Goals Document

The first step in developing proposed solutions to the electrical needs of the Wood River Valley was to develop a Goals Document that could be used to guide the committee's efforts to develop and evaluate alternatives. The committee spent a significant amount of time refining the Goals Document to ensure it represented their desires for a responsible, reliable and affordable electrical system. Much discussion took place concerning the preservation and improvement of view corridors, cost issues and comparing new lines to existing lines. The goals were divided into 6 areas:

- **Reliable Power:** Provide reliable power to the entire Wood River Valley
- **New Infrastructure Design:** Develop new transmission and delivery infrastructure as appropriate when providing for current and future power needs
- **Energy Conservation:** Implement programs that reduce demand for additional energy
- **Environment:** Cause no or minimum impacts to the natural, physical, cultural, historic, social and aesthetic environment due to development and operation of power facilities and delivery systems
- **Political Support:** Develop solutions that are politically supported throughout the Wood River Valley
- **Cost Effectiveness:** Develop solutions that are cost effective and provide associated benefits

The CAC developed a number of bullets describing the goals more fully. These can be found in Appendix C, Page 6.

The CAC also came up with a list of siting criteria. These criteria may not all be completely achievable, but they are measures to be strived for when developing and evaluating alternatives.

- **North of Wood River Transmission Station (WDRI)**
  - *Provide both redundancy and capacity to meet electrical needs north of WDRI*
  - *Do not use the existing 138 kV transmission corridor without new technology to avoid new impacts*
  - *Preserve the scenic corridor*
  - *Maintain the ordinance-required 150 ft setback from residences when using overhead transmission lines*
  - *Conform to existing hillside ordinances*
  - *Install underground lines in locations where the necessary additional funding is available.*
- **South of Wood River Transmission Station (WDRI)**
  - *Provide electrical infrastructure and systems that meet Lincoln County electrical needs*
  - *Improve structures and transmission lines in Lincoln County as needed to accommodate future growth*
  - *Maintain scenic corridors*

- *Cause no environmental impact to wetlands and habitat*
- *Use existing corridors and transmission equipment where possible*
- *The use of overhead lines and infrastructure is acceptable until the affected community can afford to fund a different proposal*
- *Maintain or reduce pole size in Bellevue*

Mapping Exercise

Using the education provided in January through March and the goals developed in March and April, the CAC set to work in April laying out proposed Wood River Valley transmission routes and substation locations. The CAC also used the load block diagrams developed by Idaho Power personnel to aid them in determining the size of lines needed to support the Valley's load. The exercise was divided into three sub-areas for planning: South of Timmerman, Mid Valley and North Valley.

The committee was broken into three groups. Each group was given a large aerial photograph showing the terrain from Ketchum in the north to Midpoint and King Substations in the south. Using the goals and siting criteria as a guide, each group developed feasible alternatives to meet buildout requirements. The following guidelines were used in forming the small groups:

- Groups were designated A, B and C for alternative discussion purposes
- Each group included committee members from throughout the planning area
- Each group included an Idaho Power representative to provide technical support and a facilitator to capture the details for each of the alternatives

The three groups came up with a total of 6 alternatives covering various parts of the Valley. To aid in screening the alternatives developed by the three groups, a screening matrix was developed that each CAC member could fill in to see numerically how each alternative ranked. It must be noted that a numerical screening of alternatives was just an initial tool to evaluate the alternatives against one another. The final decision as to which alternative or alternatives to designate as the most feasible going forward is a consensus decision reached within the CAC and the matrix was just part of this decision process. Appendix C contains detailed results of the screening matrix exercise.

Committee Consensus on Alternatives

Using the results of the scoring matrix as a basis for discussion, the committee went on to reach consensus on each of the three sub-areas of the Plan; South of Timmerman, Mid Valley and North Valley. Figure 3 is a combination of the preferred alternatives for each of the three Valley sub-areas. This figure is also in Appendix D, page 8 in a larger, more readable size.

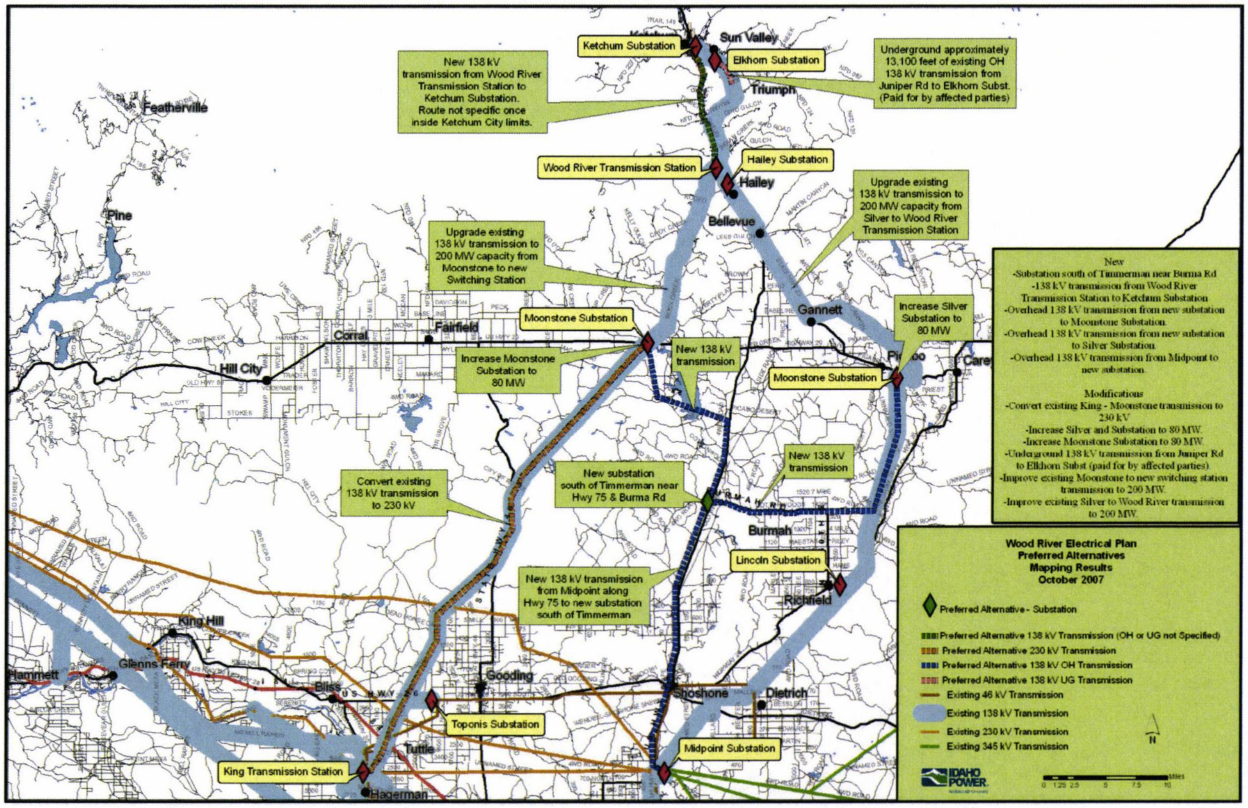

Figure 4. Preferrerd Alternatives

South Valley

For South Valley, the preferred alternative would convert the existing 138 kV transmission from King Substation to Moonstone Substation to 230 kV. It would install a new Substation south of Timmerman Hill along Highway 75 near the intersection of Highway 75 and Burmah Road (depending on land availability). For reference, this new substation will be referred to as Burmah Substation. It would then install a new 138 kV transmission line from Midpoint Substation to the new Burmah Substation and a 138 kV transmission line from the new substation to Moonstone Substation. It would also install a new 138 kV transmission line from the new Burmah Substation to Silver Substation routed along Burmah Road until it reached the existing 138 kV line. The new circuit would then be run on common towers with the existing 138 kV circuit until it reached Silver Substation.

The preferred alternative designates that both Silver and Moonstone substations be upgraded to 80 MW capacity. It is noted that the existing 138 kV transmission from Juniper Road near Sun Valley to Elkhorn Substation is to be placed underground (paid for by affected parties).

Mid-Valley

The preferred alternative for Mid-Valley would upgrade the existing Moonstone to Wood River Transmission from 105 megawatts to 200 megawatts and upgrade the existing Silver to Wood River Transmission from 120 megawatts to 200 megawatts. The Moonstone to Wood River transmission structures would have to be rebuilt, but the net result will be that the visual impact of this line will not change.

North Valley

The preferred alternative for the North Valley region constructs an additional 138 kV transmission line between Wood River Transmission Station (located in Hailey) and Ketchum Substation to increase the dependability of the electrical supply to the north end of the Valley. Today there is only one transmission line feeding north from Hailey to Ketchum. The committee recommended that this line run in parallel with and immediately adjacent to Highway 75. This route was considered the most sensible option because it follows the Valley's main transportation corridor. The committee as a whole did not specify whether this line should be installed overhead or underground. There was a preference among a few members that this line be placed underground if cost wasn't an overriding factor. Photographic overlays showing an example of a new 138 kV overhead transmission line along Highway 75 south of Ketchum can be found in Appendix J of this report.

Overhead vs Underground Transmission

By far the most challenging issue the committee addressed was overhead vs underground transmission, particularly for new transmission from Hailey to Ketchum/Sun Valley. As regulated by the Idaho Public Utilities Commission (IPUC), Idaho Power is obligated to build its infrastructure in the most cost effective manner possible. Based on past experience, underground transmission is generally 10 times more expensive than overhead transmission. Idaho Power cannot construct underground facilities unless there are extenuating circumstances that would require it. These circumstances could include environmental issues or land availability issues. If a community wishes that transmission be placed underground for aesthetic reasons, the cost difference between overhead and underground transmission would have to be provided for by that community before the transmission could be placed underground.

One committee member discussed at length the belief that right-of-way costs for underground transmission in the North Valley would be significantly lower than for overhead transmission because landowners would be more willing to grant easements for underground transmission. The cost difference for the right-of-way could overshadow the material cost difference between overhead and underground transmission. The member also asserted that the political and legal costs would be quite high if Idaho Power were to attempt to install 138 kV overhead transmission in the North Valley. It was suggested that Idaho Power analyze this potential difference in right-of-way costs. While Idaho Power agrees that community acceptance for underground transmission would be greater, there is no valid method that can be used to estimate the cost difference for right-of-way between overhead and underground transmission short of actually going out and attempting to purchase the easements. It should be noted that some other committee members believed that there would actually not be a great difference between overhead and underground easement costs.

The committee as a whole did not specify whether this line should be installed overhead or underground. There was a preference among a few of the members that this line be placed underground if cost wasn't an overriding factor.

Implementation Plan

The recommendations of the Community Advisory Committee cover infrastructure improvements to the Idaho Power system that will deliver sufficient power at the Wood River Valley's buildout. Not all the facilities are needed in the near term and will be phased in as the Valley's load increases. The following is Idaho Power's recommended implementation plan:

5 Year

- Build a second 138 kV transmission line between the Wood River Transmission Station in Hailey and Ketchum Substation. This is the top priority project.
- Site and build the new Burmah Substation south of Timmerman Hill
- Build a new 138 kV transmission line from Midpoint Substation near Shoshone to the new Burmah Substation
- Build a new 138 kV transmission line from Burmah Substation to Silver Substation (near Picabo)
- Build a new 138 kV transmission line from Burmah Substation to Moonstone Substation (east of Fairfield)

10 Year

- Upgrade Moonstone to Wood River transmission line to 200 megawatts
- Add new 230 kV to 138 kV transformer at Midpoint Substation
    - The existing transformer capacity will be inadequate to serve the Wood River Valley load at this point.

15 Year

- Add new voltage control device at Ketchum Substation
    - Won't require new lines into Ketchum Substation
    - Won't require that Ketchum Substation be enlarged

20 Year

- Add distribution feeders from Wood River Transmission Station
    - Currently, this station only serves to switch the transmission, it doesn't directly feed any of the load around Hailey
    - This would relieve some of the load from Hailey Substation

30 Year

- Upgrade Silver to Wood River transmission line to 200 megawatts
    - This will provide more capacity to the growing Valley load
    - This will also help to support the voltage at Ketchum and Elkhorn substations

When load levels require, the King to Moonstone 138 kV transmission line will be converted to 230 kV. This will require that the line be completely rebuilt but it will likely be installed in the existing right-of-way. Moonstone Substation will also require improvements at this point to accommodate the higher voltage.

Conclusion/Results

The Wood River Valley is a vibrant, growing region that depends on a reliable electrical system to serve its tourism based economy. Along with growth-related increases in electricity demand, the businesses and residents of the Wood River Valley are more dependent on electricity today than ever before. Where 25 years ago, few owned a personal computer, now many residents have multiple PCs. Many people work from home and are dependent on their PC and home network to do business. Most, if not all, businesses now have electronic or even computer driven cash registers. New technology increasingly drives the need for electricity and it will continue on into the foreseeable future.

A dependable power system becomes especially important in the cold winter months. Residents of the valley, both permanent and occasional expect and require the power system to provide electricity to furnaces and water heaters for their homes. These heating loads drive the power demands to peak in the coldest winter months. A long duration outage in the winter due to a transmission line outage would be a public emergency and could result in frozen homes, and damaged water pipes throughout the Valley. The wintertime ski industry also depends on electricity for both chair lifts and snow making. The importance of a reliable electrical system to skiing operations was even evident in the summer of 2007 when snow making equipment was used to protect Bald Mountain facilities during the Castle Rock fire. For these reasons, Idaho Power must be proactive in planning for new infrastructure to serve the needs of the Wood River Valley.

The Wood River Electrical Plan (WREP) lays out high voltage transmission and substation infrastructure from now through Valley population and load buildout. In a cooperative effort with the Community Advisory Committee, the Plan determines locations for major transmission lines serving the Valley for many years to come and provides direction for the location of a new distribution/transmission substation to serve the southern part of the Valley. Individual projects resulting from this plan will still require jurisdictional approval and will be put through a public siting process. This first step, however, will give the jurisdictions and citizens a heads-up as to where high-voltage transmission equipment may be located and allow them to plan accordingly.

The Wood River Electrical Plan takes into account the effect that demand-side management will have on future load in the Wood River Valley. Idaho Power is committed to reducing electrical load through the use of demand-side management at all customer levels. In conjunction with activities outside Idaho Power's control – such as expected improvements in Idaho building standards, customer involvement, and energy efficiency technology advancements – Idaho Power expects new electrical load can be reduced by 20 to 30 percent.

Through the consensus agreement of the CAC, the WREP recommends the following:

- An additional 138 kV transmission line between Wood River Transmission Station (located in Hailey) and Ketchum Substation to increase the dependability of the electrical supply to the north end of the Valley. Today there is only one transmission line feeding north from Hailey to Ketchum. The committee recommended that this line run in parallel with Highway 75. This route was considered the most sensible option because it follows the Valley's main transportation corridor. The consensus CAC recommendation is to build an overhead 138 kV transmission line from Wood River substation north to the St. Luke's hospital area. This new line would be in place of existing overhead distribution power lines along Buttercup Rd and Highway 75. From the hospital area north to the Ketchum substation, an underground 138 kV transmission line is preferred by the CAC. The underground option is contingent on local community funding.

- The location for a new substation south of Timmerman Hill near the intersection of Highway 75 and Burmah Road to serve the South Valley load and to act as a switching station for new transmission. For reference, this substation is named Burmah Substation.
- Construction of a new 138 kV transmission line from the new Burmah Substation to Moonstone Substation (located east of Fairfield).
- Construction of a new 138 kV transmission line from the new Burmah Substation to Silver Substation (located near Picabo).
- Increased power supply from south of the Wood River Valley to the Wood River Transmission Station in Hailey to serve the increasing electrical load in the Valley. This increased supply includes;
    - Construction of a new 138 kV transmission line from Midpoint Substation (near Shoshone) to Burmah Substation. This line would be installed in parallel with Highway 75.
    - Conversion of the existing King Transmission Station (located in Hagerman) to Moonstone Substation 138 kV transmission line to 230 kV. This will increase its capability.
    - Improve the capability of the existing 138 kV transmission lines feeding from Silver Substation (near Picabo) and Moonstone Substation into the Wood River Transmission Station in Hailey. This would be accomplished with larger wire installed on the existing structures if possible with the operating voltage remaining at 138 kV.

The cost for this infrastructure to serve the buildout projected load is about $78 million, in 2007 dollars. Future changes in technology may make some of these improvements unnecessary or, at least, delay their need. These types of shifts, however, are impossible to predict; therefore, Idaho Power can only monitor them and understand that no matter how good the present plans are, external forces can change them.

Appendix A – List of Community Advisory Committee Members

Lloyd Betts	Juniper Springs Home Owners
Len Harlig	Former Blaine County Commissioner
Rob Struthers	Real Estate and Ranching Former P&Z
Chuck Turner	Blaine County Emergency Planning
Kurt Nelson	USFS & Ketchum/Sun Valley Chamber Board
Julie Ingram	Hailey Chamber Executive Director
Tom Bergin	Director Blaine County Planning and Zoning
Tara Hagen	BLM Realty Specialist
Tom Hellen	City Engineer, City of Hailey
Chuck Carnohan	Idaho Dept. of Transportation
Tom Blanchard	City of Bellevue Administrator
Nils Ribi	Sun Valley City Councilman
Ron Le Blanc	Ketchum City Administrator
Jay Loesche	Lincoln County Commissioner
Leonard (Nick) Purdy Jr.	Rancher
Dayna Smith	Nature Conservancy Silver Creek Preserve
Wally Huffman / Dave Ziegler	Sun Valley Company
Rick Baird	Friedman Memorial Airport Manager and Carey City Mayor
Rod Kegley	Land Developer

Appendix B – Introduction and Technical Background

Introduction

Located in South-central Idaho, the Wood River Valley is a vibrant area that includes the cities of Ketchum, Sun Valley, Hailey and Bellevue. The economy of these communities has become more and more dependent upon electricity as both businesses and residents install increasing amounts electrical technology. The Valley's growth makes it important that Idaho Power improve its electrical infrastructure serving the Valley to ensure that reliability does not degrade. This growth also makes it important that plans be made for additional power supply to the Valley prior to the existing transmission lines reaching their full capability.

In 1973, the Idaho Public Utilities Commission approved Idaho Power's application requesting a Certificate of Public Convenience and Necessity for the construction of a second 138 kV transmission line between Hailey and Ketchum. In 1995, Idaho Power convened a Community Advisory Committee (CAC) to discuss installing this second 138 kV transmission line. The consensus of this committee was that Idaho Power should delay installing a new line and reconvene a committee in 10 years time to review the status of need. This decision resulted from the fact that the need for the line was to improve reliability and not because of a lack of capacity. As a result of the committee's recommendation and at the request of Idaho Power, the Idaho Public Utilities Commission amended its 1973 order, removing the authority for the construction of the second 138 kV transmission line from Hailey to Ketchum.

In accordance with the wishes of the 1995 Community Advisory Committee, Idaho Power once again formed a CAC in 2007 to evaluate the need for a second line feeding north from Wood River Transmission Station in Hailey to the Ketchum/Sun Valley area. In addition to evaluating the need for this second transmission line, the present Community Advisory Committee evaluated the *buildout* electrical infrastructure needed to serve the entire Wood River Valley from Ketchum in the north to the Timmerman Hill area in the south. The committee, comprised of area planners, city leaders, business interests, special interest groups, advocacy groups, and general citizens, met monthly over a period of six months. A list of CAC participants can be found in Appendix A. Representation from Lincoln County was also included to ensure their voice was heard in siting any transmission that must transit their county in route to the Wood River Valley.

This report documents the study process and the committee's consensus recommendations pertaining to the power system serving the Wood River Valley.

Existing Population and Electrical Load

For the area of Blaine County from Timmerman Hill to Ketchum, Idaho Power estimates the 2006 population to be 21,600. The peak historic electrical load consumed by this population was 99.5 MW, which represents the maximum recorded coincidental load fed from Hailey, Elkhorn, Silver and Ketchum Substations and the distribution serving into the Wood River Valley from Moonstone and Silver Substations.

Wood River Valley Growth

Electrical load growth calculations for the Wood River Electrical Plan were performed using two different methods. The first method was a spatial growth approach based on the comprehensive plans and current zoning for Blaine County and the cities of Sun Valley and Hailey. The second method was a population growth approach based on county economic development growth projections developed by Idaho Economics.

Spatial Growth Approach

The first method using the comprehensive plan approach and existing zoning laws assigned a load density in kilowatts-per-square mile (kW/mi^2) to each zoning area. The commercial zoning load density was estimated based on existing "buildout" areas in the Idaho Power service area. For residential zones, 5 kW per house was used to calculate the load density in areas south of and including the City of Hailey. It is assumed the average size of house is larger in Ketchum and Sun Valley so 6 kW per house was used for these cities.

Much of the zoned area in Blaine County is publicly owned land (BLM and US Forest Service) and is in the hills and mountains of the Wood River area. It was assumed that there would be no development on these publicly owned lands. Because there were no electronic maps of Bellevue zoning available, it was assumed that the zoning in Bellevue is similar to the zoning in Hailey. Multiplying the load density (kW/mi^2) for each zoning class by the total area associated with each zoning class (private land only) results in total load in kilowatts (kW) for each zoning class. The area of all the publicly owned land was not included in the load calculations for each zone. Finally, the total Wood River Valley build out load was calculated by summing the total load for all the zoning classes. This approach resulted in a total buildout load of 312 MW. Appendix I contains the load density numbers used in the calculations.

Population Growth Approach

The population growth approach utilizes county population growth projection numbers developed by John Church, President of Idaho Economics. Historic and projected Blaine County population and household growth rates are shown in Table 2. Continued growth is expected, but at a slower pace for the next 25 years compared to the previous 25 years as the amount of private, buildable land dwindles. The population for Blaine County is projected to be 13,896 households or 34,378 people in the year 2030. These growth projections result in an annual growth rate of about 1.8% for the time period 2006 to 2030. The current average power demand per person in Blaine County is about 10.3 kW per household or 4.2 kW per person. Assuming constant long term population growth of 1.8%, the projected "buildout" population (year 2080) for Blaine County is 76,161 people. Multiplying by a consistent 4.2 kW per person yields about 320 MW for the total Wood River Valley area buildout load.

Blaine County		*Population annual Growth*	*Households Annual Growth*
By Decade	1970-1979	5.49%	7.02%
	1980-1989	2.66%	2.85%
	1990-1990	2.99%	3.37%
	2000-2009	2.08%	2.09%
	2010-2019	1.41%	1.28%
	2020-2029	1.90%	1.93%
Previous 25 Years	1980-2004	3.05%	3.10%
Previous 5 Years	2001-2005	1.70%	1.67%
Next 5 Years	2006-2010	1.84%	1.85%
Next 25 Years	2006-2030	1.82%	1.78%

Table 2. Blaine County Population Growth

Both approaches to calculating the projected "buildout" electrical load in the Wood River Valley yielded very similar results giving a good level of confidence in the results. Potential variations in the spatial/zoning approach could result from future zoning changes, and developers choosing to develop at a lower density rather than at the maximum density allowed by the zoning laws. The population growth results will vary because of economic and political changes in the area and other potential limits such as limited water or transportation limits.

Existing Wood River Valley Electrical Supply System

The Wood River Valley is served entirely by transmission lines. There is no generation located within the Valley. Figure 4 shows the transmission system serving the Valley.

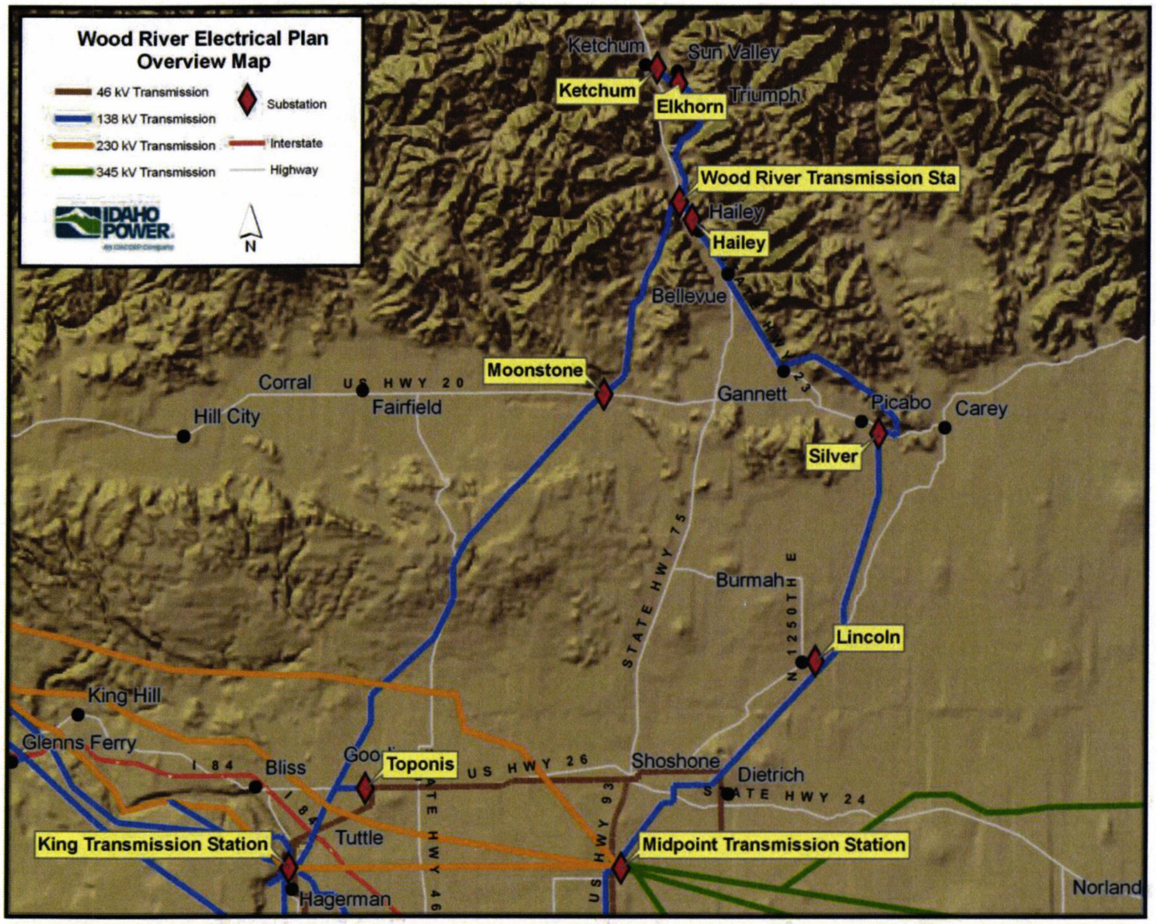

Figure 5. Wood River Electrical Plan Overview Map

There are two 138 kV transmission lines serving the Valley up to Hailey,

- King Transmission Station (KING) to Wood River Transmission Station (WDRI)
- Midpoint Substation (MPSN) to Wood Transmission Station (WDRI)

The KING to WDRI transmission line was built in 1962 and enters the Valley northwest of Hailey. It has a capacity of 105 MW. The MPSN to WDRI transmission line was put in-service in 1989 and is the stronger of the two lines, having a capacity of 120 MW. It enters the Valley east of Picabo. These two transmission lines combined are referred to as the *Wood River loop.*

From the Wood River Transmission Station in Hailey to the Ketchum/Sun Valley area, there is only one transmission line. This line was built in 1962 and has a capacity of 120 MW. Table 3 shows the technical details for these three lines.

Line	*Rating (MW)*	*Year Built*	*Historic Winter Peak Line Loading (MW)*	*Historic Winter Peak Line Loading (%)*	*Historic Summer Peak Line Loading (MW)*	*Historic Summer Peak Line Loading (%)*
MPSN-WDRI	120	1989	77	64	45	38
KING-WDRI	105	1962	58	55	36	34
WDRI-EKHN	120	1962	62	52	26	22

Table 3. Wood River Transmission System Technical Details

Note that the peak line loadings shown in Table 3 are non-coincident values. That is, these are the maximum values recorded on each individual line and were not necessarily recorded at the same instant in time. Thus, one cannot simply add the values in each column to come up with the whole Valley's peak load.

There are five substations connected to the 138 kV transmission serving the Wood River Valley. These substations reduce the voltage from 138 kV to either 12,470-volt or 34,500-volt and route the power onto distribution feeders for delivery to end users. Table 4 shows the existing peak loads on each of these six substations. Like the transmission lines shown in Table 3, the peak loads shown in the following table are non-coincident values. It should be noted that Toponis Substation near Gooding and Lincoln Substation near Dietrich are also connected to the 138 kV transmission lines serving the Wood River Valley and add to the load carried by the transmission lines. The load added by these two substations is included in the line loading shown in Table 3. There is no distribution from Wood River Transmission Station and therefore does not directly serve any load. It is purely a transmission switching station so is not included in the following table.

Substation	*Historic Winter Peak Load (MW)*	*Historic Summer Peak Load (MW)*
Ketchum (KCHM)	48	18
Elkhorn (EKHN)	12	6
Hailey (HALY)	31	18
Moonstone (MOON)	8	12
Silver (SLVR)	4.5	6.5

Table 4. Existing Substation Peak Loads

Figure 5 shows the service boundaries for the five substations serving the Wood River Valley. The boundaries described in this figure aren't static. As population and loads shift within the Valley, the load may be transferred to a substation with excess capacity to relieve a more heavily loaded substation.

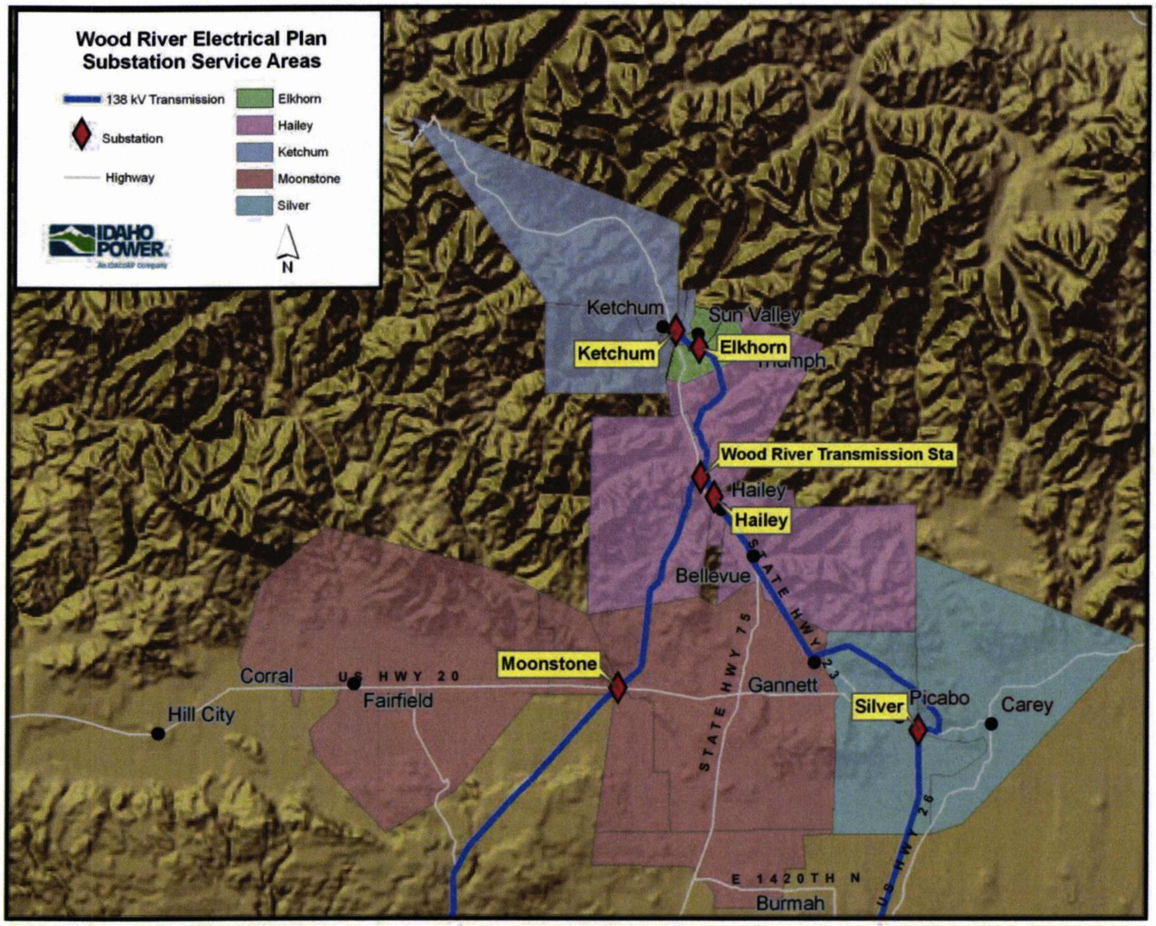

Figure 6. Existing Substation Boundaries

Existing Dependability

The southern half of the Wood River Valley, from Hailey south, is served by two 138 kV transmission lines; giving it redundant power service a majority of the year. However, the northern part of the Valley is served by a single 138 kV transmission line. When a storm or accident damages the line, there is no ability to provide power to the Ketchum/Sun Valley area. To minimize the risk of a catastrophic long term outage and to serve increasing population and electrical demand, it is increasingly important to provide a second power source to the northern part of the Wood River Valley in order to maintain electrical dependability.

Because the transmission lines serving the Wood River Valley are not part of the bulk power system, Idaho Power is not mandated by federal or state regulators to provide a fully redundant power supply. However, in accordance with Idaho Power's internal planning standards, the Wood River transmission supply is designated as an *improved radial* system. This means that:

- If both 138 kV transmission lines serving from the south into Hailey are in-service, they must be able to serve the most extreme peak at all times.

- If the weaker line is out-of-service (King Transmission Station to Wood River Transmission Station), the remaining line must be able to serve a load level that is experienced, or exceeded, less than 10% of the time.

- If the stronger line is out-of-service (Midpoint Substation to Wood River Transmission Station), the remaining line service capacity may limit the ability to serve the load. If this were to occur when loads in the Valley were high (a cold winter day), it would likely result in some Valley electrical load being interrupted via rotational outages.

Figure 6 is a load duration curve that gives an hourly breakdown of the recorded load values for the Wood River transmission loop for an entire year: March 1, 2006 through February 28, 2007 or 8,760 hours.

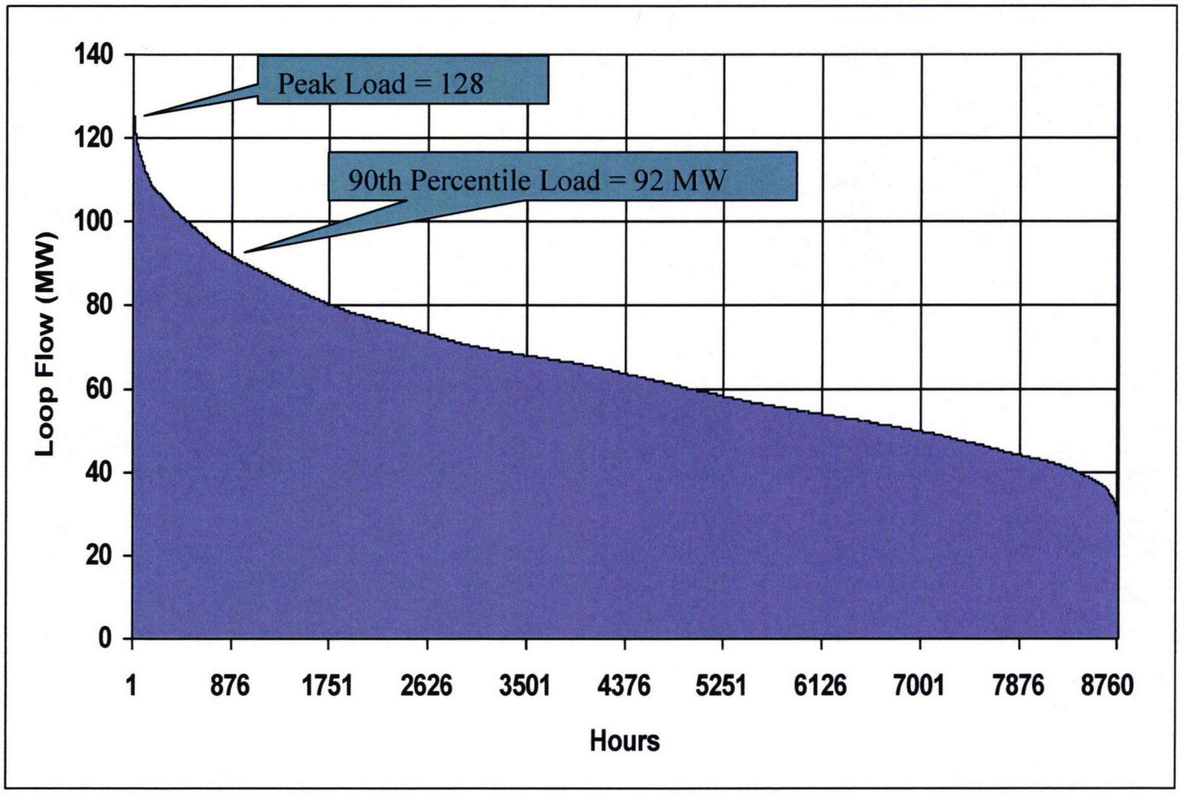

Figure 7. Load Duration Curve for Wood River Loop Transmission

In accordance with the second bullet above, the Midpoint Substation (MPSN) to Wood River Transmission Station (WDRI) line must be able to serve the entire load 90% of the year since it is the stronger line. The peak load recorded on both the lines serving the Valley combined between March 1, 2006 and February 28, 2007 was 128 MW (includes load outside the Wood River Valley served by these two transmission lines). As can be seen in the above figure, the load is 92 MW or less for 90% of the year. This is the load the Midpoint Substation to Wood River Transmission Station line must be able to carry by itself. Currently, the Midpoint to Wood River line has sufficient capacity to meet Idaho Power's improved radial reliability criteria since it has a capacity of 120 MW and the 90% load is only 92 MW. However, it will not be long before it will not meet the reliability criteria due to Valley load growth. In fact, the 90th percentile load grew from 88 to 92 MW in just one year's time. Since 2006, the MPSN – WDRI transmission line (stronger line) has not had enough capacity to serve the entire electrical load should the weaker line be out-of-service during the extreme peak loads of winter, though this only occurs for a very few hours.

Up to 13 MW of load would have to be curtailed in the case where the MPSN – WDRI line is out-of-service during extreme winter peak because the weaker line (KING – WDRI line) can only carry 105 MW. Again, with the peak load growing, the amount that would require curtailing goes up every year.

Obviously, if the transmission line serving from Wood River Transmission Station north to Ketchum/Sun Valley (KCHM) is taken out-of-service, there would be no way to serve most of the load in the Ketchum/Sun Valley area. A small amount of load could be served via distribution feeders from Hailey Substation. If this line was out in the middle of the winter, it could take a significant amount of time to repair, resulting in a long power outage to the Ketchum/Sun Valley area. Because of the potential hardships an outage of this line could cause to the citizens and businesses of the north Valley, Idaho Power maintains and patrols this line to a significantly higher degree than it does most other transmission lines in the Idaho Power system. Table 5 gives a breakdown of outages that have occurred on all three Wood River Valley transmission lines during the past 10 years (1996 – 2006)

Type and Cause of Outage	*MPSN-WDRI*	*KING-WDRI*	*WDRI-KCHM*
Total Sustained Outages	**13**	**24**	**4**
Caused by Weather	8 (62%)	5 (21%)	1 (25%)
Caused by Range Fires	3 (23%)	1 (4%)	0
Caused by Maintenance	2 (15%)	18 (75%)	2 (50%)
Caused by Equipment Failure	0	0	1 (25%)
Total Momentary Outages	**26**	**46**	**4**
Caused by Weather	8 (31%)	12 (26%)	4 (100%)
Caused by Range Fires	0	2 (4%)	0
Caused by Maintenance	1 (4%)	20 (43%)	0
Unknown Cause	17 (65%)	12 (26%)	0

Table 5. 10-Year Outage History for Transmission Lines in the Wood River Valley

Appendix C – Committee Process and Input

Community Advisory Committee meetings started in January 2007 with a bus tour of Idaho Power facilities. The bus tour began a series of primarily educational meetings that were held monthly through March 2007. Through these educational sessions, the CAC was introduced to electrical generation, substations, transmission, demand-side management, and regulatory affairs. Additionally, the CAC was presented with a view, from production to delivery, of Idaho Power's electrical system. Using the education gained from the meetings held between January and March, the CAC set to work in April and May to lay out proposed Wood River Valley transmission line routes and substation sites. Idaho Power engaged KMP Planning of Twin Falls to facilitate the CAC meetings.

Alternative Energy Generating Technologies

During the initial committee meeting, a presentation was given by Idaho Power that discussed various alternative energy generation technologies that could deliver energy to the Wood River Valley and thus displace the need for additional power lines. The technologies discussed included wind turbines, photovoltaic (solar), combustion turbines and fuel cells.

Wind Turbines – While wind turbines are becoming an important resource throughout the United States, their use in the Wood River Valley is probably not viable:

- The wind speed in the Valley is generally too low to allow the turbines to produce much usable energy.
- There is very limited space in the Valley for wind turbines.
- Even if the turbines were useable in the Wood River Valley, electrical transmission would still be required to deliver the energy to the end users.

In the Hagerman area, about 60 miles southwest of Hailey, there is a 10 MW wind turbine plant that went into operation in 2005. There are also many other wind turbine power plants proposed and in the process of being installed in southern Idaho. Of course, to receive the energy produced by these facilities requires transmission so they do nothing to reduce the need for transmission infrastructure.

On a smaller scale, residential size wind turbines mounted on houses and businesses could provide energy that could displace utility infrastructure, though again, the wind speed and its constancy is very low in the Wood River Valley. It would be up to the local residents and governments to make small scale wind turbines a reality in the Valley.

Photovoltaic – The number of sunny days that the Wood River Valley sees every year would seem to indicate that it would be an ideal location for photovoltaic use. On a large scale, however, solar energy sites would suffer from the same negatives that wind turbines do:

- There is very limited space in the Valley for a large solar generating plant.
- Even if a large solar plant were useable in the Wood River Valley, electrical transmission would still be required to deliver the energy to the end users.

But, like wind, residential and commercial size photovoltaic panels could certainly be installed and could displace the need for more utility infrastructure. Again, this would be up to the residents, businesses and local governments to bring it to fruition.

Geothermal – There are credible geothermal resources within the Wood River Valley and the immediate vicinity. While much of the geothermal is a lower temperature and thus not usable for power generation, there is some that likely is. In fact, there is at least one proposed geothermal power generation project located near to the Valley. The nearest developed geothermal power generating resource is the Raft River Project located near Raft River, Idaho. Idaho Power purchases the output from this plant.

If a geothermal facility was developed near the Wood River Valley, it would still require electrical transmission to deliver the energy to Valley residents.

Fuel Cells – Used in a distributed manner among homes and businesses, fuel cells could displace the need for additional transmission in the Wood River Valley. There are some drawbacks that will take a few years to overcome:

- Residential-size fuel cell systems are not currently commercially available, though there are a number of companies aggressively working towards that goal.
- Fuel cells require an outside fuel source, whether it is natural gas, methanol or pure hydrogen. Unless the fuel cell is fueled by pure hydrogen, there are some emissions that result from making electricity using a fuel cell.

Like the other alternative generating resources mentioned above, it will be up to the local population and governments to enable widespread use of fuel cells in the Wood River Valley.

Combustion Turbines – Based on the same technology used in aircraft jet engines, combustion turbines could certainly be used to provide energy to the Wood River Valley. Idaho Power installed a 50 MW combustion turbine that was fueled by natural gas and oil in Hailey in the early 1970s and was used primarily for dependability purposes to back up the then single transmission line serving the Wood River Valley. Once the second transmission line to Hailey was built in 1987, the combustion turbine was deemed unnecessary and was removed. By that time, it was becoming difficult to operate the turbine due to emissions limits for air quality purposes and the difficulty in fueling the turbine. The community was also unhappy about the noise this turbine emitted while operating.

Through the early meetings, the Committee was opposed to siting a new combustion turbine generator in the Wood River Valley to meet the electrical needs. In April, a committee member did bring up the idea that Idaho Power should investigate installing a natural gas fired combustion turbine in the Ohio Gulch area. After a lengthy discussion, the Committee determined that a combustion turbine generator would not be feasible for use in the Valley for the following reasons:

- The cost of a generating station adequate to provide full redundancy to the existing transmission would be over $50M. This number would more than double to provide redundancy at buildout.
- A combustion turbine for use in the Wood River Valley would need to be fueled by natural gas (for emissions purposes). The existing natural gas supply to the Valley is inadequate to fuel a turbine and a new pipeline would be needed. Even using natural gas, the Idaho Department of Environmental Quality would likely impose severe operating limits on the turbine due to the inability for the emissions to dissipate given the small width of the Valley. It was suggested that perhaps methane gas produced by the dairies in the Magic Valley could be piped into the Wood River Valley.

- A natural gas-fired combustion turbine experiences significant reduction in efficiency as the altitude increases. Unlike a liquid-fueled jet engine (aircraft engine), natural gas must be compressed for use in the turbine and at higher altitudes it takes more energy for the compression process.
- While quieter than many generating technologies, there would still be noise issues in the Wood River Valley that would have to be overcome.
- A large combustion turbine has some water requirements and it might be difficult to obtain water rights in the Wood River Valley.

Energy Efficiency

Another way to reduce the need for additional transmission resources in the Wood River Valley would be to aggressively pursue energy efficiency technologies or in utility terms, demand-side management (DSM). Idaho Power is currently providing many programs funded by a Customer Conservation Charge to customer bills that promote the use of DSM to reduce electricity usage. Idaho Power's 2004 Integrated Resource Plan (IRP) called for an average of 41 megawatts of energy savings due to DSM by 2014. The 2006 IRP calls for an average of 90 megawatts of energy savings due to DSM by 2024. Table 1 shows the current Idaho Power programs. The Idaho Power Website at www.idahopower.com contains full descriptions of these programs.

Residential	***Commercial/Industrial/Irrigation***
A/C Cool Credit	Irrigation Peak Rewards
Weatherization Assistance	Irrigation Efficiency
Rebate Advantage	Building Efficiency
Energy Star® Homes	Easy Upgrades
Energy Star® Lighting	Customer Efficiency
Energy House Calls	

Table 6. Idaho Power Demand Side Management Programs

Additionally, Idaho Power currently has rates that vary by season, with summer electricity rates being higher than winter rates in order to encourage lower energy use in the summer when the overall electricity usage on the Idaho Power system is highest. In the Wood River Valley, these seasonally varying rates do nothing to reduce power usage when the reduction is needed most…in the winter.

Idaho Power is also investigating using time-of-day pricing and critical peak pricing that would encourage customers to use less energy during the peak times (such as late afternoon and early evening).

Idaho Power Company Energy Efficiency activity and Programs in the Wood River Valley

Idaho Power offers ten distinct Energy Efficiency programs in the Wood River Valley as well as throughout most of its service territory. A listing of each program follows with a brief description of each. More information of each of the programs can be found at www.idahopower.com/energycenter.

Residential Programs:

- **ENERGY STAR® Homes Northwest**
  A $750 incentive is paid to builders for each home built to the ENERGY STAR® standards. These standards are 30 percent more efficient than one built to the Idaho building code.
- **Energy House Calls**
  This program offers a free package of services (inc. duct sealing) designed to help save energy for residents of manufactured homes heated by an electric furnace or heat pump.
- **Rebate Advantage**
  This program offers $500 payment to Idaho Power customers who purchase a new ENERGY STAR® manufactured home.
- **Weatherization Assistance for Qualified Customers**
  This program offers free weatherization measures for electrically heated homes of qualified customers to help them maintain a comfortable and efficient home environment.
- **ENERGY STAR® Lighting**
  This program is a specialty bulb promotion offered in conjunction with BPA (Change a Light, Change the World) to provide a buy-down of bulbs at large retailers. Future programs offer promotions of other bulbs at various retailers.
- **Heating and Cooling Efficiency Program**
  This program provides cash incentives to residential customers (and HVAC contractors) for choosing and installing qualified energy-efficient heating and cooling equipment and services through approved HVAC contractors

Commercial and Industrial Programs:

- **Custom Efficiency**
  This program offers financial incentives for large commercial and industrial energy users with large and complex projects to improve the efficiency of their electrical systems or process.
- **Building Efficiency**
  This program offers incentives of up to $100,000 designed to offset part of the additional capital expenses for more efficient lighting and cooling designs in small and mid-size commercial construction projects
- **Easy Upgrades**
  This program offers Incentives of up to $100,000 for a menu of simple commercial, industrial building retrofit projects. Incentives are available for lighting, HVAC, motors, building shell, plug loads and grocery refrigeration and are based on each measure's assumed energy savings.

Agricultural Programs:

- **Irrigation Efficiency Rewards**
  This program offers an incentive which pays up to 75 percent of the cost for irrigation customers who improve the energy efficiency of an existing pump system or up to 10 percent when installing a new efficient system.

- **Irrigation Peak Rewards**
  This program offers a demand credit for specific irrigation customers who allow Idaho Power to use electric timers to turn off their pumps for a few hours on selected summer days reducing afternoon peak demand and lowering the customer's electric bills.

Wood River Valley projects:

Although Idaho Power doesn't commonly track Energy Efficiency programs specifically by area or city, a manual examination of the Energy Efficiency incentive records show that from 2005 to October 2007 Idaho Power has identified 24 individual projects completed in the Wood River Valley area. These projects were completed in Ketchum, Bellevue, Hailey, Sun Valley, Fairfield, Carey, and Picabo. Four projects were under the Custom Efficiency Program. One project was completed under each of the Building Efficiency, Easy Upgrades and Rebate Advantage programs and seventeen projects were completed under the Irrigation Efficiency Rewards program. Idaho Power paid a total of $130,290 dollars in incentives for an annual energy savings of approximately 1,342,602 kilowatt hours (kWh) and 155 kilowatts (KW) in demand savings for the non-irrigation programs. Under the Irrigation Efficiency Rewards program, Idaho Power paid $28,637 in incentives for an annual savings of approximately 205,717 kWh and about 57 savings in KW.

There are many other activities in addition to those sponsored by Idaho Power that customers could undertake to reduce their energy use and, like the alternative generating resources discussed previously, it will be up to the local residents, businesses and governments to make them a reality.

Transmission Characteristics

The Committee was provided with costing for various voltages of transmission. Table 7 shows these costs. Note that right-of-way widths provided are for total right-of-way requirements, not width from center line. Appendix J shows photographic examples of the types of overhead transmission towers referenced in Table 7. The transmission line cost on a per mile basis does not include right-of-way cost.

Voltage	*Type*	*$/mi*	*ROW (ft)*
230,000 V	Overhead, H-Frame	$350,000	120
230,000 V	Overhead, Single Pole	$400,000	70
138,000 V	Overhead Single Pole (low profile)	$200,000	50
138,000 V	Underground	$3,000,000	12
69,000 V	Overhead, Single Pole	$175,000	40
69,000 V	Underground	$2,700,000	12
35,000 V	Overhead, Single Pole	$150,000	30
35,000 V	Underground	$1,500,000	12

Table 7. Estimated Transmission Costs for Various Voltage Levels

A CAC member asked if the maintenance costs between overhead and underground transmission differed significantly. Since Idaho Power has no experience with underground transmission this question was asked of cable manufacturers and other utilities. Maintenance practices at the various utilities surveyed differed greatly and there was not much in common between them. In most cases, the maintenance is quite conservative because the effect of a catastrophic failure on an underground cable is so great. And the cable manufacturers also recommended an aggressive maintenance approach. This conservative approach is quite costly and causes the maintenance costs for underground transmission to be approximately equivalent to that of overhead.

Goals Document

The first step in developing proposed solutions to the electrical needs of the Wood River Valley was to develop a goals document that could be used to guide the committee's efforts to develop and evaluate alternatives. The goals were divided into 6 areas:

- **Reliable Power:** Provide reliable power to the entire Wood River Valley
  - *Provide redundant transmission facilities throughout the Wood River Valley*
  - *Provide sufficient reliable, quality power necessary to support the Valley's current and future business and economic activities*
  - *Include Lincoln and Camas counties' electricity needs*
- **New Infrastructure Design:** Develop new transmission and delivery infrastructure as appropriate when providing for current and future power needs
  - *Optimize the use of existing infrastructure; increase use or upgrade as feasible*
  - *Implement feasible mechanical alternatives to new transmission or delivery systems to provide redundancy*
  - *Identify and utilize alternative and renewable sources of power that minimize the need for new transmission/delivery infrastructure*
  - *Plan and implement infrastructure improvements that integrate with future system development*
  - *Explore and implement new power system technologies as feasible and appropriate*
- **Energy Conservation:** Implement programs that reduce demand for additional energy
  - *Implement feasible "Demand Side Management" programs to reduce power demand as a portion of an overall solution to meet the Valley's energy needs*
  - *Optimize the use of existing "conservation" programs as feasible to reduce power demand*
  - *Develop new "conservation" programs with education, as feasible and supported by Valley residents*
- **Environment:** Cause no or minimum impacts to the natural, physical, cultural, historic, social and aesthetic environment due to development and operation of power facilities and delivery systems
  - *Utilize existing/shared utility and transportation corridors where feasible*
  - *Site new corridors that have no or minimal impact on the environment*
  - *Preserve the Wood River Valley's aesthetic and scenic qualities*
- **Political Support:** Develop solutions that are politically supported throughout the Wood River Valley
  - *Address individual and collective political concerns for design, operation, siting and funding*
  - *Integrate WREP recommendation into local land use plans; comply with local plans if possible*
  - *Consider the least obtrusive and least objectionable option to enhance opportunity for public support and implementation*
- **Cost Effectiveness:** Develop solutions that are cost effective and provide associated benefits
  - *Implement solutions that are affordable to construct*
  - *Implement solutions that are affordable to operate and maintain*
  - *Cause no or minimum rate increases to support new infrastructure/system improvements*
  - *Minimize local public or private funding participation or support new or upgraded infrastructure*
  - *Implement solutions that have available public or private funding where required*

The CAC also came up with a list of siting criteria. These criteria may not all be completely achievable, but they are measures to be strived for when developing and evaluating alternatives.

- **Wood River Transmission Station (WDRI) North**
  - *Provide both redundancy and capacity to meet electrical needs north of WDRI*
  - *Do not use the existing 138 kV transmission corridor without new technology to avoid new impacts*
  - *Preserve the scenic corridor*
  - *Maintain the ordinance-required 150 ft setback from residences when using overhead transmission lines*
  - *Conform to existing hillside ordinances*
  - *Install underground lines in locations where the necessary additional funding is available.*
- **Wood River Transmission Station (WDRI) South**
  - *Provide electrical infrastructure and systems that meet Lincoln County electrical needs*
  - *Improve structures and transmission lines in Lincoln County as needed to accommodate future growth*
  - *Maintain scenic corridors*
  - *Cause no environmental impact to wetlands and habitat*
  - *Use existing corridors and transmission equipment where possible*
  - *The use of overhead lines and infrastructure is acceptable until the affected community can afford to fund a different proposal*
  - *Maintain or reduce pole size in Bellevue*

Load Blocks

The CAC was provided with a series of load blocks to help them determine the amount of transmission to allocate for buildout needs. Figure 7 is a geographic based depiction of these load blocks with no transmission lines connected.

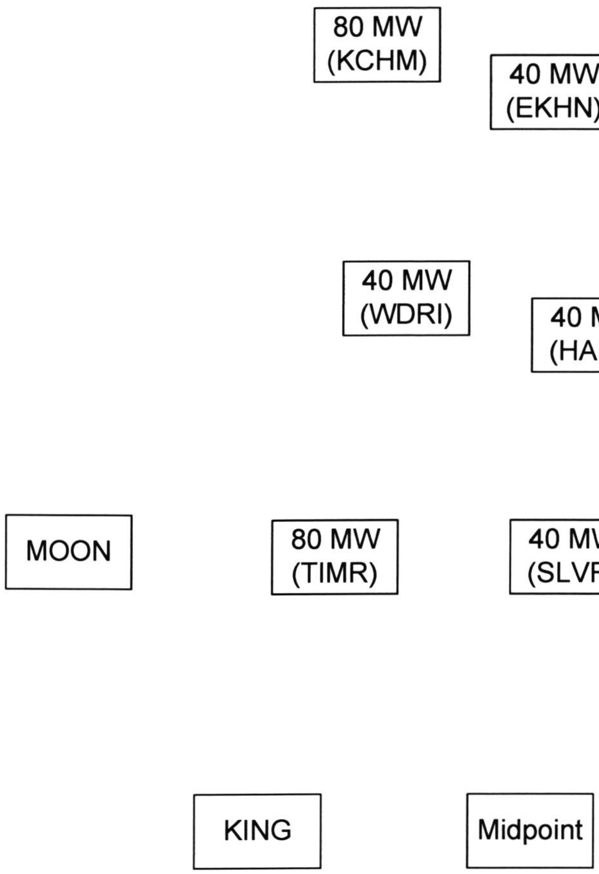

Figure 8. Load Blocks with no Transmission

Figure 7 shows a total of nine substations associated with the Wood River Valley. King and Midpoint Substations are shown for reference as the originating point for power fed to the Valley. A new substation called Timmerman Substation (TIMR) is shown with the assumption that at buildout, the Valley will require at least one additional substation in order to serve the load. In this figure, no load is assigned to Moonstone Substation (MOON) because at buildout this substation will only serve load in the area of Magic Reservoir and Camas County, thus it is not part of the committee's assignment other than to allocate sufficient southern transmission to serve it.

Figure 8 builds upon the previous figure by adding southern transmission sufficient to serve the entire Valley load from Timmerman Hill north. Note that the following figures or transmission configurations were only used as an example for discussion and not as a recommendation by Idaho Power. The committee was encouraged to be creative in how they recommended serving the Wood River Valley load at buildout.

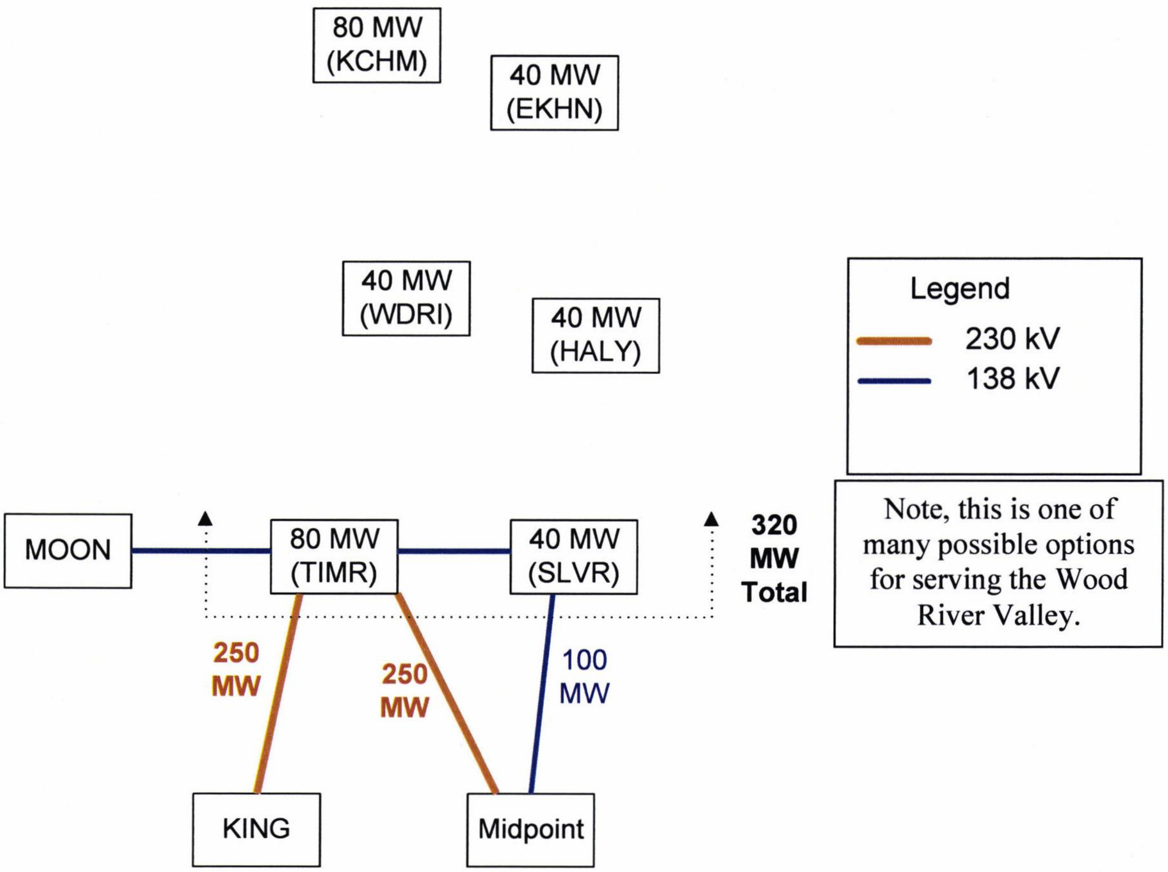

Figure 9. Load Blocks with Example Southern Transmission

In the figure above, two 230 kV transmission lines are constructed from King and Midpoint Substations to the new Timmerman Substation. Additionally, one 138 kV transmission is installed from Midpoint to Silver Substation. These three transmission lines would provide both adequate capacity and adequate dependability to serve the Wood River Valley load at buildout.

In Figure 9, a number of 138 kV transmission lines are added to provide for the entire 350 MW buildout load.

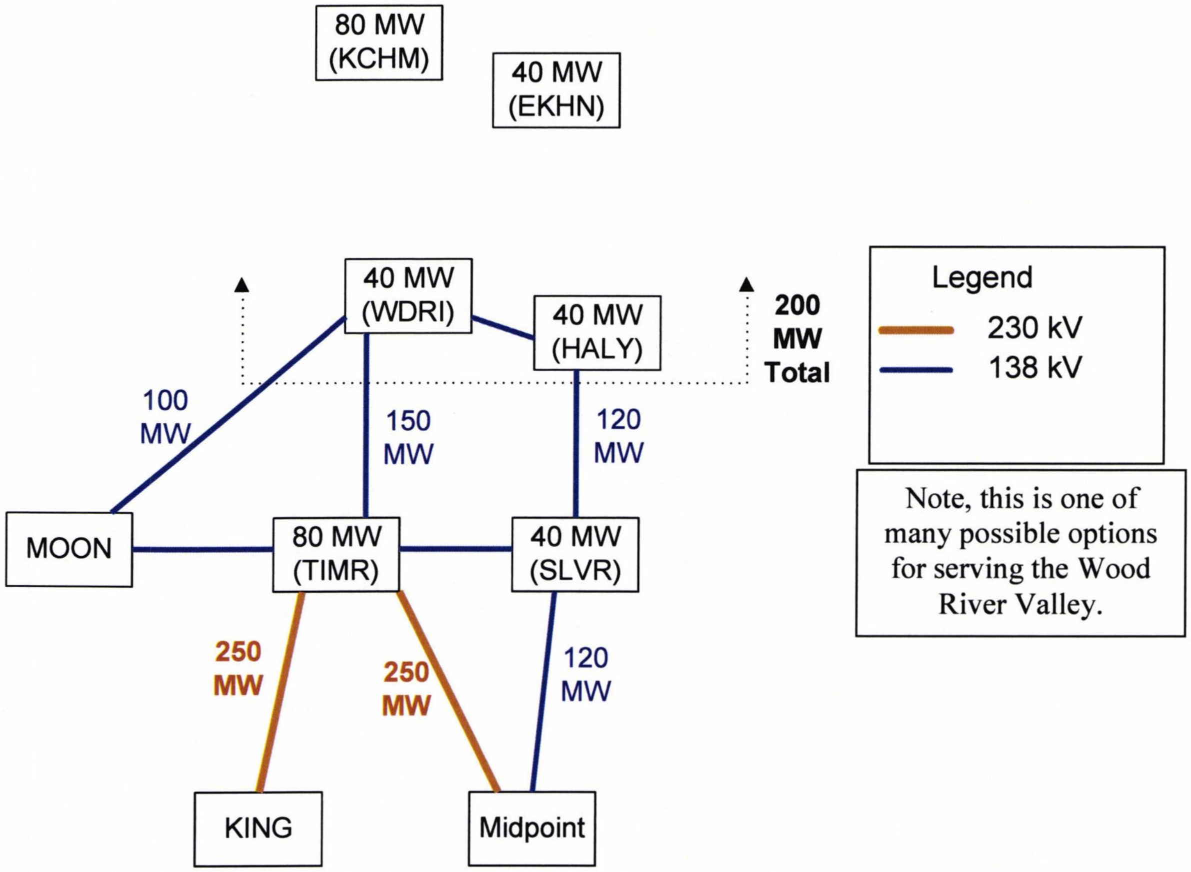

Figure 10. Load Blocks with Example Mid-Valley Transmission

The above figure shows 138 kV transmission interconnecting Moonstone, Timmerman and Silver substations and then serving into the Valley at 138 kV to Wood River and Hailey substations. Three transmission lines are shown serving into Wood River and Hailey substations to provide fully redundant supply to the Valley. That is, the three transmission lines provide sufficient capacity such that if one of the three is out, the remaining two transmission lines can carry the entire load.

Figure 10 adds two 138 kV transmission lines serving north from Hailey into the Ketchum/Sun Valley area. Again, these two transmission lines have sufficient capacity to provide fully redundant power to the buildout Ketchum/Sun Valley loads.

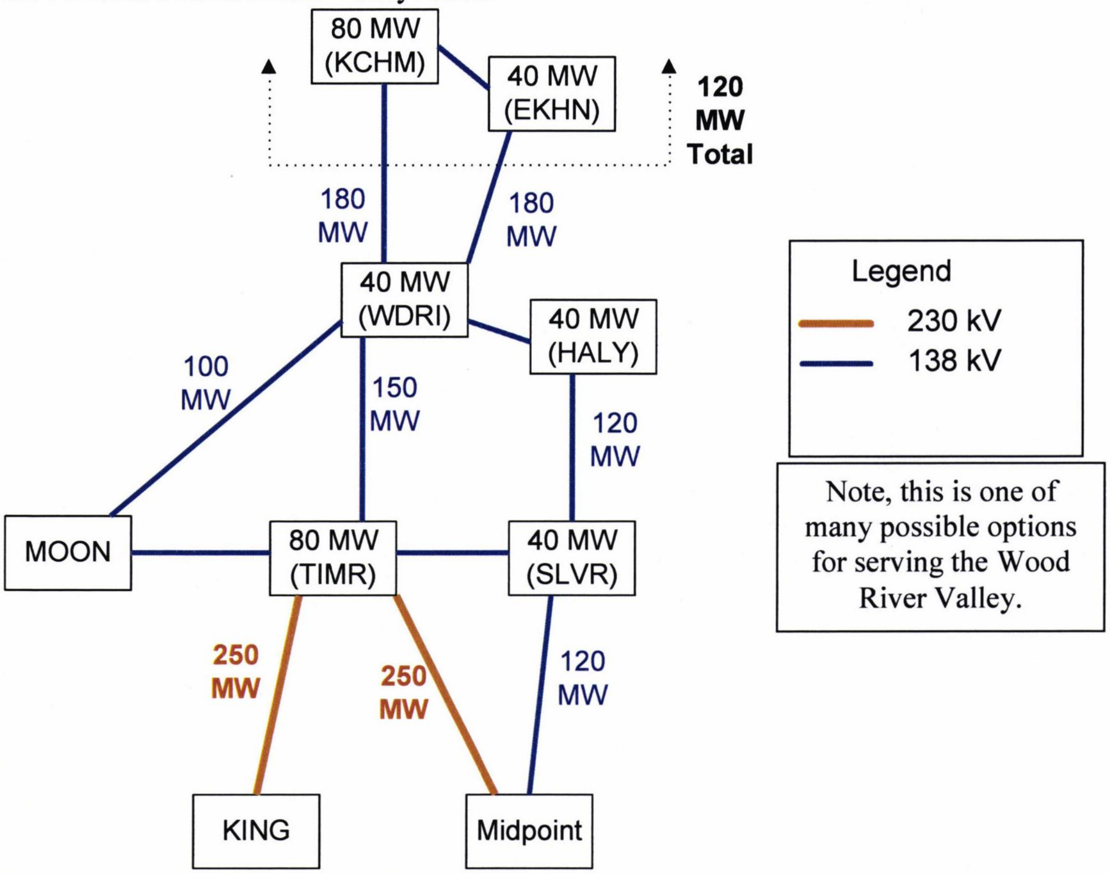

Figure 11. Load Blocks with Example North-Valley Transmission

Mapping Exercise

Using the education provided in January through March and the goals developed in March and April, the CAC set to work in April laying out proposed Wood River Valley transmission routes and substation locations. The CAC also used the load block diagrams to aid them in determining the size of lines needed to support the Valley's load.

The committee was broken into three groups; each group was given a large aerial photograph showing the terrain from Ketchum in the north to Midpoint and King Substations in the south. Using the goals and siting criteria as a guide, each group developed feasible alternatives to meet buildout requirements. The following guidelines were used in forming the small groups:

- Groups were designated "A, B and C" for alternative discussion purposes
- Each group included committee members from throughout the planning area
- Each group included an Idaho Power representative to provide technical support and a facilitator to capture the details for each of the alternatives

Group A Mapping Results

Group A, which consisted of five members, created a total of four alternatives. The first two alternatives covered the area from Timmerman Hill south while the second two alternatives covered from Timmerman Hill north. Appendix C contains notes taken from Group A during the mapping exercise. Appendix D contains larger, more readable versions of the following maps.

Group A – Alternative 1

This alternative covers transmission from Midpoint and King Substations in the south to Silver, Moonstone and Timmerman substations in mid-Valley and onto the Wood River Transmission Station in Hailey. It would build a new Timmerman Substation near the existing Idaho Transportation Department's Timmerman rest area and connect it to both Moonstone and Silver substations using 138 kV transmission. It would convert the existing Midpoint to Silver 138 kV transmission line to 230 kV and also convert the existing King to Moonstone 138 kV transmission line to 230 kV.

The 138 kV transmission from Moonstone Substation to Wood River Transmission Station and from Silver Substation to Wood River Transmission Station would be improved to increase their capacity each to 200 MW.

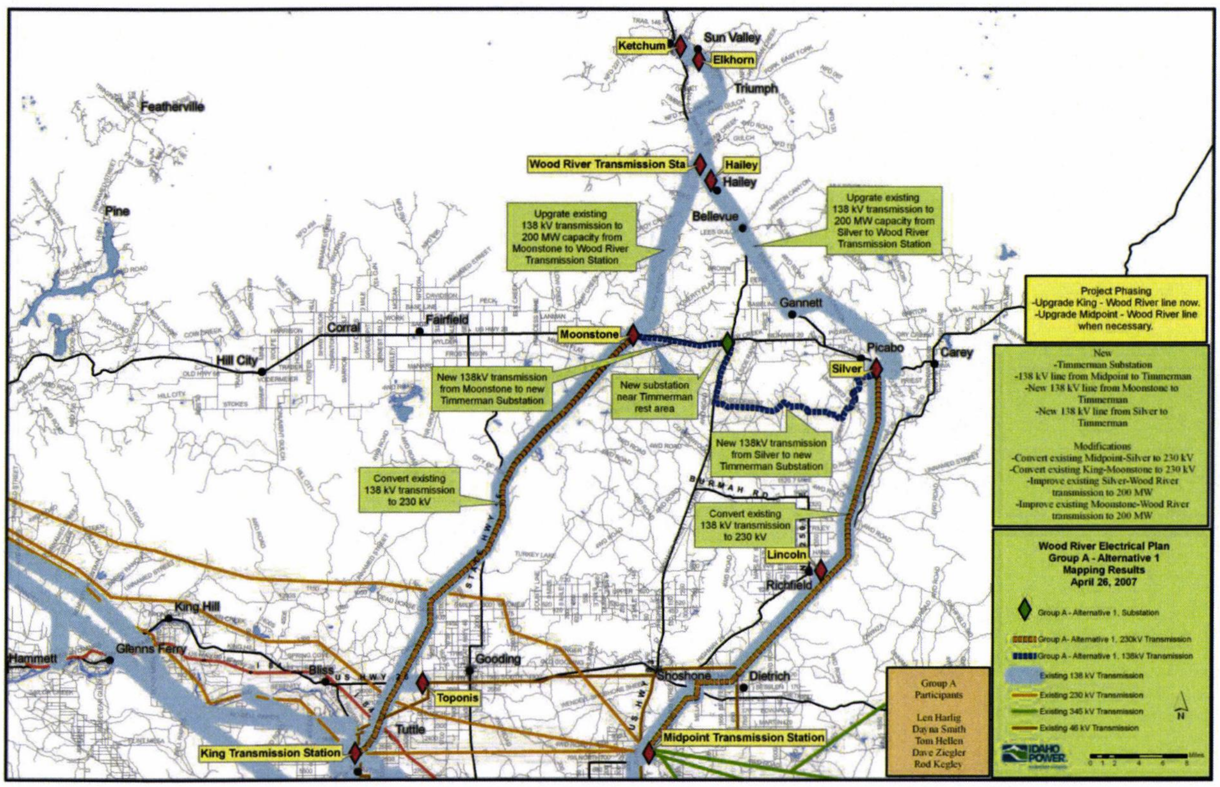

Figure 12. Group A - Alternative 1 Mapping Results

Group A – Alternative 2

Group A – Alternative 2 builds a new Timmerman Substation near the existing Idaho Transportation Department's Timmerman rest area and connects it to both Moonstone and Silver substations using 138 kV transmission. It would improve the existing King Substation to Wood River Transmission Station transmission line to 200 MW. The 138 kV transmission from Silver Substation to Wood River Transmission Station would be improved to increase its capacity to 200 MW.

This alternative would also build a new 138 kV transmission line from Midpoint Substation to the new Timmerman Substation routed approximately parallel to Highway 75.

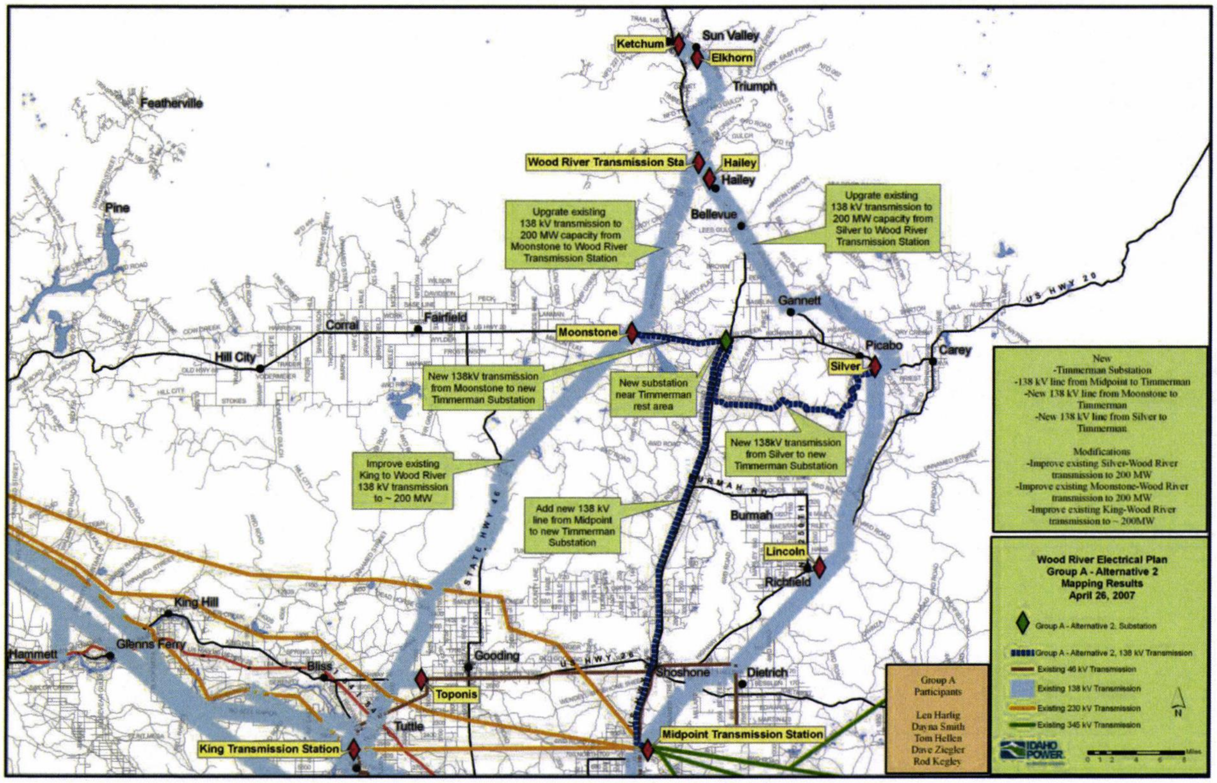

Figure 13. Group A - Alternative 2 Mapping Results

Group A – Alternative 3

This alternative installs a new 138 kV transmission underground from Wood River Transmission Station to Ketchum Substation, following Highway 75 north from Hailey to the Ketchum city limits. Group A did not specify a route through the City of Ketchum to Ketchum Substation, leaving that to the City of Ketchum to determine.

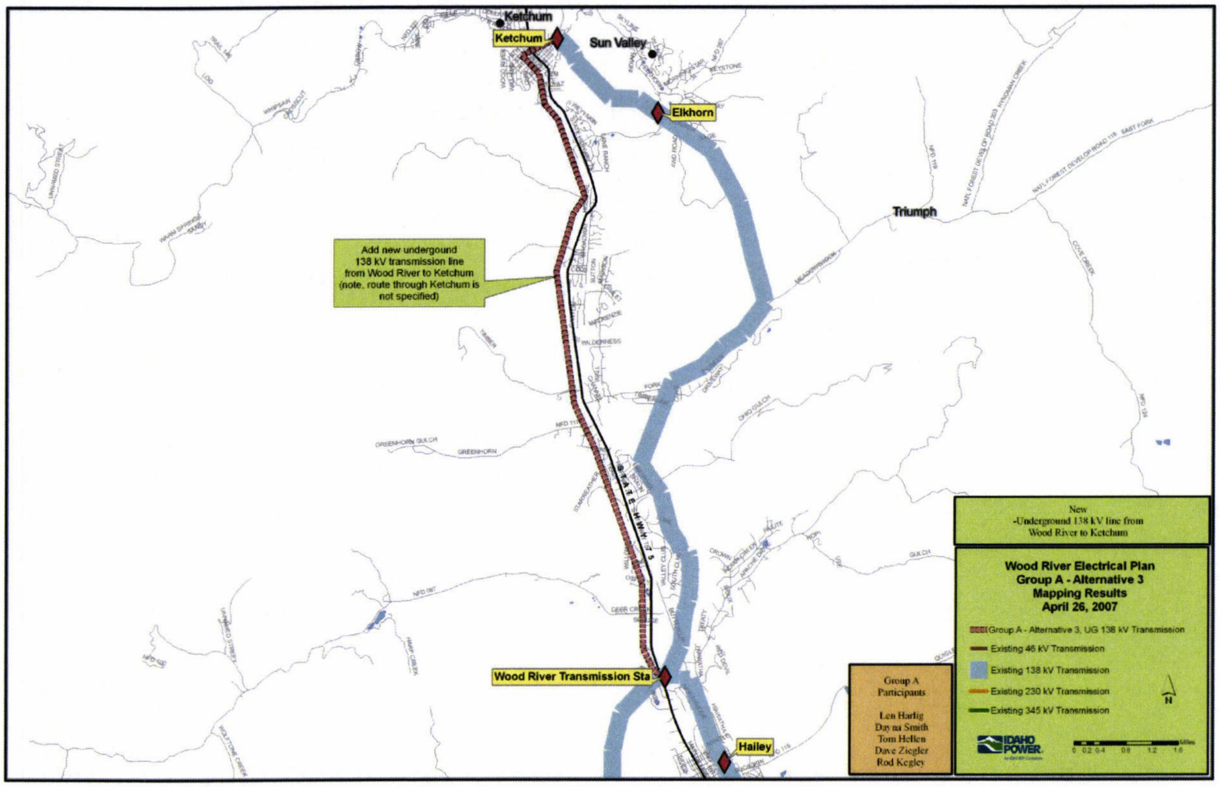

Figure 14. Group A - Alternative 3 Mapping Results

Group A – Alternative 4

In this alternative, Group A proposes to add a new overhead 138 kV transmission line from Wood River Transmission Station to the Ketchum City Limits, in the same right of way as the existing distribution circuits. From the Ketchum City Limits to Ketchum Substation, the line would be underground. Again, Group A did not specify a route through the City of Ketchum to Ketchum Substation, leaving that to the City of Ketchum to determine.

Additionally, this alternative specifies that the existing distribution circuits along Highway 75 between Hailey and Ketchum be put underground with the assumption that placing a distribution circuit underground costs much less than placing 138 kV transmission underground.

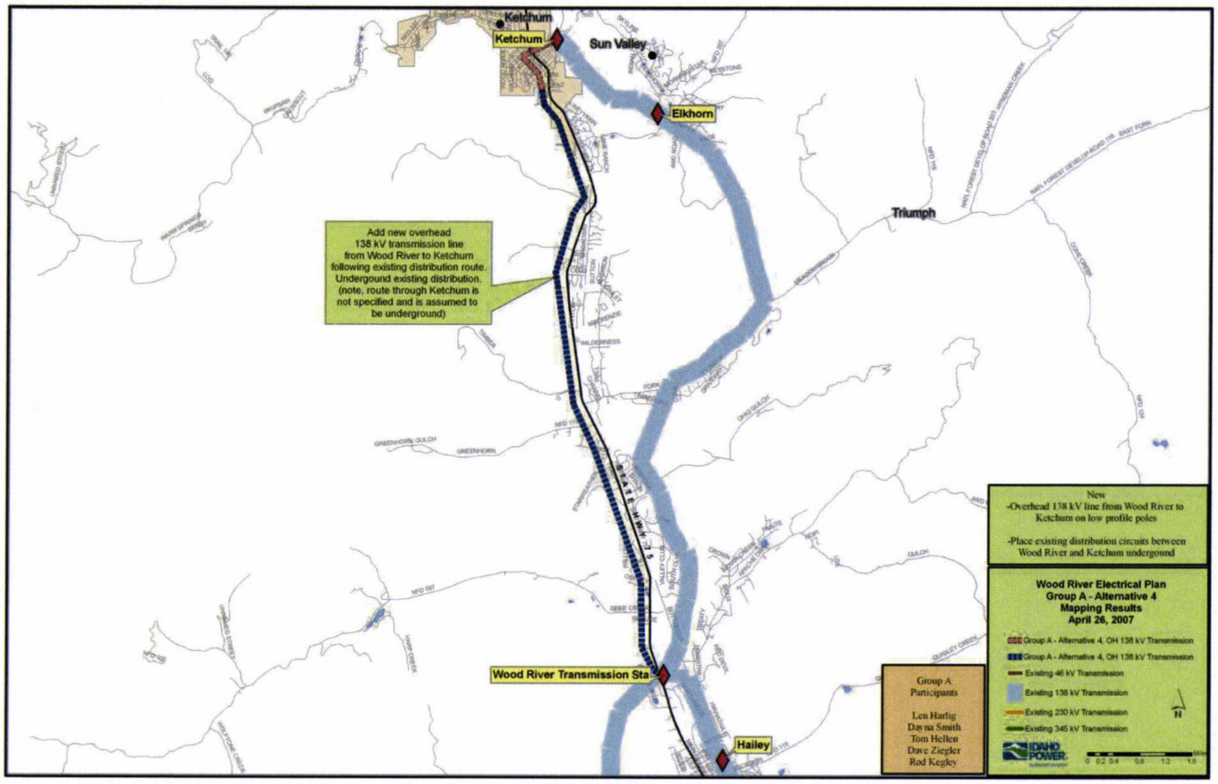

Figure 15. Group A - Alternative 4 Mapping Results

Group B Mapping Results

Group B, which consisted of five members, created one alternative – Alternative 1 – that was all-inclusive of the area from Midpoint and King Substations to Ketchum Substation. Appendix C contains notes taken from Group B during the mapping exercise. Appendix D contains larger, more readable versions of the following map.

Group B's alternative would convert the existing 138 kV transmission from King Substation to Moonstone Substation to 230 kV. It would install a new Timmerman Substation south of Timmerman Hill along Highway 75. It would then install a new 230 kV transmission line from Midpoint Substation to Timmerman Substation and a 230 kV transmission line from Timmerman Substation to Moonstone Substation.

This alternative would install a new 138 kV transmission line from Timmerman Substation to Wood River Transmission Station then on to Ketchum, all overhead. Group B specified that the 138 kV transmission should run along Highway 75 from Timmerman Substation to Glendale Road then follow Broadford Road until Hailey. It would then run west of Hailey until it reached Wood River Transmission Station. From Wood River Transmission Station it would follow the existing distribution circuits, constructed such that the 138 kV transmission would have distribution underbuild on the same poles. The line would terminate at Ketchum Substation.

This alternative also specified that the Moonstone Substation be upgraded from 138 kV to accommodate the new 230 kV supply. Group B noted that the existing 138 kV transmission from Juniper Road near Sun Valley to Elkhorn Substation is to be placed underground (paid for by affected parties).

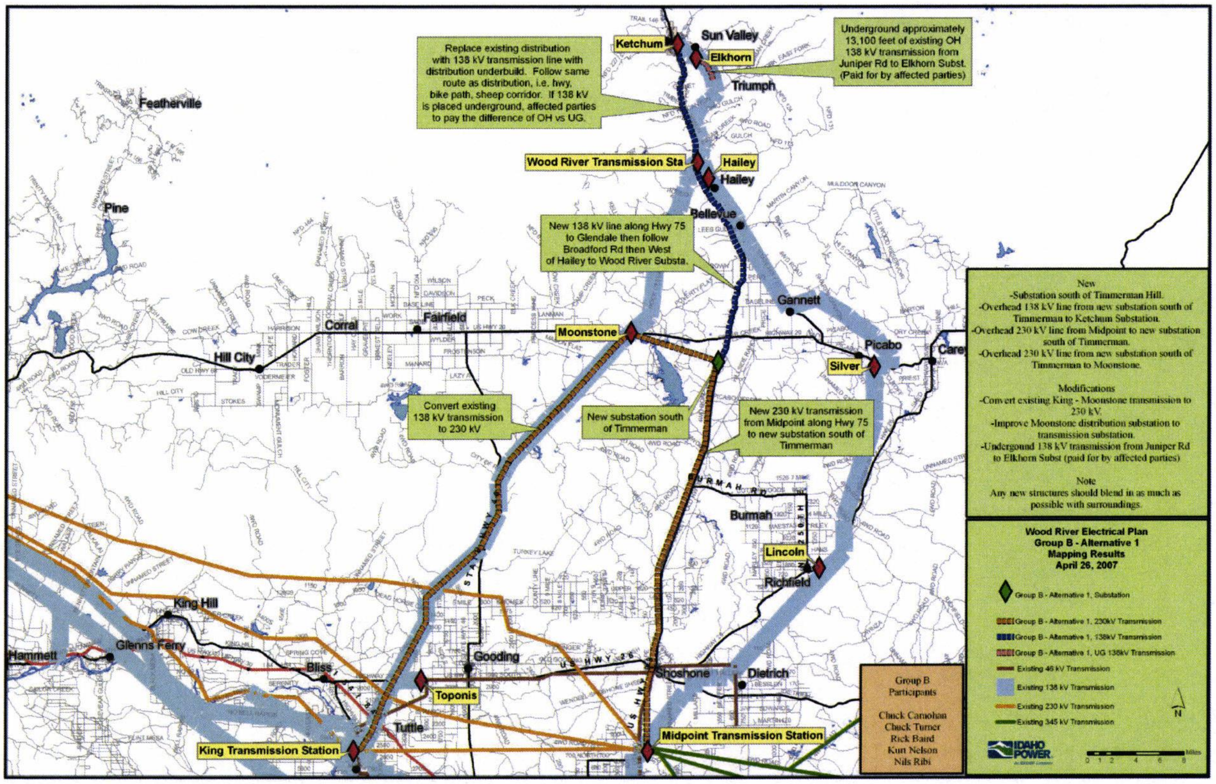

Figure 16. Group B - Alternative 1 Mapping Results

Group C Mapping Results

Group C consisted of six members. Like Group B, it created one alternative – Alternative 1 – that was all-inclusive of the area from Midpoint and King Substations to Ketchum Substation. Appendix C contains notes taken from Group C during the mapping exercise. Appendix D contains larger, more readable versions of the following map.

Group C's alternative would convert the existing 138 kV transmission from King Substation to Moonstone Substation to 230 kV. It would install a new Timmerman Substation south of Timmerman Hill along Highway 75. It would then install a new 138 kV transmission line from Midpoint Substation to Timmerman Substation and a 138 kV transmission line from Timmerman Substation to Moonstone Substation. It would also install a new 138 kV transmission line from Timmerman Substation to Silver Substation. Group C did not designate precise right-of-way routes for the transmission from Timmerman to Silver or from Timmerman to Moonstone.

This alternative would build a new transmission switching station west of Bellevue along the route of the existing King Wood River 138 kV transmission line. From this new switching station, a new overhead 138 kV transmission line would be built running along the west side of the mountains and coming out in the Cold Springs area. From the Cold Springs area it would then run underground to Ketchum Substation.

Group C's alternative would also upgrade the existing 138 kV transmission from Moonstone to Wood River to 200 MW and upgrade the existing 138 kV transmission from Silver to Wood River to 200 MW.

Group C designates that both Silver and Moonstone Substation be upgraded to 80 MW capacity. Like Group B, this group noted that the existing 138 kV transmission from Juniper Road near Sun Valley to Elkhorn Substation is to be placed underground (paid for by affected parties).

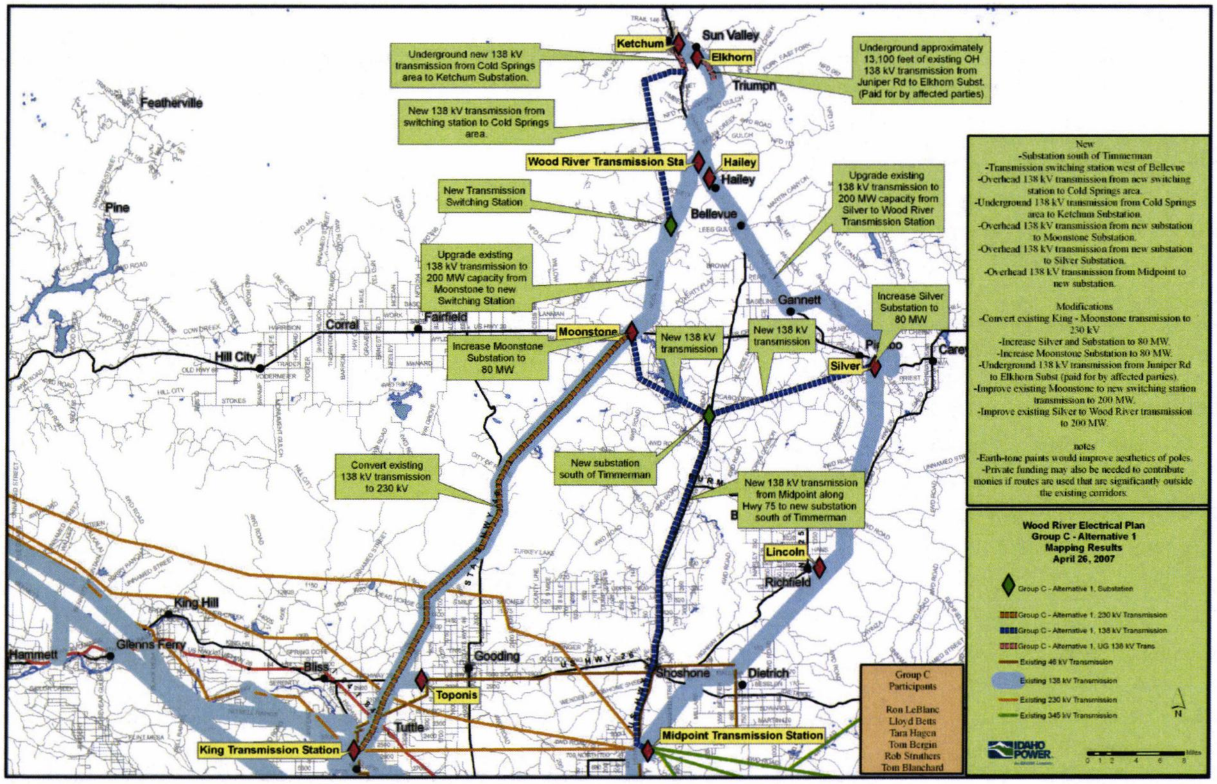

Figure 17. Group C - Alternative 1 Mapping Results

Screening Alternatives

To aid in screening the alternatives developed by the three groups, a screening matrix was developed that each CAC member could fill in to see numerically how each alternative ranked. It must be noted that a numerical screening of the alternatives is just a tool to evaluate the alternatives against one another. The final decision as to which alternative or alternatives to designate as the most feasible going forward is a consensus decision reached within the CAC.

Table 8 contains the totals for the scoring developed by the committee. Thirteen of twenty members filled out the matrix and their scores were totaled for each alternative. The categories used in the matrix came from the goals the committee had developed at an earlier meeting.

Alternatives	*Grand Total Scoring*							*Total Score*
Zone 1: South of Timmerman	*Reliable Power*	*New Infrastructure Design*	*Energy Conservation*	*Environ -ment*	*Political Support*	*Cost Effectiveness*	*Siting*	
A-1	52	42	39	42	47	31	44	297
A-2	56	35	39	30	34	42	32	268
B-1	62	39	39	39	33	53	40	305
C-1	56	39	39	34	36	51	38	293
Zone 2: Mid Valley								
A-1	56	49	39	49	49	41	44	327
A-2/C-1	53	41	39	36	39	44	38	290
B-1	59	34	39	35	23	53	32	275
Zone 3: North Valley								
A-3	58	50	39	55	46	16	50	314
A-4	55	44	39	52	39	42	42	313
B-1	58	42	39	39	35	57	38	308
C-1	53	37	39	33	34	44	35	275

Table 8. Alternatives Scoring Matrix

The committee decided to score "Energy Conservation" equally between the alternatives, hence the grand total score of 39 for each alternative. This is because energy conservation measures are not going to affect any one alternative differently than any other alternative since these are all transmission alternatives. It was decided that communities or public entities in the future may be willing to support different levels of energy conservation, which would have to be applied at the time any of the alternatives are in design or construction and could mitigate the energy demands to be met with new infrastructure.

There was some discussion regarding weighting the scores for the various categories. In the end, the committee determined that it was unnecessary to vary the category weighting since the scoring matrix is simply a screening tool and the committee may determine their preferred alternatives exclusive of the scoring matrix.

Using the scoring matrix approach, it can be seen that on a numerical basis, the alternative choices are,

- Zone 1: South of Timmerman – Alternative B-1
- Zone 2: Mid Valley – Alternative A-1
- Zone 3: North Valley – Alternative A-3 (Alternative A-4 was a close second)

Committee Alternative Consensuses

Using the results of the scoring matrix as a basis for discussion, the committee went on to reach consensus on each of the three sub-areas of the Plan; South of Timmerman, Mid Valley and North Valley.

Zone 1: South of Timmerman

The committee determined that the final Zone 1 scores in the matrix were quite similar for Alternatives B-1, A-1 and C-1 and were to close to call using the scoring. The final consensus, in preference order, for Zone 1 is as follows:

- Preferred Choice: Alternative C-1
- Second Choice: Alternative A-1
- Third Choice: Alternative B-1
- Alternative A-2 will be dropped due to the undesirable location of the new substation

The committee shared numerous comments concerning the South of Timmerman zones, which are recorded below.

- Substation placement cannot be north of Timmerman Hill crest
- Do not locate substation in the area of the potential new town (west side)
- Probably ought to avoid potential airport locations
- Might consider putting the new substation at the "square hole" on the north side of Picabo Desert Road
- Might consider old ITD material site
- Structures: Stay away from two-pole design (H-frame). Stay with single pole design. Steel poles would be preferable; less fire hazard
- South of Burmah Road, the BLM has some Wilderness Study Areas and Areas of Critical Environments Concern. The further south of Burmah Road one goes, the more difficulty BLM has with the route due to these special management areas
- Stay within existing corridors, distribution areas and highways, etc.

Zone 2: Mid Valley

The CAC consensus recommendations for Zone 2 are as follows:

- Preferred Choice: Combination/modified Alternatives C-1/A-1 (moving new substation south side of Timmerman Hill). Named Alternative C-2.
- Dropped Alternative A-2 – this is a duplicate to A-1 in Zone 2 when the location of the new substation to the south side of Timmerman Hill is moved
- Dropped Alternative B-1 – due to undesirable route along Broadford Road

A number of committee comments concerning Zone 2 are recorded below.

- Do not go up the highway
- Don't skyline the structures in any phase of the project; especially as you top Timmerman Hill looking north
- Just have one set of taller poles for distribution and transmission instead of multiple shorter poles, generally speaking

Zone 3: North Valley

Finding consensus for North Valley transmission was by far the most contentious of all the zones. The committee agreed that the north end of the Valley needed a second 138 kV transmission line for redundancy (dependability). The primary issue was whether that transmission should be overhead or underground. Some on the committee insisted that the only acceptable alternative to the land owners, and thus those who would grant easements for transmission, would be to put the transmission underground. Others believed that would be unreasonable since Idaho Power is required by the Idaho Public Utilities Commission to recover the costs associated with undergrounding transmission from those wanting it. That is, Idaho Power is not allowed to spread the cost of underground transmission across its entire customer base.

The committee consensus decision for North Valley transmission follows.

- Preferred Choice – New alternative: new overhead 138 kV line along SH 75 from Wood River Transmission Station to Ketchum. Underbuild distribution circuit on same towers with transmission.
- Funding Contingent Alternative – New underground 138 kV line and underground distribution along SH 75 from Wood River Transmission Station to Ketchum. Install underground where funding is available to pay cost difference between overhead and underground transmission
- Dropped Alternative A-4 – due to uncertainty of funding for Ketchum underground transmission
- Dropped Alternative A-3 – due to uncertainty of funding for full length underground transmission
- Dropped Alternative B-1 – due to lack of support for distribution underbuild and resulting structure height
- Dropped Alternative C-1 – due to undesirable route off SH 75 to Cold Springs

In addition to the consensus described above, the committee generally agreed that if the 138 kV transmission is installed overhead, Idaho Power should investigate putting the existing distribution circuits underground. Like underground transmission, this would require that stakeholders bear the cost difference between overhead and underground, though it would be a much lower cost than placing transmission underground.

Notes taken from the Zone 3 discussions are recorded below.

- Committee consensus support for providing physical redundancy in North Valley and throughout the other portions of the Wood River Valley's electrical system
- Committee consensus support for a new 138 kV line along SH 75 between Wood River Transmission Station and Ketchum
- Support for overhead transmission line installation (Idaho Power's industry standard with costs shared by everyone in the electrical system (rate payers), with no additional cost to individuals along the route – details within this choice are how and why?
    - Include with this recommended alternative a photo illustration for the public, depicting what this option will look like in-place.
- Support for underground line installation – "Here's the optimal, if you can find the money"
    - Include cost estimate description, what Idaho Power will pay for and what must be paid for by others
- The Plan should describe "who pays" for each part of each alternative

- When introducing this and other parts of the Committee's recommendation, public education is critical. Education to the public about the need for redundancy, need for additional power to meet future "build out" needs and general education about the system and how it works, photo illustrations of alternatives, etc. is critical to successful public support of the Committee's recommendations.

Combined Alternatives Based on Committee Consensus

Figure 17 is a combination of the preferred alternatives for each of the three Valley segments; north, mid and south.

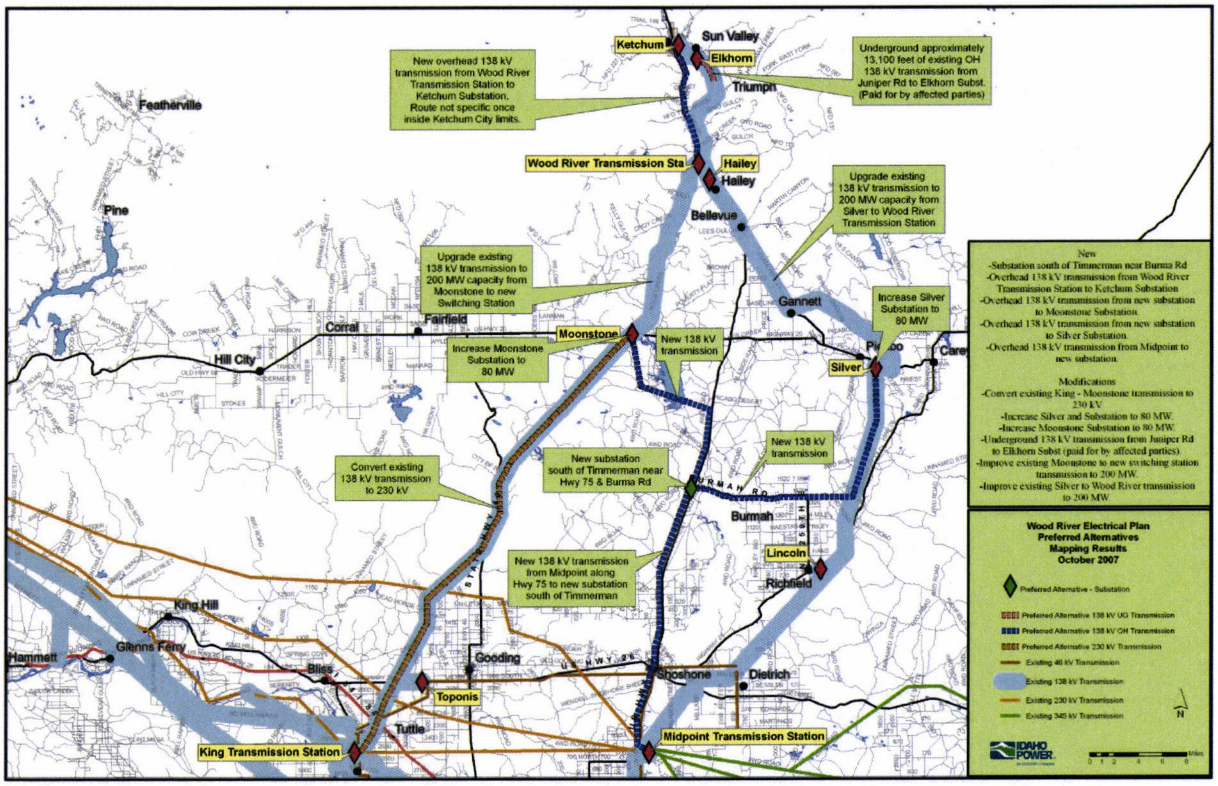

Figure 18. Preferred Alternatives

For south Valley, the preferred alternative would convert the existing 138 kV transmission from King Substation to Moonstone Substation to 230 kV. It would install a new Substation south of Timmerman Hill along Highway 75 near the intersection of Highway 75 and Burmah Road (depending on land availability). It would then install a new 138 kV transmission line from Midpoint Substation to the new substation and a 138 kV transmission line from the new substation to Moonstone Substation. It would also install a new 138 kV transmission line from the new substation to Silver Substation routed along Burmah Road until it reached the existing 138 kV line. The new circuit would then be run on common towers with the existing 138 kV circuit until it reached Silver Substation.

The preferred alternative designates that both Silver and Moonstone substations be upgraded to 80 MW capacity. It is noted that the existing 138 kV transmission from Juniper Road near Sun Valley to Elkhorn Substation is to be placed underground (paid for by affected parties).

The preferred alternative for mid-Valley would also upgrade the existing 138 kV transmission from Moonstone to Wood River to 200 MW and upgrade the existing 138 kV transmission from Silver to Wood River to 200 MW.

The preferred alternative for the north Valley region would install a new 138 kV line along SH 75 from Wood River Transmission Station to Ketchum City limits with the existing distribution circuit(s) placed on common towers with the 138 kV transmission, if placed overhead. Once the circuit reaches Ketchum City limits, the routing is not specified.

A funding contingent alternative to overhead transmission in the north Valley is to install a new 138 kV transmission circuit underground from Wood River Transmission Station to Ketchum Substation, running along Highway 75. This alternative is contingent upon local entities paying the cost difference between overhead and underground transmission.

Comments and Suggestions Recorded During Mapping Exercises:
(Note: these notes only reflect the flip chart notes from the small group work, not the complete discussion.

Group A: **Len Harlig, Dayna Smith, Tom Hellen, Dave Zeigler, Rod Kegley**

South Valley Options: - see Group A maps

- Upgrade the King line to 230 kV now, upgrade the Silver line to 230 kV when necessary, which would create redundant capacity. Do not build a high-voltage line up the highway corridor.
- Use three 138 kV lines, creating new corridors; upgrade two existing lines to 138 kV lines, using new poles.

Options from Hailey Substation North: - see Group A maps

- Run a new 138 kV line following the existing distribution lines, and bury the existing distribution lines so that we have fewer power poles, less visible wires. The existing distribution lines are less expensive to bury than the larger lines.
- Combine lines on the same poles, so as not to increase the number of poles.

Group A Mapping Notes:

- 230 kV from Midpoint to Silver; 230 kV from King to Moonstone; 138 kV from Moonstone to Timmerman; 138 kV from Silver to Timmerman; upgrade Moonstone to Wood River to 200 MW; upgrade Silver to Wood River to 200 MW; upgrade silver & Moonstone stations
- Third 138 kV from Midpoint to Wood River; improve King to Wood River to 200 MW; add Timmerman station
- Underground 138 kV & distribution from Wood River to Ketchum.
- Underground distribution; put in low profile 138 kV in same R.O.W., Wood River to Ketchum
- Look for 138 kV route to east through BLM land from Wood River to Ketchum. (No map created for this option)

Group B: **Chuck Carnohan, Chuck Turner, Rick Baird, Kurt Nelson, Nils Ribi**

South Valley Options: - see Group B maps

- Define a 230 kV line to come from Midpoint to Moonstone- use existing highway corridor, and then cut off near Magic, going to Moonstone. Create a new transmission station at Moonstone. Upgrade line from King to Moonstone to 230 kV. Create substation south of Timmerman Hill. Create third feed of 138 kV through the Valley to WR substation. Follow right of way until Glendale. Then create a split and follow Broadford Rd. west of SH 75.

North Valley Options: - see Group B maps

- Going north, use single pole concept and put all lines on single pole on existing highway corridor; consolidate distribution lines on poles (not adding new poles but use bigger poles), minimizing additional impact and increasing dependability and redundancy.

DISCUSSION: Discussed using existing corridors and use mostly existing facilities, being a far less intrusive option; possibly use sheep trail and hike/bike trail for additional rights of way.

- 1st phase. New line to get 230 kV.
- 2nd phase: Upgrade 1962 (King – Wood River) line to 230 kV.

Group B Mapping Notes:

- From WRSS to Ketchum, if line goes in existing corridor, consolidate transmission and distribution on same structures; new structures required.
- South- new line (230 kV) along SH 75, midpoint to moonstone; replace and improve 230 kV (existing) King to Moonstone—can be phased, 138 kV now, 230 kV later; upgrade over time. Moonstone becomes transmission substation.
- New substation in Gannet Triangle (south end)—north end or new line from midpoint.
- North of WRSS- to Ketchum (water wheel); replace distribution lines with 138 kV single pole; both on same pole; in existing corridors—highway, bike path, sheep corridor.
- New 138 kV line from new substation along SH 75 to Glendale
- Upgrade existing west line (138 kV) from Moonstone to Wood River substation.
- East side- 138 kV line north from new substation to south of Bellevue, follow Broadford Road west of SH 75 to Wood River substation

*Underground- Juniper Road to Elkhorn substation paid by affected parties, 2 miles @ 138 kV; upgrade available if affected parties will pay for cost difference; any new structures should blend in as much as possible to surroundings.

Group C: **Ron LeBlanc, Lloyd Betts, Tara Hagen, Tom Bergin, Rob Struthers, Tom Blanchard**

- Use existing highway easement in south Valley. Upgrade King to Moonstone line to 230 kV.
- North Valley, from Ketchum station to Hospital would be buried with common transmission lines, thus hopefully eliminating county overlap. New line……would be beyond private property, so minimal impact on private landowners. Come across the top into Cold Springs and down behind the hospital, so it wouldn't be visible for most of the ski area. Group C didn't try to be too specific with routing but stayed general to feasibility.
- Commonalities in south end with other groups reporting.

Group C Mapping Notes:

- 230 kV from King to Moonstone
- 138 kV from Midpoint to south of Gannett, new switching station with 138 kV lines to Moonstone substation and Silver substation.
- Upgrade 138 kV from Moonstone north to new switching station west of Bellevue
- Upgrade 138 kV from Silver to Hailey
- New 138 kV from switching station to Cold Springs area, underground to Ketchum substation.

ADDITIONAL COMMENTS FROM ALL GROUPS regarding options:

- Can the poles be made with earth-tone paints? This would improve aesthetics. A: Yes, there are options for steel towers that look more earth-tone.
- It wouldn't be a bad idea for the group to come up with two proposals for the public. However, it might be best if the group presents one as a preferable option and the other as a secondary option.
- Private funding may also need to contribute monies if routes are used that are significantly outside the existing corridors.
- If we leave existing corridors and move onto forest or BLM land, it would almost certainly necessitate an Environmental Impact Statement, which adds a time component and also an improbability component.
- **** Request: When IP breaks down the costs of different construction plans, could they also break down costs by "legs" of the route?*
- **** Request: Would IP provide cost expectations of Idaho Power's share versus private funding share for different legs of the route?*
- At this point, should the committee be discussing these preliminary routes with constituents? Feedback from constituents would be helpful from individual conversations but WREP is not ready for public debate at this juncture. – Yes, the committee is encouraged to gather input from their constituents, but not in a formal or public venue, as the committee's recommendations is not yet complete and ready for public discussion.

*** Idaho Power tasks by next CAC mtg

Appendix D – Group Mapping Results

Detailed Maps

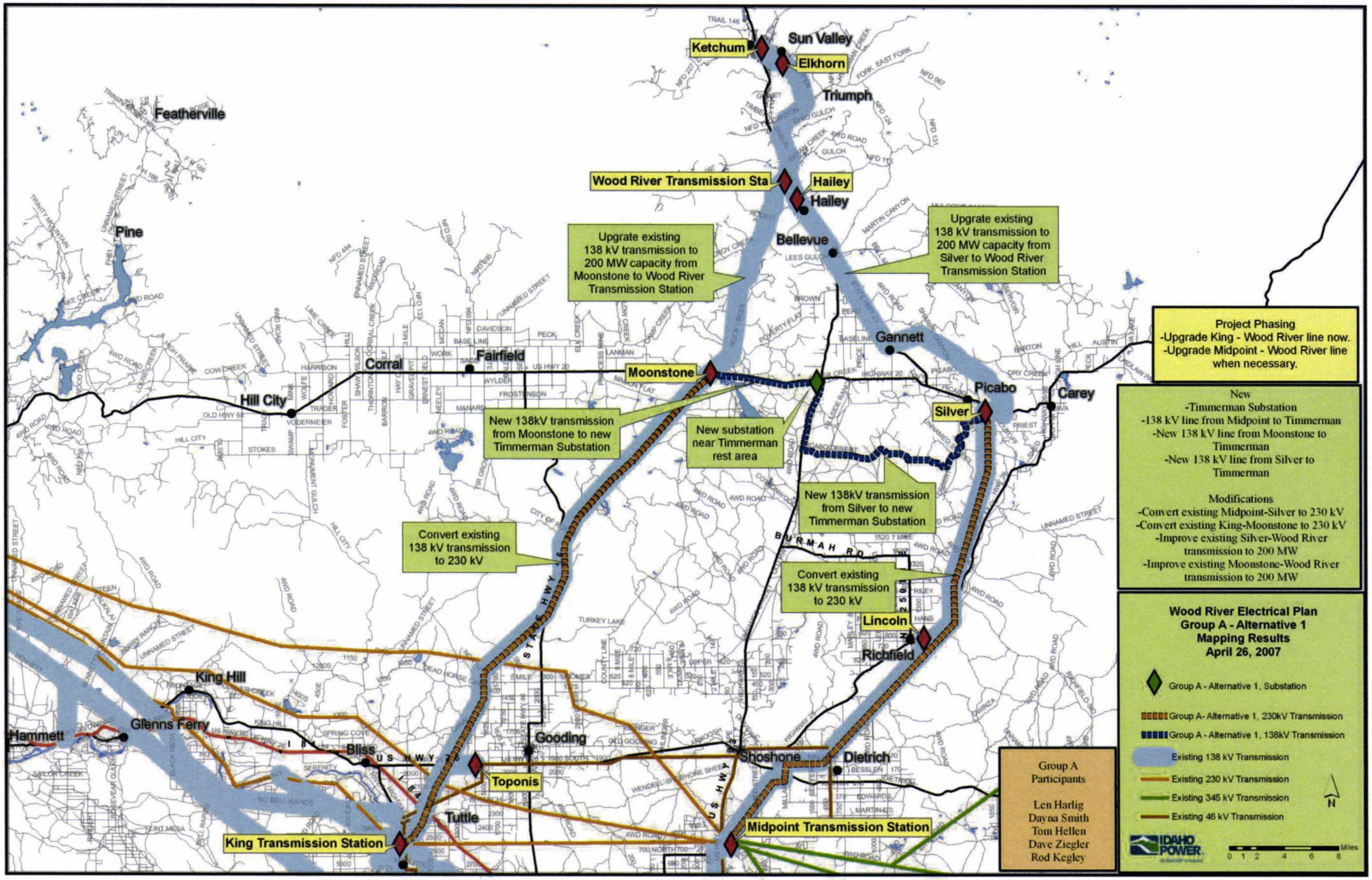

Exhibit No. 2
Case No. IPC-E-16-28
D. Angell, IPC
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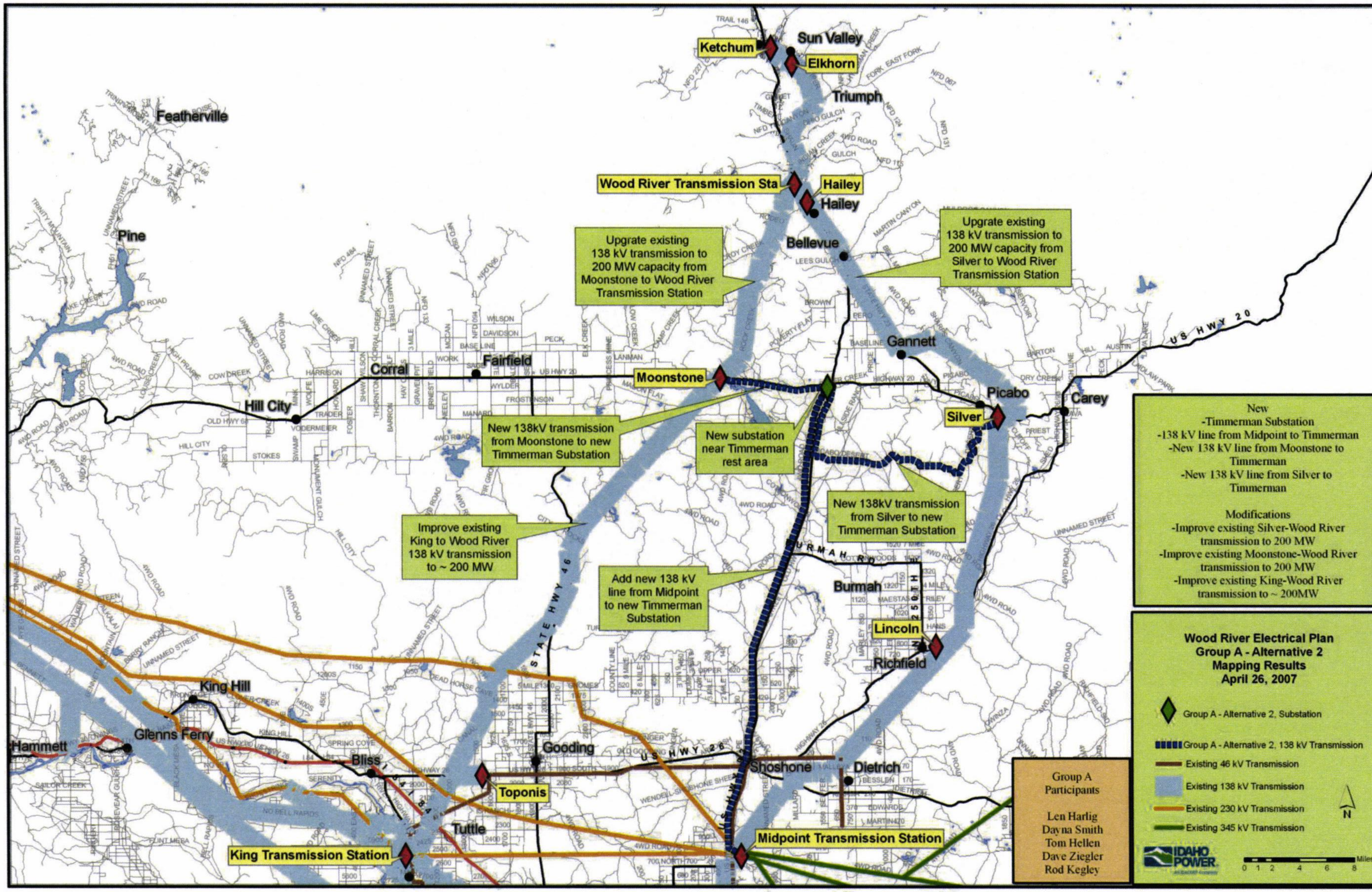

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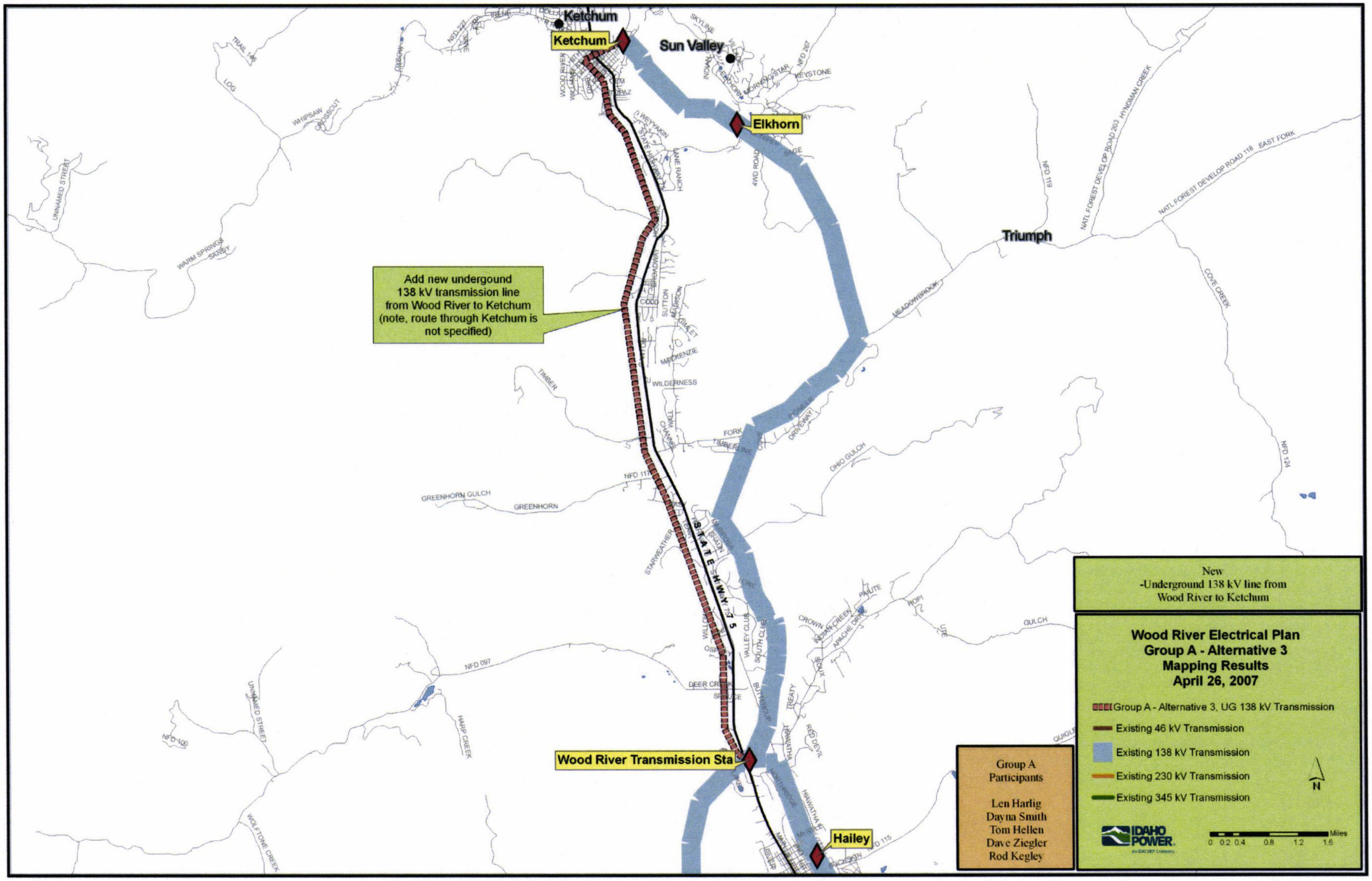

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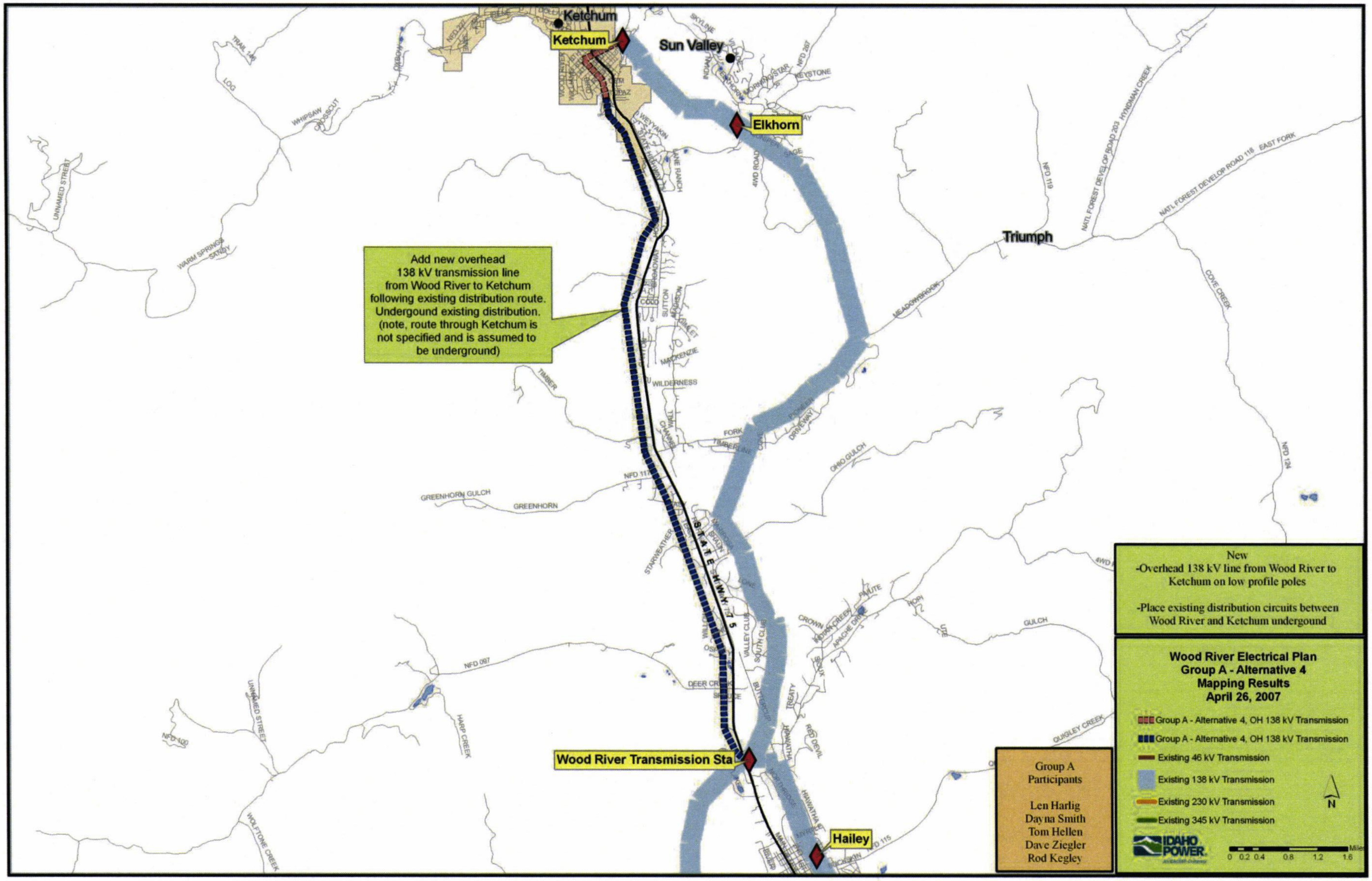

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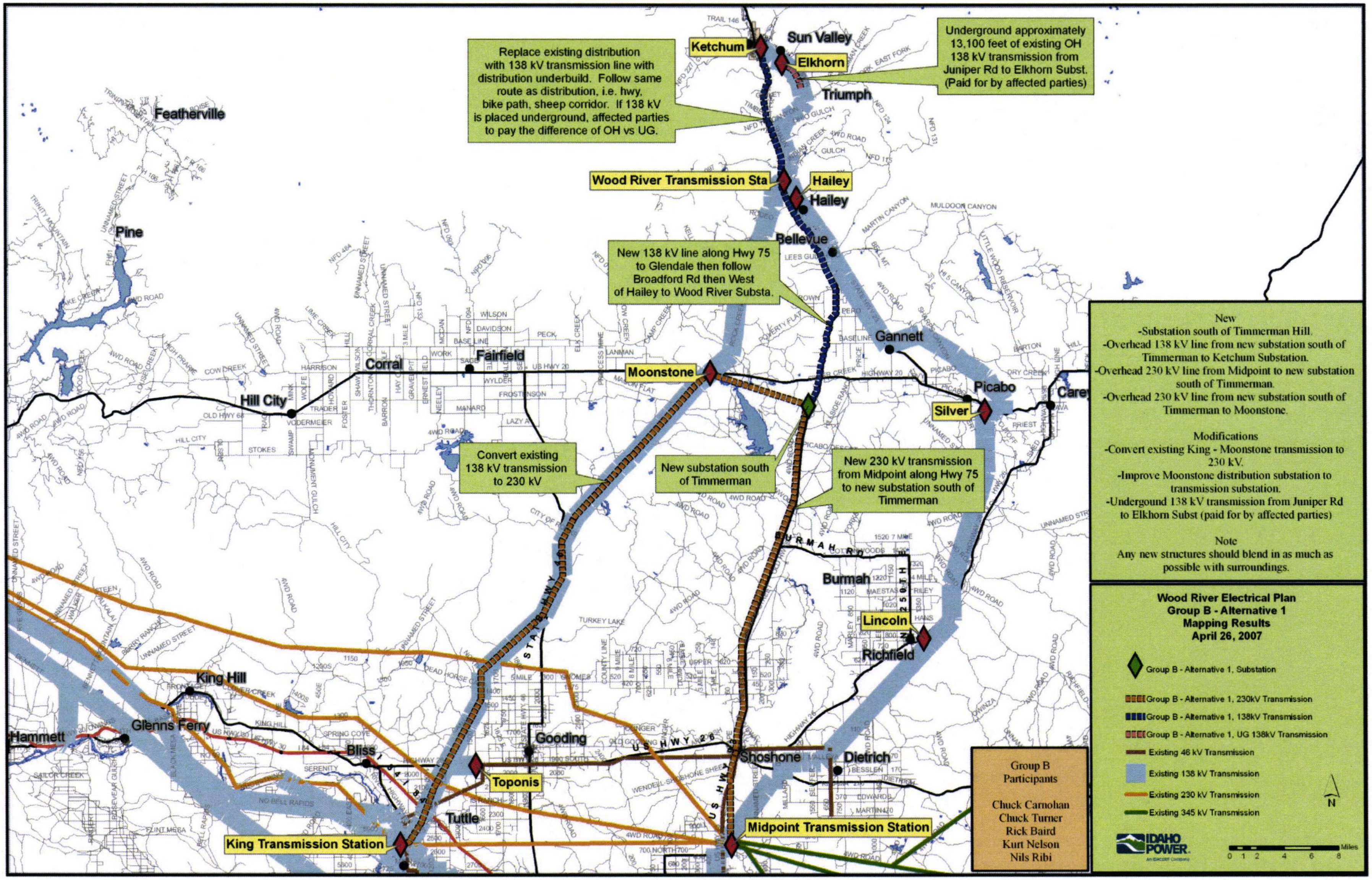

Replace existing distribution with 138 kV transmission line with distribution underbuild. Follow same route as distribution, i.e. hwy, bike path, sheep corridor. If 138 kV is placed underground, affected parties to pay the difference of OH vs UG.
Underground approximately 13,100 feet of existing OH 138 kV transmission from Juniper Rd to Elkhorn Subst. (Paid for by affected parties)
New 138 kV line along Hwy 75 to Glendale then follow Broadford Rd then West of Hailey to Wood River Substa.
Convert existing 138 kV transmission to 230 kV
New substation south of Timmerman
New 230 kV transmission from Midpoint along Hwy 75 to new substation south of Timmerman
Ketchum
Sun Valley
Elkhorn
Triumph
Wood River Transmission Sta
Hailey
Hailey
Bellevue
Gannett
Picabo
Silver
Carey
Moonstone
Fairfield
Corral
Hill City
Featherville
Pine
Burmah
Lincoln
Richfield
Shoshone
Dietrich
Gooding
Toponis
Tuttle
Bliss
King Hill
Glenns Ferry
Hammett
King Transmission Station
Midpoint Transmission Station
New
-Substation south of Timmerman Hill.
-Overhead 138 kV line from new substation south of Timmerman to Ketchum Substation.
-Overhead 230 kV line from Midpoint to new substation south of Timmerman.
-Overhead 230 kV line from new substation south of Timmerman to Moonstone.
Modifications
-Convert existing King - Moonstone transmission to 230 kV.
-Improve Moonstone distribution substation to transmission substation.
-Undergound 138 kV transmission from Juniper Rd to Elkhorn Subst (paid for by affected parties)
Note
Any new structures should blend in as much as possible with surroundings.
Wood River Electrical Plan
Group B - Alternative 1
Mapping Results
April 26, 2007
Group B - Alternative 1, Substation
Group B - Alternative 1, 230kV Transmission
Group B - Alternative 1, 138kV Transmission
Group B - Alternative 1, UG 138kV Transmission
Existing 46 kV Transmission
Existing 138 kV Transmission
Existing 230 kV Transmission
Existing 345 kV Transmission
Group B Participants
Chuck Carnohan
Chuck Turner
Rick Baird
Kurt Nelson
Nils Ribi
IDAHO POWER
0 1 2 4 6 8 Miles
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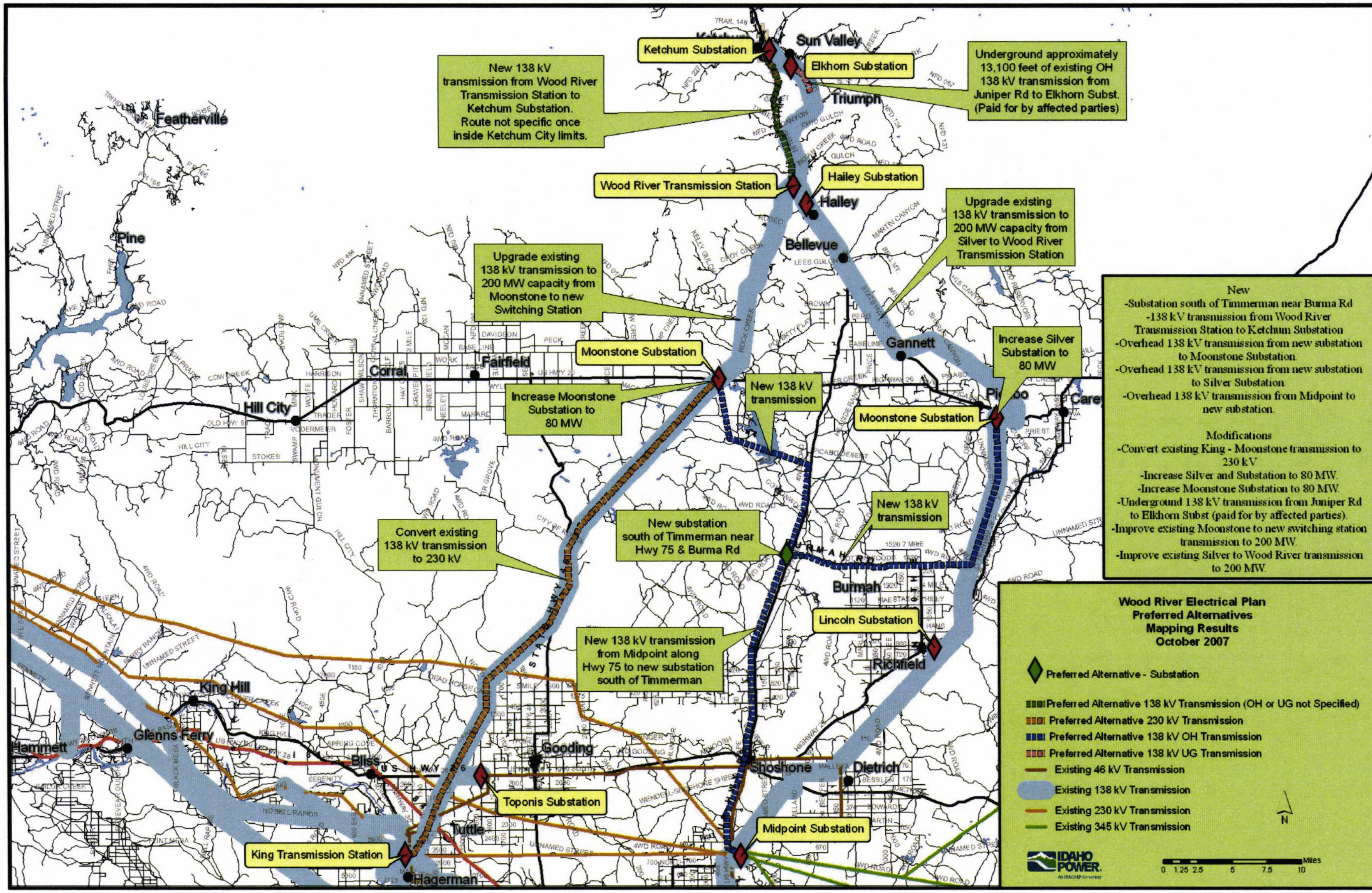

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Appendix E – Technical Analysis

Technical analysis was performed by Idaho Power staff on each alternative that the CAC came up with. Computer models were developed using PowerWorld power flow software to evaluate the power flow that would result in each alternative and to evaluate the dependability of each configuration.

The Wood River Valley's electrical system is modeled only down to the 138 kV level. Distribution lines are not modeled. For a high-voltage analysis such as this, the results will be adequate and accurate.

The PowerWorld model shows how the power flows on the system. It is used to evaluate voltage levels at all substations, reactive and real power flows, whether the lines are adequately sized, and whether or not the model meets n-1 reliability criteria.

n-1 Reliability Criteria

Because of the predicted large future load, the buildout goal for the Wood River Valley is to have a fully redundant transmission system. The system will be designed to perform to n-1 reliability criteria. This means that for multiple transmission lines delivering power to the same point, if one of the lines goes out of service, the remaining line(s) must be able to carry both the load they were carrying before the event, plus the load carried by the line that is out of service. This is true even if the line with the highest capacity is the one that goes out of service. See Appendix K for an example of the n-1 criteria. At buildout, the transmission serving from King and Midpoint substations to Wood River Transmission Station can be considered parallel paths in that if one of the lines is out of service, the remaining line cannot be overloaded and none of the substations can have voltages lower than an acceptable level. This also holds true for the case where there are two transmission lines serving from Wood River Transmission Station to the Ketchum/Sun Valley area.

The maximum line-loading criterion used under n-1 contingencies (events) in this study is 100%. This means that if the system experiences one line out of service, the remaining transmission line cannot be loaded beyond 100%of its capability. The minimum voltage acceptable under n-1 contingency is 90%, meaning that the voltage cannot be less than 90% of the normal value at any given substation.

Line-Loading Criteria

The only requirement applied to the amount of power a transmission line is allowed to carry under normal operating conditions is that it cannot go beyond 100% of its capacity. If a line is loaded to 100%, it still must be able to meet the n-1 criteria described above; thus, normally, a line will not be allowed to carry 100% of its capacity during normal operating conditions.

Modeling Results

The models developed for each alternative using the PowerWorld power flow software indicate that each alternative, as recommended by the CAC, will perform within the set criteria. The computer models indicate that at buildout using the given alternatives, none of the lines within the Wood River Valley become overloaded during an n-1 contingency, nor do any substation voltages fall below 90% during an n-1 contingency. Thus, for electrical service purposes, the alternatives developed by the Committee are equivalent.

Appendix F – ROW Analysis

As discussed previously, the Community Advisory Committee chose a number of routes in which Idaho Power could place 138 kV transmission lines. Most of the routes follow existing road and transmission rights-of-way. If the lines are placed in existing transmission corridors, it will require either replacing/upgrading the existing infrastructure or expanding the corridor's width. Securing the rights-of-way necessary for all the transmission slated for the Wood River Valley will likely prove the most challenging task facing Idaho Power as it constructs electrical infrastructure toward the Valley buildout scenario.

Transmission line rights-of-way can be obtained using any of the following methods:

Easement – An easement gives Idaho Power the right to use the land for a specific purpose. Idaho Power acquires rights from private property owners through negotiations. The easement specifies rights and restrictions on Idaho Power's use of the land while the property owner retains ownership of the land. This is the most common arrangement.
Fee Title Ownership – A landowner may sell the land needed for the transmission line to Idaho Power. Idaho Power then owns the property, receiving title through a deed.
Permit – Idaho Power makes application to the appropriate agency for a permit to place the necessary facilities across public lands.
Eminent Domain or Condemnation – If the landowner and Idaho Power are unable to negotiate a price for an easement or purchase of property, Idaho Power may exercise its rights under state law to take the easement or property through court action. The court then determines the fair price to be paid based on testimony provided by Idaho Power and the property owner's witnesses.

If a transmission line route follows a transportation corridor, Idaho Power can either place the transmission line within the road right-of-way or purchase a private easement along the road right-of-way. Normally, Idaho Power chooses to secure private easement since if the road is widened in the future making it necessary to move the line, the cost of moving the transmission line would fall upon the agency widening the road. If the line were within the road right-of-way, Idaho Power would have to bear those costs.

One Committee member discussed at length the belief that right-of-way costs for underground transmission in the North Valley would be significantly lower than for overhead transmission because landowners would be more willing to grant easements for underground transmission. The cost difference for the right-of-way could overshadow the material cost difference between overhead and underground transmission. The member also asserted that the political and legal costs would be quite high if Idaho Power were to attempt to install 138 kV overhead transmission in the North Valley. It was suggested that Idaho Power analyze this potential difference in right-of-way costs. While Idaho Power agrees that community acceptance for underground transmission would be greater, there is no valid method that can be used to estimate the cost difference for right-of-way between overhead and underground transmission short of actually going out and attempting to purchase the easements. It should be noted that some other committee members believed that there would actually not be a great difference between overhead and underground easement costs.

Appendix G – Cost Estimates

Idaho Power personnel developed some projected costs for the various alternatives the CAC came up with in their April mapping sessions. Note that these costs represent 2007 values and are not escalated into the future.

Alt.	*South Valley*	*Mid Valley*	*North Valley Total*	*North Valley Private*	*Total (excluding Private)*	*Total*
B1 (1)	$29,605,000	$31,687,500	$12,400,000	$8,800,000	$64,892,500	$73,692,500
C1 (2)	$32,542,500	$36,525,000	$15,350,000	$9,000,000	$75,417,500	$84,417,500
C2 (3)	$30,405,000	$42,925,000	$15,350,000	$9,000,000	$79,680,000	$88,680,000
A1/A4 (4)	$36,258,000	$42,525,000	$20,800,000	$17,800,000	$81,783,000	$99,583,000
A1/A3 (5)	$36,258,000	$42,525,000	$43,050,000	$39,600,000	$82,233,000	$121,833,000
A2/A4 (6)	$48,531,250	$30,875,000	$20,800,000	$17,800,000	$82,406,250	$100,206,250
A2/A3 (7)	$48,531,250	$30,875,000	$43,050,000	$39,600,000	$82,856,250	$122,456,250
Preferred (8)	$30,405,000	$42,925,000	$4,600,000	$0	$77,930,000	$77,980,000

Table 9. Estimated Alternative Buildout Costs

Notes to Table 9:

(1) Construct new King to Moonstone 230 kV transmission line adjacent to existing 138 kV line. This includes upgrade to Moonstone to Wood River Transmission Station 138 kV line. After the 230 kV line is built, remove existing 138 kV line.
(2) Construct new King to Moonstone 230 kV transmission line adjacent to existing 138 kV line. After the 230 kV line is built, remove existing 138 kV line.
(3) Alternative C2 was developed by the CAC in addition to the alternatives developed in April. This alternative moved the location for the new south of Timmerman substation further south near the intersection of Highway 75 and Burmah Road. It then installed a new 138 kV transmission line from this substation to Silver Substation routed along Burmah Road and then double circuiting (common towers) the existing Midpoint to Silver 138 kV transmission line until it reached Silver Substation. This alternative would also build the new 230 kV transmission line adjacent to the existing King to Moonstone 138 kV line. After the 230 kV line is built, remove existing 138 kV line.
(4) Construct new King to Moonstone and Midpoint to Silver 230 kV transmission lines adjacent to existing 138 kV transmission lines. After the 230 kV lines are built, remove existing 138 kV lines.
(5) Construct new King to Moonstone and Midpoint to Silver 230 kV transmission lines adjacent to existing 138 kV transmission lines. After the 230 kV lines are built, remove existing 138 kV lines.
(6) Must upgrade the Midpoint to Silver 138 kV transmission line also.
(7) Must upgrade the Midpoint to Silver 138 kV transmission line also.
(8) This row represents the estimated cost for construction of the preferred alternatives for the South, Mid and North Valley segments.

In Table 9, the column labeled "North Valley Private" shows the funding that would have to be provided by entities other than Idaho Power and represents the difference between what Idaho

Power would pay for an overhead transmission line and what it would cost to put that transmission line underground. Because of the tremendous material cost difference between overhead and underground transmission, the Idaho Public Utilities Commission regulates Idaho Power as an overhead utility meaning that unless there are physical obstructions to installing a transmission line overhead and thus forcing it to be installed underground, Idaho Power must always place transmission lines overhead. If communities or persons want a transmission line installed underground, they must pay the difference between what it costs to build overhead versus what it cost to install it underground.

Appendix H – Implementation Plan

The recommendations of the Community Advisory Committee cover infrastructure improvements to the Idaho Power system that will deliver sufficient power at the Wood River Valley's buildout. Not all the facilities are needed in the near term and will be phased in as the Valley's load increases. The following is Idaho Power's recommended implementation plan:

5 Year

- Build a second 138 kV transmission line between the Wood River Transmission Station in Hailey and Ketchum Substation. This is the top priority project.
- Site and build the new Burmah Substation
- Build new 138 kV transmission line from Midpoint Substation near Shoshone to the new Burmah Substation
- Build new 138 kV transmission line from Burmah Substation to Silver Substation (near Picabo)
- Build a new 138 kV transmission line from Burmah Substation to Moonstone Substation (east of Fairfield)

10 Year

- Upgrade Moonstone to Wood River transmission line to 200 megawatts
- Add new 230 kV to 138 kV transformer at Midpoint Substation
    - The existing transformer capacity will be inadequate to serve the Wood River Valley load at this point.

15 Year

- Add new voltage control device at Ketchum Substation
    - Won't require new lines into Ketchum Substation
    - Won't require that Ketchum Substation be enlarged

20 Year

- Add distribution feeders from Wood River Transmission Station
    - Currently, this station only serves to switch the transmission, it doesn't directly feed any of the load around Hailey
    - This would relieve some of the load from Hailey Substation

30 Year

- Upgrade Silver to Wood River transmission line to 200 megawatts
    - This will provide more capacity to the growing Valley load
    - This will also help to support the voltage at Ketchum and Elkhorn substations

When load levels require, the King to Moonstone 138 kV transmission line will be converted to 230 kV. This will require that the line be completely rebuilt but it will likely be installed in the existing right-of-way. Moonstone Substation will also require improvements at this point to accommodate the higher voltage.

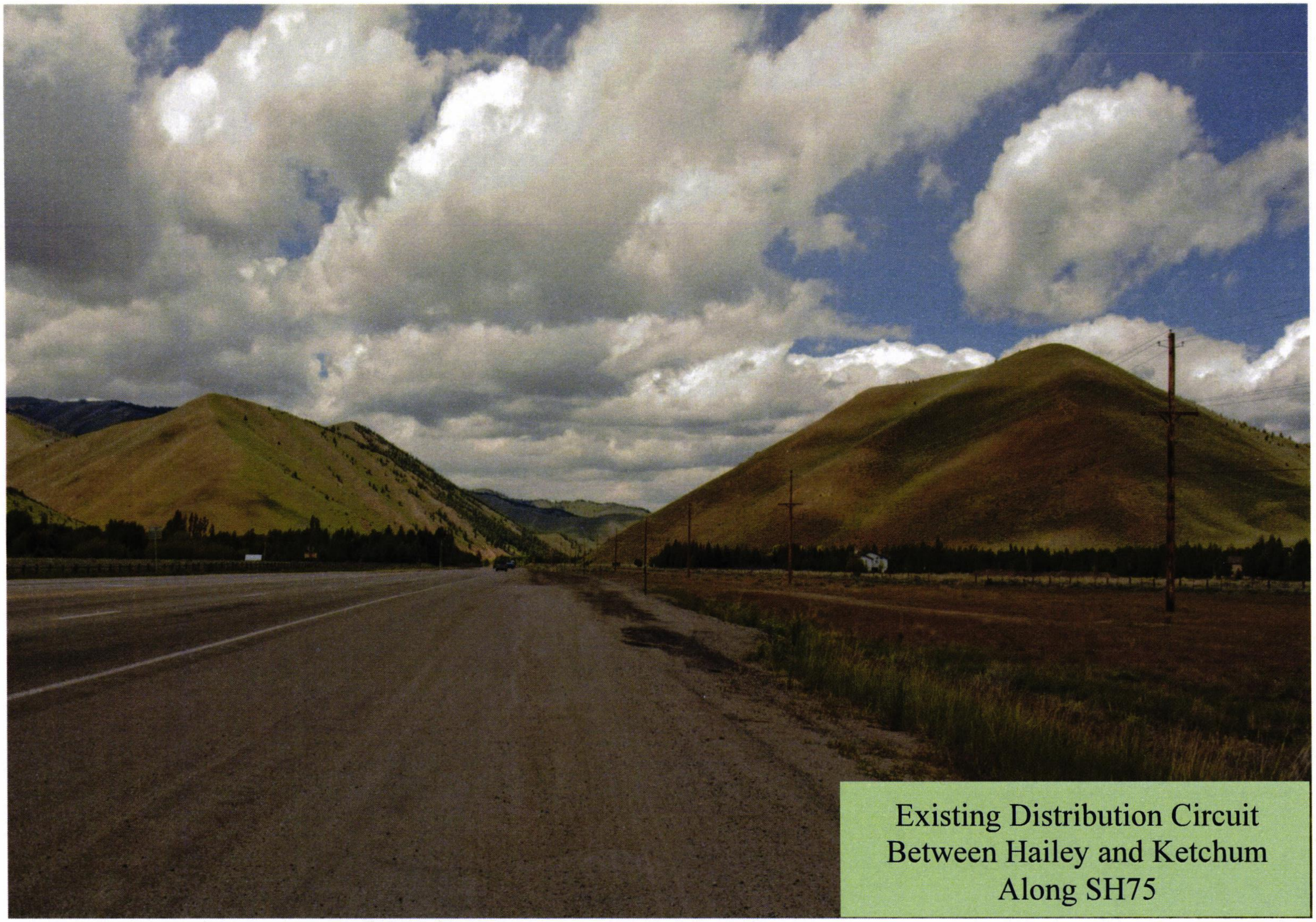
Appendix I – Load Density Based on Zoning

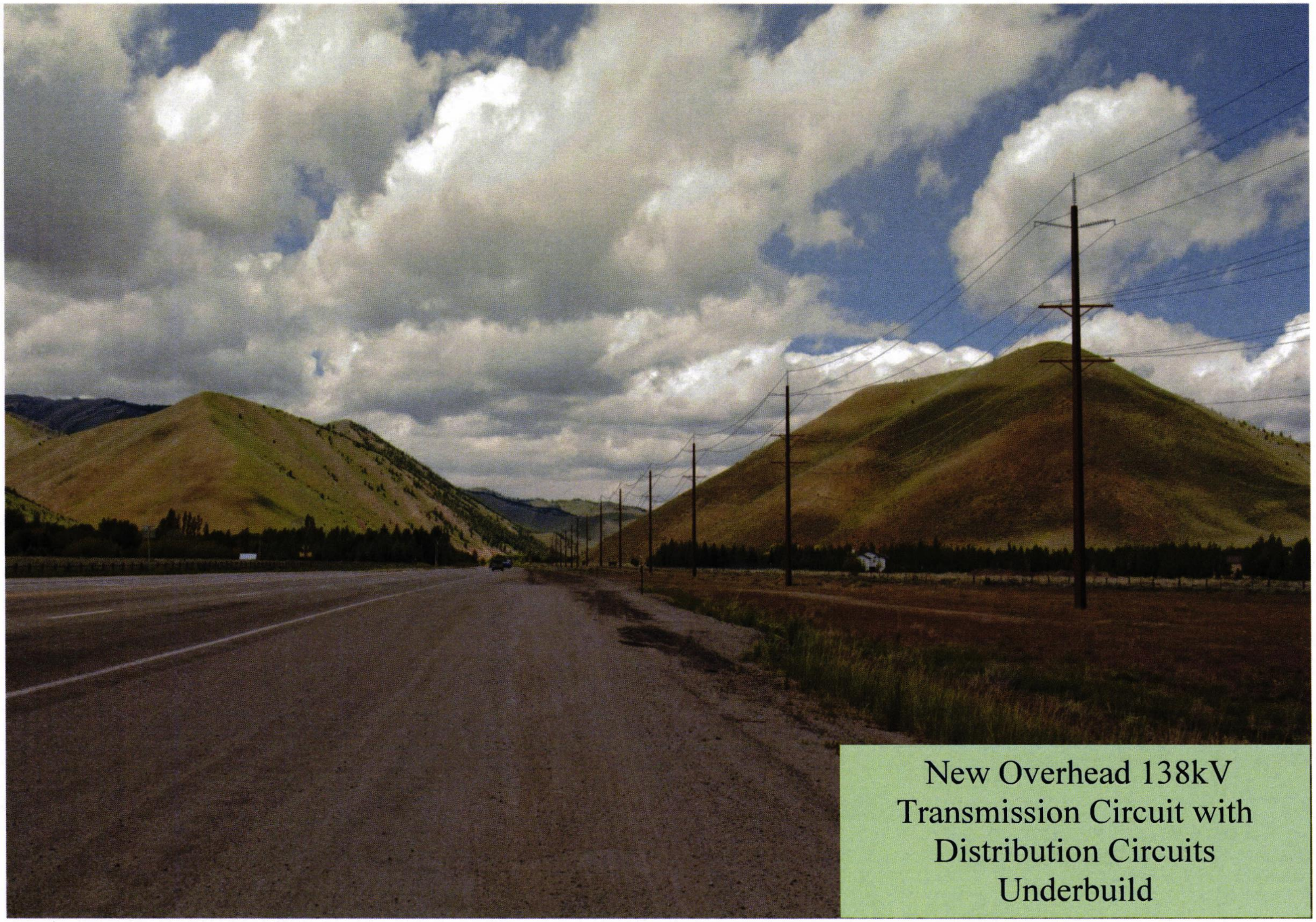
City/County	Description	Code	kW/mi^2
Blaine	Productive agricultural, one unit per twenty (20) acres.	A-20	500
Blaine	Productive agricultural, one unit per forty (40) acres.	A-40	300
Blaine	Rural residential, one unit per ten (10) acres.	R-10	820
Blaine	Rural remote, one unit per forty (40) acres.	RR-40	180
Blaine	Residential/agricultural, one unit per five (5) acres.	R-5	840
Blaine	Rural residential, one unit per two and one-half (21/2) acres.	R-2.50	1280
Blaine	Planned residential development district, one unit per two (2) acres.	R-2	1600
Blaine	Low density residential, one unit per one acre.	R-1	3200
Blaine	Medium density, one unit per four-tenths (0.4) of an acre.	R-.40	8000
Blaine	High density, one unit per one-fourth (1/4) of an acre.	R-1/4	12800
Blaine	Sawtooth City medium density residential.	SCR.4	8000
Blaine	Recreation development district.	RD	50
Blaine	Commercial district.	C	15000
Blaine	Sawtooth City commercial.	SCC	15000
Blaine	Light industrial use district, no residential density.	LI	15000
Blaine	Heavy industrial use district, no residential density.	HI	20000
Blaine	Floodplain management district, one unit per five (5) acres.	FP	320
Blaine	Riparian setback district.	R	0
Blaine		UI	800
Blaine		UIB	1200
Hailey	TRANSITIONAL		7000
Hailey	TECHNOLOGICAL INDUSTRY		15000
Hailey	SERVICE COMMERCIAL INDUSTRIAL		10000
Hailey	RECREATIONAL GREEN BELT		10
Hailey	LIMITED BUSINESS		7500
Hailey	LIMITED RESIDENTIAL – 8000 S.F.		12800
Hailey	LIMITED RESIDENTIAL – 12000 S.F.		6400
Hailey	LIGHT INDUSTRIAL		20000
Hailey	GENERAL RESIDENTIAL		12800
Hailey	BUSINESS		10000
Hailey	AIRPORT		12000
Sun Valley	Commercial Center	CC	10000
Sun Valley	Recreational	OR-1	400
Sun Valley	Public Institution (public use – almost open space)	P-1	100
Sun Valley	Residential max 1 per acre	RA	3200
Sun Valley	Residential 4-16 units per acre	RM-1	51200
Sun Valley	Residential 4-24 units per acre	RM-2	76800
Sun Valley	Residential max 2 per acre	RS-1	6400
Sun Valley	Residential 4-8 units per acre	RS-2	25600
Sun Valley	Service Commercial (Limited "low intensity")	SC	7000
Ketchum	LR – Limited Residential District,	LR	15360

Ketchum	LR-1 – Limited Residential – One Acre Zoning District,	LR-1	3840
Ketchum	LR-2 – Limited Residential – Two Acre Zoning District,	LR-2	1920
Ketchum	GR-L – General Residential – Low Density District,	GR-L	15360
Ketchum	GR-H – General Residential – High Density District,	GR-H	19200
Ketchum	MH – Mobile Home District,	MH	30720
Ketchum	STO-.4 – Short-Term Occupancy - .4 Acre Zoning District,	STO-4	9600
Ketchum	STO-1 – Short-Term Occupancy – One Acre Zoning District,	STO-1	3840
Ketchum	STO-H – Short-Term Occupancy – High Density Zoning District,	STO-H	19200
Ketchum	T – Tourist District,	T	15000
Ketchum	T-3000 – Tourist – 3000 Zoning District,	T3000	15000
Ketchum	T-4000 – Tourist – 4000 Zoning District,	T4000	15000
Ketchum	CC – Community Core District,	CC	20000
Ketchum	LI-1 – Light Industrial District Number 1,	LI-1	18000
Ketchum	LI-2 – Light Industrial District Number 2,	LI-2	30000
Ketchum	LI-3 – Light Industrial District Number 3,	LI-3	18000
Ketchum	RU – Recreation Use District,	RU	100
Ketchum	AF – Agricultural and Forestry District,	AF	2500

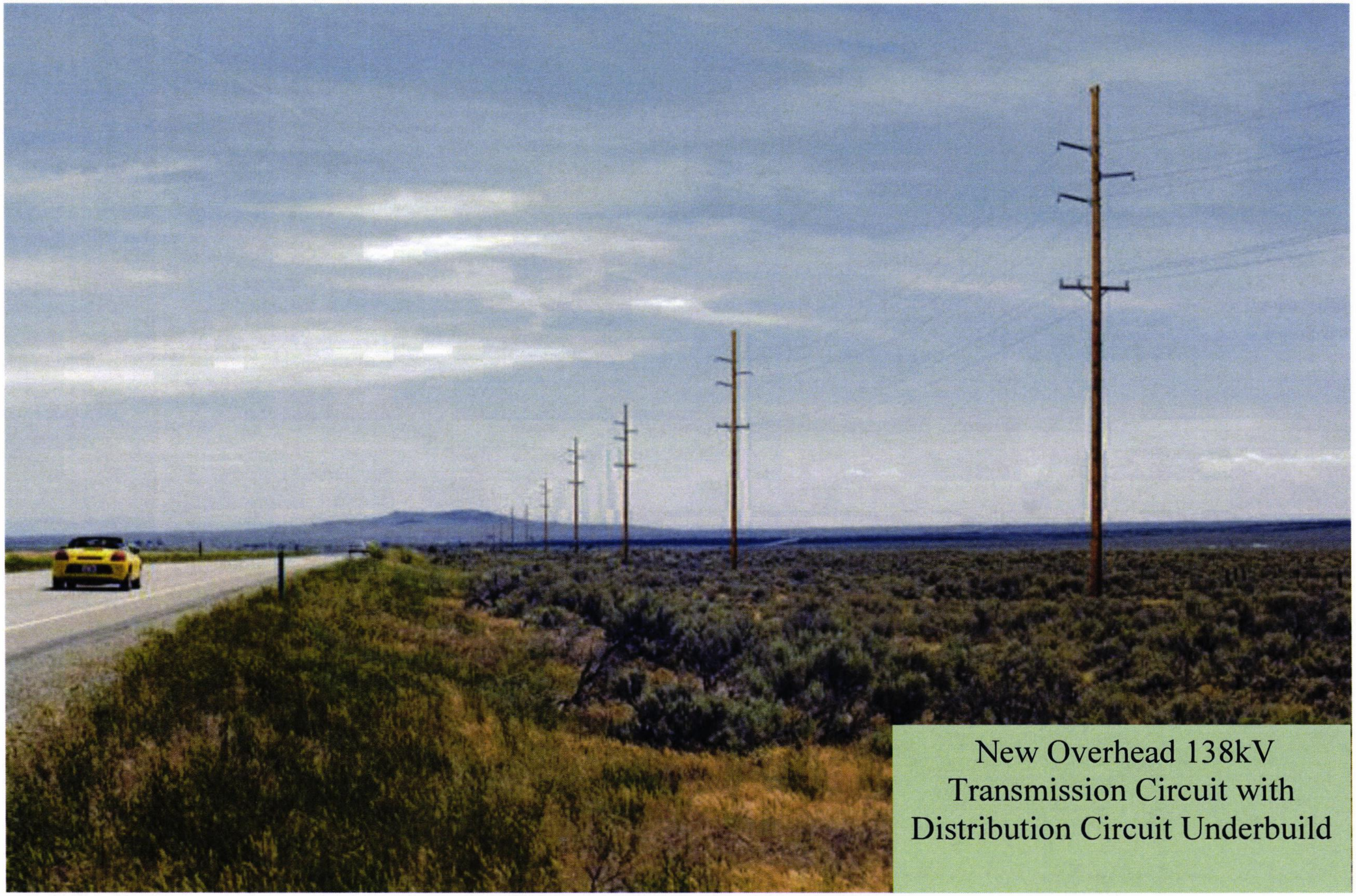
Appendix J – Example Transmission Tower Photographs

The following photo overlays were created at the request of the Community Advisory Committee in order to evaluate the visual effects of various transmission configurations.

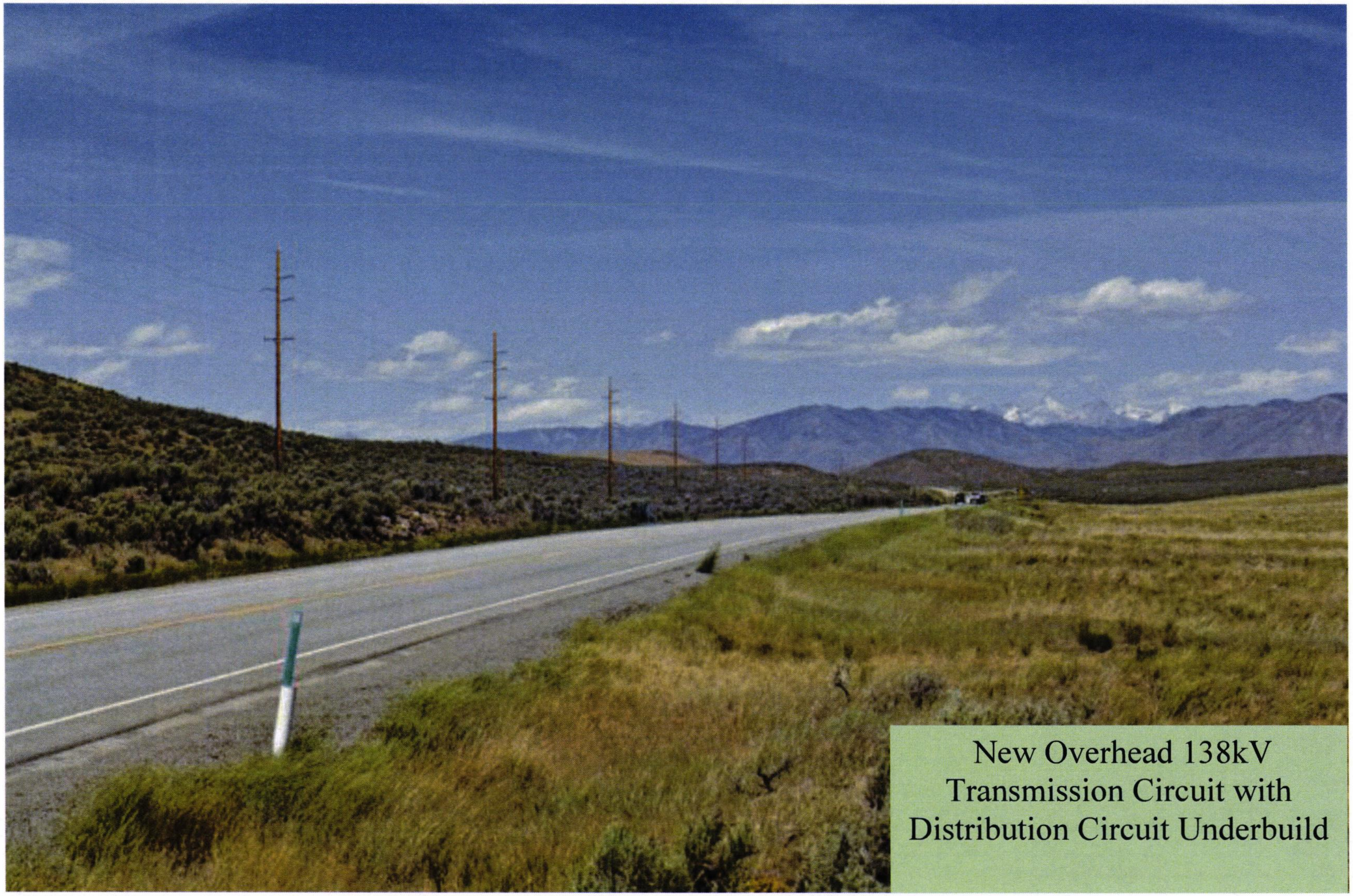

Existing Distribution Circuit
Between Hailey and Ketchum
Along SH75

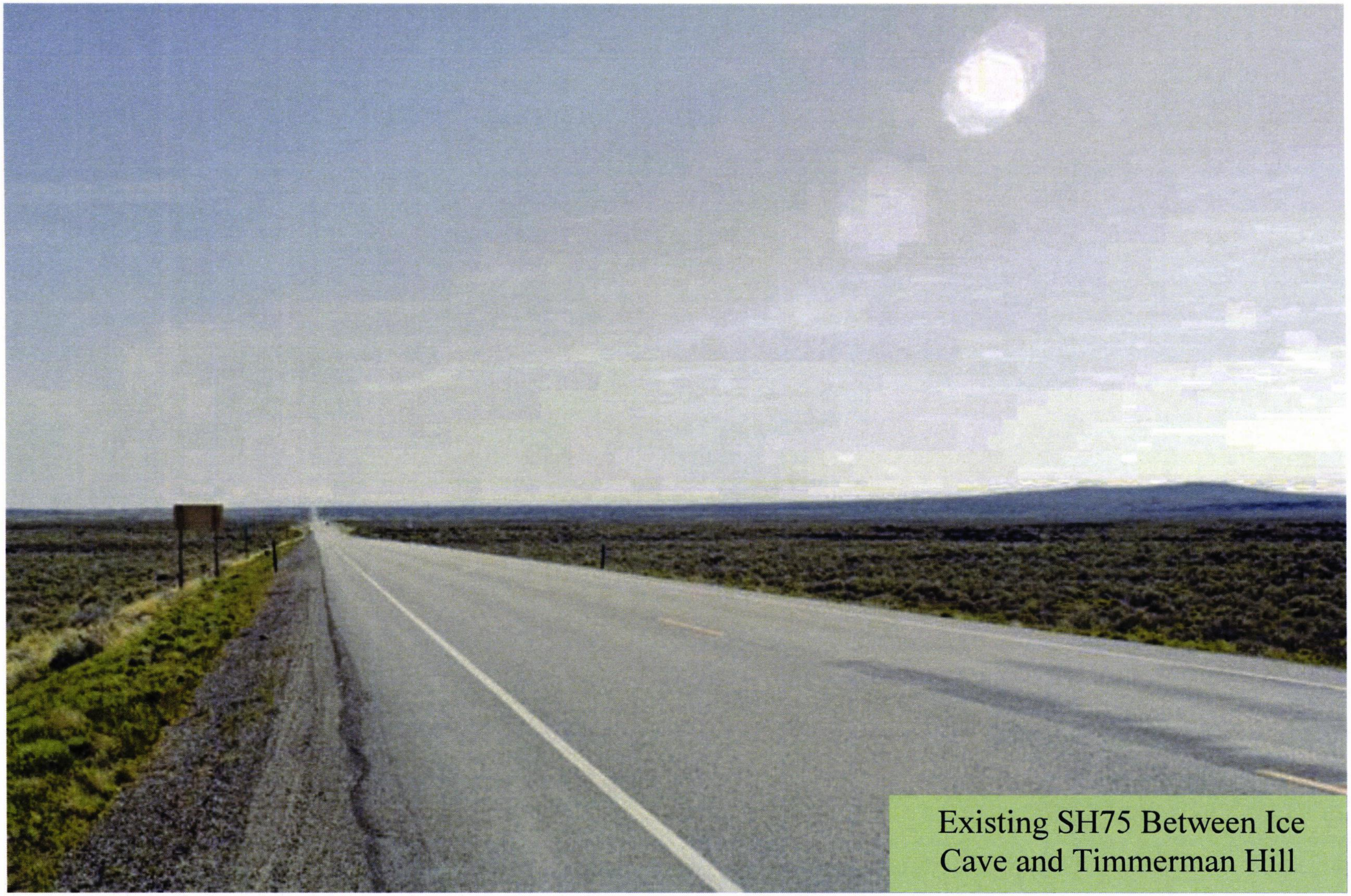

New Overhead 138kV
Transmission Circuit with
Distribution Circuits
Underbuild


Existing SH75 Between Ice
Cave and Timmerman Hill


New Overhead 138kV
Transmission Circuit with
Distribution Circuit Underbuild


Existing SH75 Between Ice
Cave and Timmerman Hill


New Overhead 138kV
Transmission Circuit with
Distribution Circuit Underbuild



Existing SH75 Between Ice Cave and Timmerman Hill

Appendix K – n-1 Reliability Criteria Example

n-1 Reliability Example

Idaho Power must adhere to what's known as an "n-1" criterion for main grid transmission.

> ***For multiple transmission lines delivering power to the same point, if one of the lines goes out of service, the remaining lines must be able to carry both the load they were carrying before the event, plus the load carried by the line that is out of service.***

- This is true even if the line with the highest capacity is the one that goes out of service.
- Only holds true for major transmission lines.

Take for example three, extra-high voltage, 345,000-volt transmission lines operating electrically in parallel as shown in Figure 1. This means that they all originate in the same location and deliver power to the same location. Each line might take a different path to get there, but all three begin and end in the same locations.

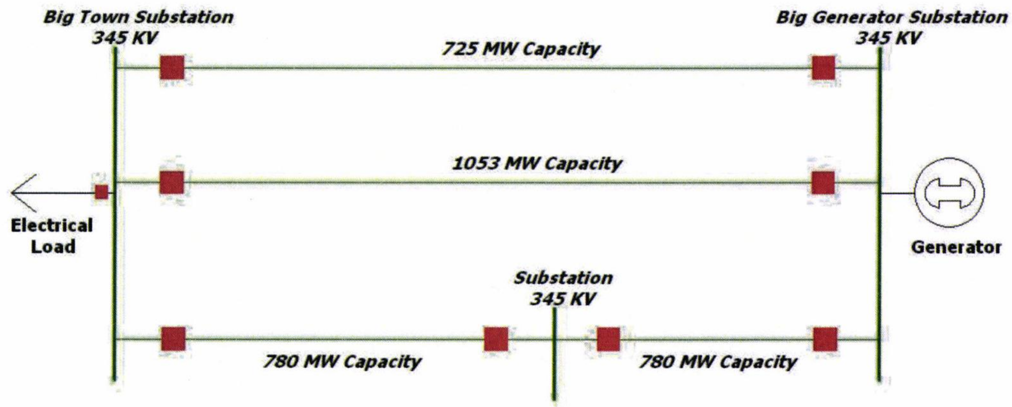


Figure 1. Three Parallel Transmission Lines

The top line is 100 miles long and has a capacity of 725 MW. The middle line is also 100 miles long and has a capacity of 1,053 MW. The bottom line is 200 miles long and has a capacity of 780 MW. There is a substation located at the halfway point on the bottom line but it has no effect on the power flow.

Normal Operation, No Lines Out

The three lines in Figure 2 are carrying a total of 1,400 MW to a load located at Big Town Substation. Note that the generator is producing 1,406 MW of power while the load is only consuming 1,400 MW. The difference between the two is due to losses on the transmission system…losses that must be provided for by the generator. The green arrows shown on the drawings indicate the direction of power flow.

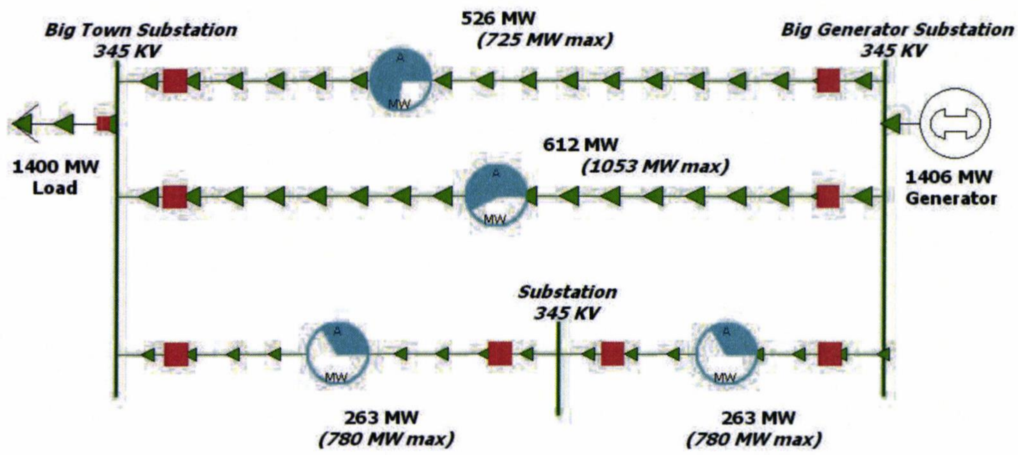


Figure 2. Three Parallel Transmission Lines During Normal Operation

The blue circle on each transmission line is a visual indication of how much each line is loaded. The top circle indicates that the line is carrying about ¾ of the amount it is capable of. If the circle turns orange, it indicates that the line is approaching its maximum capacity. A red circle indicates that the line has exceeded its capacity.

All three lines are operating within their capacity and could operate like this indefinitely.

Top line capacity = 725 MW
  Top line operating at 526 MW
Middle line capacity = 1053 MW
  Middle line operating at 612 MW
Bottom line capacity = 780 MW
  Bottom line operating at 263 MW

Bottom Line Out of Service

Now lets see what happens if we take the bottom line out of service. The circuit breaker located on the right side of the line (red box in upper drawing) turns to a hollow green when the circuit breaker is open, de-energizing the line.

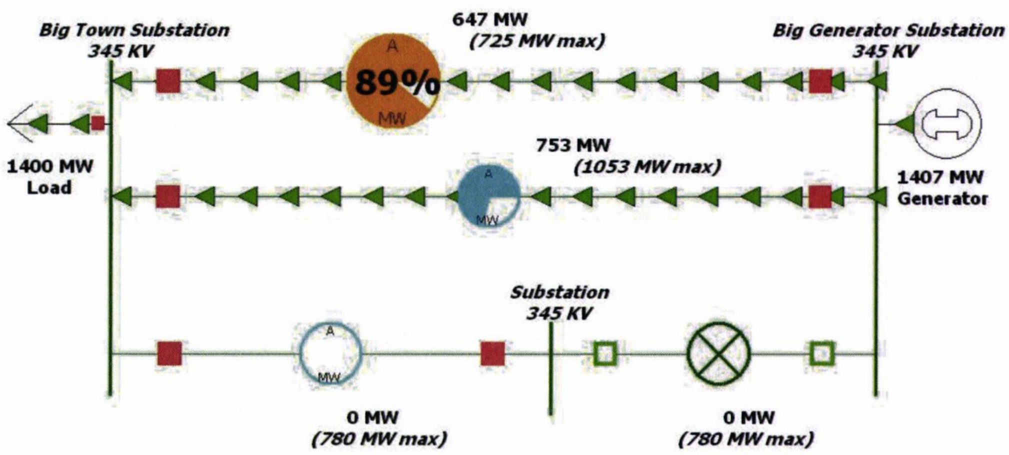


Figure 3. Three Parallel Transmission Lines, Bottom Line Out of Service

Notice that no power flows on the bottom line now. The middle line, which has the highest capacity of all three, is now operating to about ¾ of its capability. The top line indicates that it is operating at 89% of its capability, giving us a warning. However, these lines could operate like this indefinitely so no action is required. In this case, we have met the n-1 criteria.

Top line capacity = 725 MW
Top line operating at 647 MW

Middle line capacity = 1053 MW
Middle line operating at 753 MW

Bottom line capacity = 780 MW
Bottom line operating at 0 MW

Note that the generator on the right side of the drawing is producing more power compared to the last case. The power losses are higher with one of the lines out of service because there is more resistance to power flow.

Top Line Out of Service

Now we will put the bottom line back in-service and take the top line out of service. Again, the circuit breaker on the right of the top line will go from solid red to hollow green indicating that the line is out of service.

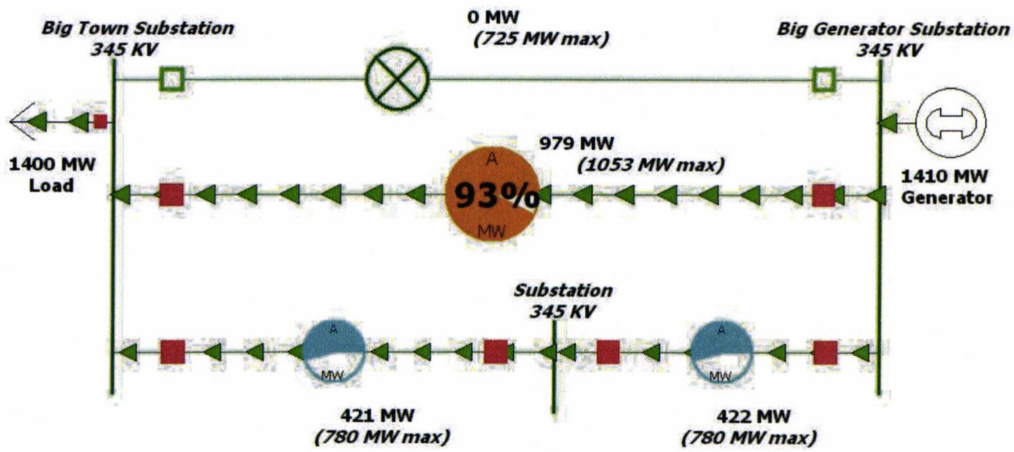


Figure 4. Three Parallel Transmission Lines, Top Line Out of Service

Notice that no power flows on the top line now. The bottom line indicates that it is operating at about 2/3 of its capability while the middle line is warning us that it is operating at 93% of its capability. These two lines could operate like this indefinitely so again no action is required.

Top line capacity = 725 MW
Top line operating at 0 MW

Middle line capacity = 1053 MW
Middle line operating at 979 MW

Bottom line capacity = 780 MW
Bottom line operating at 421 to 422 MW

Again, notice that the generator is now producing more power due to the higher line losses with one of the lines out of service.

Middle Line Out of Service

The top line is put back in service and the middle line is taken out of service. This is indicated in Figure 5 by the circuit breaker located on the right side of the middle line changing from a solid red box to a hollow green box.

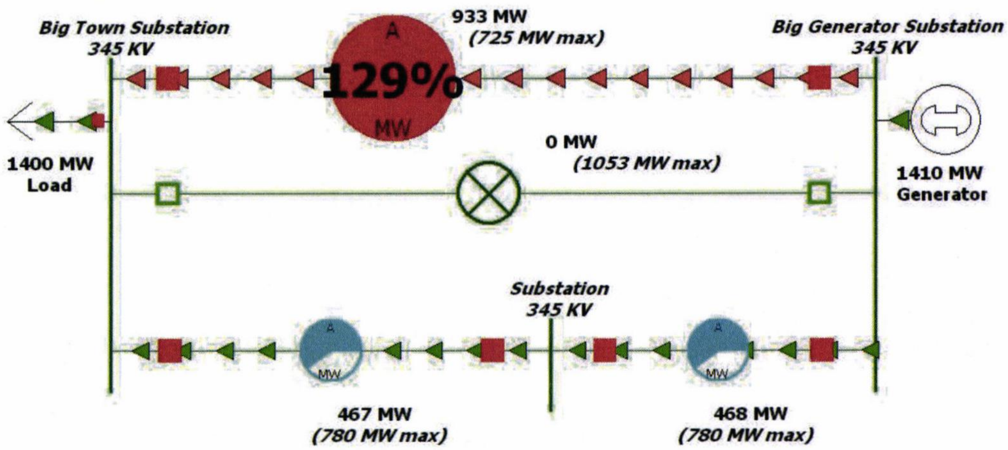


Figure 5. Three Parallel Transmission Lines, Middle Line Out of Service

Figure 4 indicates that the bottom line is operating at about 2/3 of its capability and this can be maintained indefinitely. However, notice that the top line's indicator shows that it is now operating at 129% of its capability. A transmission line cannot operate like this for very long because the line gets too hot and can be damaged to the point of breaking. So, in this case, our three transmission lines have failed the n-1 test. When the largest transmission line was taken out of service, the other two could not safely carry the power it was carrying plus the power they were carrying before the incident.

Top line capacity = 725 MW
Top line operating at **933 MW**

Middle line capacity = 1053 MW
Middle line operating at 0 MW

Bottom line capacity = 780 MW
Bottom line operating at 467 to 468 MW

BEFORE THE

IDAHO PUBLIC UTILITIES COMMISSION

CASE NO. IPC-E-16-28

IDAHO POWER COMPANY

ANGELL, DI
TESTIMONY

EXHIBIT NO. 3

October 13, 2016

Wood River Community Advisory Committee Members

Subject: Wood River Valley Transmission Line Update

Dear Advisory Committee Member:

Update on Recent Activities

Idaho Power began the construction phase to replace the King to Wood River 138-kilovolt (kV) transmission line this summer. This project is one of the two near-term priority projects identified in the 2007 Community Advisory Committee (CAC) process. The construction activity is going well and the replacement is scheduled to be complete next year. This replacement line, in combination with the prior modifications to the Midpoint to Wood River 138 kV line, will provide increased capacity and reliability to the Wood River substation in Hailey.

You may have noticed the increased Hailey to Ketchum redundant transmission line coverage in the Mountain Express recently. Idaho Power has been actively engaged with the local jurisdictions this past summer. The Blaine County Planning and Zoning Commission hearing on transmission line will take place today. Later this month, Idaho Power will file an application for a Certificate of Public Convenience and Necessity with the Idaho Public Utilities Commission to construct the Hailey to Ketchum 138 kV redundant transmission line.

Another area of activity has centered on local backup generation. Individuals in the Wood River Valley have asked whether local electric generation resources combined with the distribution grid (i.e., a microgrid) would be a cost-effective solution to increasing the reliability of service to the northern portion of the Wood River Valley. This prompted a CAC member to ask for updated local backup generation information. The attached report provides a summary of Idaho Power's recent work in this area and an updated analysis of microgrid requirements and capability. Idaho Power's preliminary and conceptual investigation reveals that the cost to provide a 65-megawatt (MW) microgrid with backup generation for a 24-hour period ranges from approximately $57 million (diesel engine system) to $955 million (photovoltaic [PV] plus battery system).

Alternate Generation Background

Idaho Power has been engaged with alternate energy resources for many years. During the 1990s, Idaho Power developed a tariff for the installation and maintenance of solar PV and battery systems for remote electrical energy requirements. Idaho Power contracted for the first utility-scale wind project to interconnect to our system near North Powder, Oregon. This was

1221 W. Idaho St. (83702)
P.O. Box 70
Boise, ID 83707

followed by agreements to purchase geothermal generation from facilities located south of Malta, Idaho, and west of Vale, Oregon. Alternate energy resources are evaluated along with traditional resources during the development of the biennial Integrated Resource Plan (IRP).

During the 2007 Community Advisory Committee process, Idaho Power shared information about alternative energy generating technologies. The discussion included wind, solar, geothermal, fuel cells, and combustion turbine technologies. At that time, Idaho Power identified that small-scale solar could provide energy to the region but would not act as a true backup source because of its intermittent qualities. Idaho Power also identified a suitable geothermal electric generating resource in the Moonstone area but noted that "it would still require electrical transmission to deliver the energy to Valley residents."

Since 2014, Idaho Power has taken part in three primary activities to explore alternative energy generating technologies in relation to the Wood River Valley. First, Idaho Power brought together the Wood River Renewable Energy Working Group to better understand the desire for renewable resources and work collaboratively with Wood River Valley residents to explore the feasibility of creating one or more new energy products to help serve the valley. The group explored the following electric generation resources: solar, wind, geothermal, hydro, fuel cells, batteries, biomass, and bio digesters. The group also developed revisions to Idaho Power's Green Power Program to enable customers to offset a portion or all of their energy use with renewable energy through the purchase of renewable energy credits, or green tags.

Second, during this process, backup power questions were raised, and Idaho Power provided some high-level conceptual cost estimates for a storage and diesel project. These estimates revealed that the cost of such options—particularly storage—far exceeded the estimates of the installation of a redundant transmission line.

Third, in 2015, two Idaho Power employees attended the Rocky Mountain Institute eLab Accelerator workshop. This workshop was focused on collaborative innovation to address technical barriers to the economic deployment of distributed resources, with representatives from the City of Ketchum, Sun Valley Company, and NRG. Idaho Power provided load data and ideas at the workshop and developed the two report appendices following the workshop in continued support of the collaborative effort. To my knowledge, these two reports and a confidential presentation from NRG are the only items that were shared with the eLab team since the workshop.

Idaho Power's engineers spent notable time working on Rocky Mountain Institute's eLab Accelerator project. Indeed, representatives from the City of Ketchum openly applauded Idaho Power's participation, stating, "eLab Accelerator was extremely important to help us get started, to get to know the other stakeholders, to hear from national experts, and to grow trust. *Bringing the utility together with the community was key* [emphasis added]." For more information on Idaho Power's efforts, please see
http://blog.rmi.org/blog_2015_09_08_elab_accelerator_explores_resilience_options_in_sun_valley.

Alternate Generation Analysis

The attached report summarizes Idaho Power's recent analysis of resources to provide service to the northern portion of the Wood River Valley during an outage of the existing 138-kilovolt (kV) Hailey to Ketchum transmission line. This report was produced by Idaho Power staff with some independent technical review and feedback from the Idaho National Laboratory (INL). Idaho Power has an internal team focused on 1) seeking opportunities for funding sources for piloting alternative technologies and 2) evaluating non-traditional approaches to resolve distribution voltage and equipment overload issues. This team of engineers has been evaluating potential applications of PV generation and battery storage technology the last few years. Employees on this team simulated and contracted for the installation of 18 kilowatt (kW) of PV to mitigate a system voltage issue, participated in the solicitation process for 500 kW of PV, and solicited budgetary quotes for a 500 kilowatt-hours (kWh) energy storage system in response to an Oregon grant opportunity.

Over the past decade, these employees have developed a relationship with energy system researchers from the INL. The INL researchers are leaders in implementing reliable energy systems, with more than 1,000 MW of hybrid power, solar, and wind energy systems deployed at Department of Defense and industry/utility sites around the world. Based on this existing relationship, Idaho Power was able to solicit some assistance on the analysis and report from an INL researcher.

The costs provided in the report have been largely obtained from third-party resources. The report contains references to these third parties throughout the document. Although the attached report contains helpful information related to renewable technologies, it is still conceptual in nature. Idaho Power would need to take part in extensive design and engineering work to provide more detailed estimates.

Idaho Power Electric Energy

Idaho Power's renewable portfolio is significant. In addition to our 1,660 MW nameplate hydroelectric fleet, Idaho Power has about 727 MW of wind, 35 MW of geothermal, 29 MW of biomass, and 290 MW of utility-scale solar installed or planned to be installed through the end of 2017. To put this additional 1,081 MW of renewable resources into perspective, Idaho Power's average load is approximately 1,800 MW.

In addition, Idaho Power continues to produce electricity while reducing carbon emissions. Since 2015, Idaho Power has reduced carbon emissions by over 20 percent. Idaho Power is ranked as the 41st-lowest carbon dioxide emitter among the nation's 100 largest electricity producers. These reductions are present during the winter months where greater than 60 percent of the fuel mix during the 2015 to 2016 winter months was sourced from hydro and renewable sources.[1]

[1] Because Idaho Power sells (or does not own) the renewable energy certificates or "green tags" associated with certain projects in its resource portfolio, and uses the proceeds to benefit customers, Idaho Power is not permitted to state that renewable energy from those projects is delivered to customers.

Summary

Since 2007, Idaho Power has been engaged in meetings with various members of the Wood River Valley and held numerous discussions on reliability and renewable energy issues. The attached report provides a high-level summary our assessment of local backup generation options. All these options include higher initial and ongoing maintenance costs compared to a transmission line alternative.

Thank you for your continued interest and participation in our community advisory process.

Sincerely,

David M Angell

Manager, Customer Operations Planning

enclosure: Northern Wood River Valley—Local Backup Electrical Supply Report

Northern Wood River Valley—Local Backup Electrical Supply Report

Customer Operations Planning

October 2016

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List of Acronyms

BESS—Battery Energy Storage System

CT—Natural Gas Combustion Turbine Generation

DRE—Diesel Reciprocating Engine Generation

F—Fahrenheit

HOMER—Hybrid Optimization of Multiple Energy Resources

INL—Idaho National Laboratory

kV—Kilovolt

kW—Kilowatt

m^2—Square Meter

MW—Megawatt

MWh—Megawatt-Hour

NREL—National Renewable Energy Laboratory

O&M—Operation and Maintenance

PV—Photovoltaic

Executive Summary

This document presents the results of a preliminary study to provide the northern Wood River Valley customers served by the Ketchum and Elkhorn substations with backup electrical supply from locally sited generation. The resources considered in the study are diesel reciprocating engine (DRE), natural gas combustion turbines (CT), photovoltaic (PV) plus battery energy storage system (BESS), geothermal generation, and biomass generation.

The analysis was performed using industry-standard energy resource simulation software, HOMER®, which was developed by the National Renewable Energy Laboratory (NREL). The capital, operations and maintenance (O&M), and fuel cost estimates for the resources identified above were obtained from *Lazard's Levelized Cost of Energy Analysis—Version 9.0* (Lazard 2015a). Idaho Power also compared the Lazard estimated with pre-engineering budgetary quotes from several vendors. Additionally, the Idaho National Laboratory (INL), with more than 1,000 megawatts (MW) of hybrid power, solar, and wind energy systems deployed at Department of Defense and industry/utility sites around the world, provided independent technical review and feedback on the analysis and report.

Table 1 summarizes the estimated equipment, installation, O&M, and fuel cost of each resource. The following assumptions were made: 1) the area served requires 60 MW of peak power based on an Idaho Power study of the requirements to maintain residential and commercial building at 55 degrees Fahrenheit (F) (see Appendices A and B); 2) the total energy consumed during the 24-hour period would be 1,150 megawatt-hours (MWh); and 3) the PV peak output of the area would be 21 MW based on Idaho Power's *Solar Availability in Ketchum* study (see Appendix C). The diesel generator and battery equipment costs were compared against budgetary quotes received during the last year. This study and the estimates provided are preliminary and conceptual in nature. Therefore, Idaho Power cannot guarantee any cost estimates based on this preliminary analysis.

Table 1. Resource cost summary

Resource	Manufacturer Equipment Cost	Total Installation Cost	O&M Annual Cost	24-Hour Fuel Cost
Diesel Engine	$800/kW	$57,000,000	$1,000,000	$197,000
Gas Turbine	$1500/kW	$101,000,000	$455,000	$41,000
PV plus Battery Storage	$800/kWh	$924,000,000	$3,450,000	$46,000

The analysis demonstrates that the most economical way to provide backup electrical supply from local generation (i.e., a microgrid) is by either diesel engines or gas turbines. With respect to the other resources considered, the study area does not have a geothermal resource suitable for electrical generation, and biomass generation costs are significantly higher and the startup time would be substantially longer than for diesel engines or gas turbines. Additionally, the biomass generation would require more investigation into the availability of and cost to extract the local biomass material. Finally, the large winter energy requirement results in a cost-prohibitive battery system at this time.

The study does not address, among other things, the ability to site, permit, or determine the operational limitations that might be imposed on the electrical generation resources. Idaho Power contacted Intermountain Gas to verify the ability to supply natural gas to fuel the generators. However, a response was not provided by the time of report distribution.

SCOPE

The intent of this study is to provide a preliminary examination of the resource capital (including equipment procurement, installation, land, and grid integration costs); operation and maintenance (O&M); and fuel costs of local generation resources that may be used to supply backup electrical energy for the customers served by the Ketchum and Elkhorn substations. The assessment of the capital and O&M costs are based on the pre-engineering estimates of the performance and cost of commercial or near-commercial technology available at the time of this study.

Local permitting requirements, environmental mitigation, and noise levels for diesel and gas turbine plants were not considered in this study.

STUDY

This study considered a scenario in which the 138-kilovolt (kV) Hailey to Ketchum transmission line is out of service for a 24-hour period during the winter. The present winter peak load in the area is 60 megawatts (MW) and is projected to reach 65 MW by 2025. The model simulated a single year in 1-hour intervals using each resource and a combination of them. A previous study shows that winter load cannot be substantially reduced by rotating outages but could be reduced by 10 percent if thermostats could be automatically set to 55 degrees during an outage, resulting in a reduction of the forecasted 2025 recent peak loads (see Appendices A and B). A load profile, shown in Figure 1, modified to reflect reduced Bald and Dollar Mountain operations for December 31, 2015, is used to simulate the total energy consumed during the 24-hour period of 1,150 megawatt-hours (MWh). Idaho Power recognizes that a transmission structure failure during the winter may require several days to repair. The 24-hour period is used merely to determine a base cost. This cost could be multiplied by the desired days of backup service to establish the total cost of a local backup resource option.

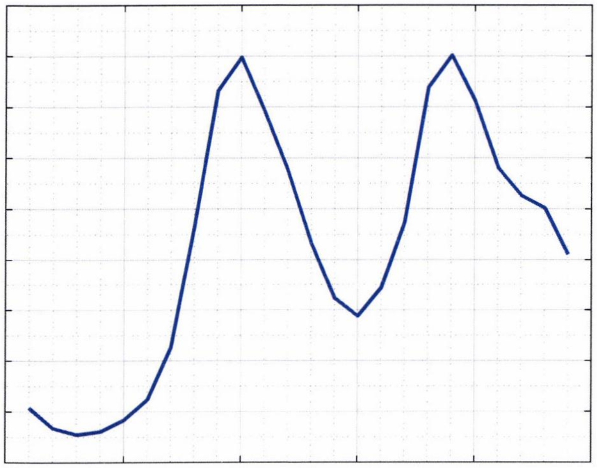

Figure 1. December 31, 2015, load profile

With the transmission line out of service, the customers served by both Ketchum and Elkhorn substations need to be served by the evaluated alternative resource. The study assumes Ketchum and Elkhorn substations respectively supply 46 and 14 MW of the 60 MW peak load.

The generator sizes have been selected based on commercially available units that can manage load restoration and provide reactive power requirements of the loads. These selections result in a total generation capacity of about 110% of the peak load.

LAND AND INTERCONNECTION REQUIREMENTS

Over one acre of land would be required for the diesel reciprocating or combustion turbine generators. It is likely that additional land would be required to site the battery system.
The interconnection cost estimates include the transformer, protection, and control systems to interface with the existing substations. The estimated land and interconnection costs are shown in Table 2.

Table 2. Land and interconnection costs

Substation Site	Land Cost	Interconnection Cost	Total
Ketchum	$1,306,800	$862,000	$2,168,800
Elkhorn	$871,200	$558,000	$1,429,200
Total	$2,178,000	$1,420,000	$3,598,000

RESOURCES CONSIDERED

The resources analyzed in the study are diesel reciprocating engine generation (DRE), natural gas combustion turbines (CT), photovoltaic (PV) plus battery energy storage system (BESS), geothermal generation, and biomass. The costs for each resource were obtained from *Lazard's Levelized Cost of Energy Analysis—Version 9.0* (Lazard 2015a). The diesel engine and battery storage costs were compared against budgetary quotes received during the last year. The Idaho National Laboratory (INL) provided feedback on their experience with the cost of the resources.

Diesel Reciprocating Generators

DRE remains the most common choice for emergency power systems worldwide. It is a mature resource that has provided backup power for decades. According to the Lazard (2015a) report, the capital cost for installing DRE can range from $500 per kilowatt (kW) to $1,000 per kW. This price does not include the cost of land or the cost to interconnect to the system. The price of diesel fuel is assumed to be $2.50 per gallon, and the O&M costs for a diesel generator are $15 per kW per year and $15 per MWh (Lazard 2015a). These reciprocating generators could be fueled by natural gas with the fuel pricing shown in the following Natural Gas Combustion Turbine section.

A quote from a vendor during the third quarter of 2016 shows the price of diesel generators is close to the upper end of the range discussed in the Lazard report.

Natural Gas Combustion Turbines

The use of gas turbine technology, while not as common as diesel generation, has increased in recent years as an alternative to providing backup power. According to the Lazard (2015a) report, the capital cost for installing CT can range from $2,500 per kW to $2,700 per kW. However, the INL provided information that shows the cost of CT as being as low as $1,500 per kW. The price does not include the cost of land or the cost to interconnect to the system. The fuel price for natural gas is $0.124 per cubic meter ($m^3$) and the O&M costs associated with CT are $6.85 to $9.12 per kW per year and $7.0 to $10.9 per MWh.

Battery Energy Storage System

One of the emerging technologies used for providing backup power is the BESS. Even though batteries do not generate electricity, they can be charged from the grid and can provide backup power when the grid is off-line. Because of the size and application of the project, a flow battery was chosen for the study with a price of $800 per kWh (Lazard 2015b).

Solar Photovoltaic

The solar capability of the Ketchum area was determined by approximating the amount of residential and commercial roof area suitable for PV installation and following National Renewable Energy Laboratory (NREL) guidelines. The results show that an estimated roof area of 112,578 square meters (m^2) is suitable for roof-mounted PV installation. See Appendix C for the complete study.

Based on the calculated roof area available to install solar PV, the total amount of PV that could be installed in the Ketchum area is 21.4 MW_{dc}. The solar irradiance was obtained for the Ketchum area using NREL's PVWatts calculator. This level of PV penetration may take many years to achieve but is included in the study to represent a potentially reduced level of energy storage requirements in the future.

Geothermal

The geothermal resource was reviewed through the NREL Geothermal Prospector tool (NREL 2016) and is supported by an Idaho Department of Water Resources 1990 report (ID DWR) reference by INL during a Wood River Renewable Working Group presentation on geothermal. The NREL tool indicates the Ketchum area has class 2 and class 3 geothermal resources. Both geothermal classes could support residential or commercial heating but would be inadequate for power generation. The INL researcher, during his presentation, identified only the Magic Hot Springs thermal resource as suitable for electrical generation.

Biomass

According to the Lazard (2015a) report, the capital cost of installing biomass ranges from $3,000 per kW to $4,000 per kW. The installation cost for 60 MW of biomass generation would likely exceed $200,000,000. The biomass option has not been fully evaluated based on the comparably higher capital cost; large land requirements; and uncertainty of fuel capacity, expense and emission requirements.

RESULTS

The analysis evaluated each resource total cost (capital, O&M) and the HOMER simulation results. Additional simulation results are provided in Appendix D.

Total Installed Costs

The locations of the proposed diesel generators, gas turbines, and battery systems were split onto the 2 main sites—50 MW of generation were added to the Ketchum Substation and 15 MW at the Elkhorn Substation. The capital costs for each resource are shown in Table 3. The resources for the capital costs are based on the following: 1) the diesel generation price is based on the Lazard (2015a) report and verified with a Wartsila Company budgetary level quote, 2) the gas combustion turbine price is based on $1,500 per kW which is situated between the microturbine price and the gas peaker plant in the Lazard (2015a) report, and 3) the battery price is based on $800 per kWh for the battery system and assumes 21 MW of local PV installed by others. The size of the battery was calculated based on the energy needs for a one-day outage. The capital cost of the battery will increase if the backup power is needed for more than a single day.

Table 3. Capital costs

Resource	Capital cost
Diesel Generation	$57,000,000
Gas Turbine	$101,000,000
PV plus Battery System	$924,000,000

O&M Cost

There are two components to the O&M cost. The first is a fixed annual cost based on the size of the generator and the routine start-up and operation of the generator, typically 4 hours per month. The second component is directly proportional to the operation time of the generators during an outage of the existing transmission line. Table 4 shows the fixed annual cost for fuel and O&M.

Table 4. O&M costs

Resource	Fixed O&M (per year)
Diesel Generation	$1,000,000
Gas Turbine	$455,000
PV plus Battery System	$3,450,000

The study assumed the existing Hailey to Ketchum 138-kV transmission line was out of service for 1 day. Table 5 shows the fuel cost when operating the diesel generators and gas turbines, and the electricity cost (energy delivered to the battery with associated transmission and substation costs) for charging the battery.

Table 5. Fuel costs for a 1-day transmission outage

Resource	Variable Fuel
Diesel Generation	$197,000
Gas Turbine	$41,000
PV plus Battery System	$46,000

CONCLUSIONS

A study to provide backup power to the Ketchum and Elkhorn area using local generation was performed. The study demonstrates that the use of DRE is the more cost-effective of the local resources considered. A local geothermal generation resource is not available. Biomass generation will require a significantly higher capital cost and require much more resource investigation. Finally, a battery system is cost-prohibitive at this time.

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IDAHO POWER
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Property Protection Analysis Report

Ketchum Energy Resilience Team

Rev. 2

October 2016

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BACKGROUND

A multi-stakeholder team, including the City of Ketchum, Sun Valley Company, Idaho Power, and NRG, attended the Rocky Mountain Institutes Electricity Innovation Lab (e-Lab) during March of 2015. The team decided that four levels of electrical demand would be evaluated relative to the local renewable resource capability: critical life safety, property protection, summer peak load and winter peak load. This report addresses the property protection demand required to maintain building heat at a level to avoid freezing water pipes during sub-zero temperature conditions.

The report was updated October 2016 to improve readability.

METHODOLOGY

The minimum amount of heat generation necessary to keep water pipes from freezing in homes and businesses with a rotating outage is calculated based on the following elements:

- Minimum indoor temperature
- Heat loss rate
- Heating capacity
- Heating system duty cycle

A formal study can be conducted to determine the heat loss rate for homes in the Ketchum Area and the minimum indoor temperature required to keep the pipes from freezing. If a formal study is desired, it should be conducted during an extreme winter peak.

Minimum Indoor Temperature

The minimum requirement to protect property is based on maintaining a minimum temperature inside homes and businesses. It does not guarantee that pipes will not freeze, as all buildings are not constructed in the same manner. Water pipe placement within exterior walls and along attics will impact the likelihood that property damage occurs. The American Red Cross, Consumer Reports, and State Farm all recommend maintaining an indoor temperature of 55°F to keep pipes from freezing. The report will use 65°F because the buildings will need to be heated above the point at which pipes would freeze, and then be allowed to cool over time in a rotating outage.

Heat Loss Rate

Heat loss determines how quickly indoor temperatures drop and how long the power must be on to prevent damage.

Heat is lost in a variety of ways:

- Walls

- Windows
- Ceiling
- Floor
- Ventilation
- Infiltration

Heat loss for each of these ways can be estimated based upon a set of assumptions and equations. This is done in Appendix A.

Heating Capacity

The heating capacity of a home or business is based on its heat strip size. The recommended heat strip size can be determined based upon the size of the building and the region. An example calculation for the Ketchum area can be found in Appendix B.

Heating System Duty Cycle

The duty cycle of the heating system determines the amount of time that the system can be off compared to how long it must remain on to maintain a set temperature. The equation is located in Appendix B. The calculation results in the heating system must remain on 77% of the time in order to keep the indoor temperature at or above 55°F and avoid frozen water pipes.

Cold Load Pick Up Effect

Under normal conditions in cold weather, the hundreds to thousands of homes and businesses served by an area's substation do not have all of their heating systems, lights, and appliances using power at the same time. The heating and refrigeration loads cycle on and off based on temperature. Due to the temperature cycling effect, a portion of the home and business heating and refrigeration load will be off at a given time. This is known as load diversity.

When a transmission line is out of service, all buildings served from the substation lose power at the same time. When service is restored after some period of time, more heating and refrigeration equipment will be in an on-state at the same time. For greater outage periods prior to restoration, the homes and businesses will require more time to bring the temperature up to thermostat settings. This requires the substation to serve a greater amount of electrical load at the same time. The condition where a substation restores electrical load following an outage is called cold load pick up.

The distribution circuits out of the substation that serve customers in the Ketchum Area have a 12.5MVA loading design limit. Idaho Power does not normally the circuits beyond 10MVA. The additional 20% reserve capacity is used to during situations such as cold load pick up. However, the load on the circuits must be restored in sections resulting in less than 12.5MVA of power. This requires carefully adding the circuit sections over time to allow load diversity to occur within each section. If sections are added prior to the load diversity occurring, an overload will occur, the circuit will be taken out of service, and the restoration process will have to begin again. The customers located in the most remote section will be restored last and are often out of service two to four times as long as the customers located near the substation. A rotating outage backup system would need to protect all of the customers from property damage. More details regarding cold load pick up can be found in Appendix C.

Other Considerations

The time for different houses to drop temperature varies widely based on their thermal mass, square footage, tightness of construction, solar orientation, building use, wind speed and direction, and other factors. Heat loss studies are inherently risky since incorporating all factors is unfeasible and the consequences of a ruptured pipe can be substantial.

CONCLUSION

This study demonstrates that the heating system must remain on 77% of the time to protect the property. Assuming rotating outages on the distribution circuits, the remote sections will experience a restoration delay exceeding one hour due to cold load pick up effects. Therefore, rotating outages to reduce load during transmission outages cannot prevent property damage for all homes and businesses.

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Appendix A.A

Heat Loss Rate

For the following calculations, these assumptions were made:

- The building size is 2000 sq ft.
- The building is one level with 8 foot ceilings.
- An outside temperature of -21°F was assumed for the extreme peak.

Walls

The average heat loss through a wall can be determined by the following equation:

$$Heat\ loss\ rate\ (walls) = \frac{Q}{t} = \frac{Area \cdot (1 - \frac{Window}{Wall}) \cdot (T_{inside} - T_{outside})}{Thermal\ resistance\ of\ wall}$$

Where:

$$Area = Height_{wall} \cdot Length_{wall} \cdot (Number\ of\ Walls)$$

Additional assumptions are necessary to use the equation:

- The building length is approximately equal to the width.
- The window to wall ratio is 30%.
- The R-Value of the wall is 19.

$$Heat\ loss\ rate\ (walls) = \frac{\left(8 \cdot \sqrt[2]{2{,}000} \cdot 4\ ft^2\right) \cdot (1 - 0.7) \cdot (65 - (-21))}{19 \frac{ft^2 \cdot °F}{BTU/hr}}$$

$$Heat\ loss\ rate\ (walls) = 4{,}535 \frac{BTU}{hr}$$

Windows

Heat loss is greater through windows than through walls. A window-to-wall ratio can be assumed for buildings to help with this calculation. Energy code guidelines typically state a window to wall ratio of 12 to 18%, but the actual ratio can be higher than 30%. 30% was assumed for the calculations. If the window-to-wall ratio is higher than assumed, heat loss will occur more rapidly.

The efficiency of windows is typically measured by a U-factor, which is the reciprocal of an R-value. Most windows have a U-factor value between 0.15 and 1.20. Through a window replacement program, a reasonable assumption for the U-factor is 0.35.

$$Heat\ loss\ rate\ (windows) = \frac{Area \cdot \frac{Window}{Wall} \cdot (T_{inside} - T_{outside})}{Thermal\ resistance\ of\ wall}$$

$$Heat\ loss\ rate\ (windows) = \frac{\left(\sqrt[2]{2{,}000} \cdot .3 \cdot 8 \cdot 4\, ft^2\right) \cdot (65 - (-21))}{\frac{1}{.35} \frac{ft^2 \cdot {}^\circ F}{BTU/hr}}$$

$$Heat\ loss\ rate\ (windows) = 12{,}923\ BTU/hr$$

Ceiling

Attic insulation typically has an R-value of 49-60. Assuming R49:

$$Heat\ loss\ rate\ (ceiling) = \frac{2{,}000 ft^2 \cdot (65 - (-21))}{49 \frac{ft^2 \cdot {}^\circ F}{BTU/hr}}$$

$$Heat\ loss\ rate\ (ceiling) = 3{,}510\ BTU/hr$$

Floor

Heat loss through the floor can be a complicated calculation, but it typically amounts to 20-30% of the total energy loss in a home. 25% will be used in the total heat loss calculation.

Ventilation and Infiltration

Ventilation is heat loss that occurs due to the venting of air from the heating system.

Infiltration heat loss occurs due to leakages in building construction and the opening and closing of windows and doors.

Together they account for approximately 43% of the total heat loss.

Total Heat Loss Rate

The percentage of heat loss through the floor, ventilation, and infiltration total 68% of the total heat loss. The remaining heat loss, 32%, is lost through the walls, windows, and ceiling. The total heat loss can be obtained through the following calculation:

$$Heat\ Loss\ Rate\ (walls) + Heat\ Loss\ Rate(windows) + Heat\ Loss\ Rate(ceiling) = 32\% \cdot Total\ Heat\ Loss$$

$$Total\ Heat\ Loss = \frac{4{,}535 BTU/hr + 12{,}923 BTU/hr + 3{,}510 BTU/hr}{0.32}$$

$$Total\ Heat\ Loss = 65{,}525 BTU/hr$$

Appendix A.B

Heating Capacity and Duty Cycle

The heating capacity of the assumed building size can be found based on the region and heat strip recommendations:

- The Ketchum Area lies in Region 1 and a 2000 sq ft building would require a 25kW heat strip.
- 1 kWh of energy is equivalent to 3,412 BTU.

The heating capacity of the building is:

$$Heating\ Capacity = Heat\ strip\ size \cdot \frac{BTU}{kWh}$$

$$Heating\ Capacity = 25kW \cdot \frac{3{,}412BTU}{kWh}$$

$$Heating\ Capacity = 85{,}300\ BTU/hr$$

The duty cycle can then be determined using previous calculations:

$$Duty\ Cycle_{Heating\ System} = \frac{Total\ Heat\ Loss}{Heating\ Capacity}$$

$$Duty\ Cycle_{Heating\ System} = \frac{65{,}525}{85{,}300}$$

$$Duty\ Cycle_{Heating\ System} = 0.77\ \ (77\%)$$

Appendix A.C

Cold Load Pick Up

Through many years of operational experience, Idaho Power has determined that load increases as indicated in Table 1 where:

- Outage Duration is given in the format Hours:Minutes.
- Percent Normal refers to the percentage of load that can be expected when power is restored compared to the normal load before the outage occurred. As an example, if there is twice as much load when power is restored as there was before the outage occurred, Percent Normal is 200%.

Table 1

Cold load effect on load duration chart

Outage Duration	Percent Normal
0:00	100.0%
0:32	162.0%
1:04	200.0%
1:37	234.0%
2:09	260.0%
2:41	270.0%
3:14	276.0%
3:46	280.0%
4:18	283.0%
4:51	285.0%
5:23	287.0%
5:55	288.0%
6:27	289.0%

Example: If a circuit is loaded to 10MVA normally and a power outage lasts 7 hours (the coincidence factor has saturated), the load will be 28.9MVA when power is restored, exceeding the 12.5MVA circuit rating. In this example, the load must be restored in at least 4 tiers. After each tier is restored, a period of time, typically around 20 minutes, must pass while the coincidence factor decreases and the load diversity normalizes.

Table 2

Load tiers associated with cold load pick up

	Normal Load Restored	Load Added in Previous Tier (Now Normal)	Total Circuit Load with Cold Load Effect	Total Normal Circuit Load Restored
Tier 1	4.33	0.00	12.5	4.33
Tier 2	2.83	4.33	12.5	7.15
Tier 3	1.85	7.15	12.5	9.00

Tier 4	1.00	9.00	11.9	10.00

It would be a minimum of an hour from the time when load was restored to Tier 1 before Tier 4 could be added to the distribution circuit. In that time, the temperature would drop below the minimum temperature threshold of 55°F.

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An IDACORP Company

Power Usage Distribution Ketchum, Idaho, Area

Ketchum Energy Resilience Team

Study Report V.2

November 2016

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Power Usage Distribution

This report describes three independent methods that are used to estimate the heating load percentage of the peak load during the winter peak. The purpose of the study is to estimate the potential electric load reduction associated with heating that can be achieved during the winter peak period.

Background

A multi-stakeholder team, including the City of Ketchum, Sun Valley Company, Idaho Power, and NRG, attended the Rocky Mountain Institute's Electricity Innovation Lab (e-Lab) during March of 2015. The team is exploring the feasibility of reducing electrical demand during an emergency event (e.g. loss of transmission) and supplying the electrical demand with local generation. To that end, this report breaks down the electricity demand during extreme winter conditions (peak demand energy) into usage categories. With that breakdown, the benefit of various demand response programs, such as lowering thermostat settings can be estimated.

There are different ways to look at electricity usage: energy (the amount of electricity consumed over time) and demand (the amount of electricity being used at a given time). This calculations in this study use both annual electrical energy and electrical peak demand. Annual energy is the total energy used over the period of one year, and does not include data on the distribution of the energy usage throughout the year. Electrical peak demand is based on the time when electricity usage is at its highest.

This study is focused on estimating the electricity used to support heating during peak demand. Three independent methods were used to obtain this estimate. Method 1 uses annual energy and temperature data to obtain peak demand and estimates the percent of peak demand used for heating. Method 2 uses average hourly customer energy consumption and area population to estimate the percent of peak demand used for heating. Method 3 analyzes daily data to determine the usage distribution at peak demand and estimates the percent of peak demand used for heating from the results.

Once the percent of peak demand used for heating is known, a method can be determined to estimate the percentage of load that can be reduced by lowering thermostats from a comfortable setting to an emergency setting.

Method 1: Temperature Based Energy Usage

The first method for determining system loading utilizes statistics to determine peak demand from annual energy usage and temperature data. According to the US Energy Information Administration (EIA) *Residential Energy Consumption Survey*,[1] annual energy usage in the

[1] *Residential Energy Consumption Survey*, US Energy Information Administration. Retrieved July 13, 2015 from http://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/co.pdf.

Mountain North region of the United States (which includes Idaho) can be broken down as follows:

- 50% heating
- 29% appliances
- 19% water heating
- 2% air conditioning (AC)

The EIA survey is for energy in general. This study focuses on electric energy only.

The breakdown of loads during the winter peak can be estimated using temperature data.

Daily temperature values were used to calculate the number of Heating Degree Days (HDD) or Cooling Degree Days (CDD). One HDD (or CDD) represents a need to raise (or lower) the inside temperature one degree on that day. Days with a small HDD (under 20) were not considered to have a significant portion of energy dedicated to heating. This resulted in a total of 161 days during the year where heating was considered to be a significant portion of energy usage. Assigning all of the heating energy to those 161 days yields cold weather energy ratios.

The base household load (water heaters, appliances, etc.) are considered to be consistent from season to season. Based on the percentages above, the amount of energy used for heating, hot water heaters, appliances and lighting during the cold weather period considered can be calculated.

See Appendix A for these calculations.

With this method, winter loading was estimated to be:

- 70.25% heating
- 17.97% appliances
- 11.77% water heating
- 0% air conditioning (AC)

Method 2: Population and Occupancy Based Energy Usage

The second method is based upon average hourly customer energy consumption and area population. One consideration to take into account is the large number of cabins and non-permanent residences. In order to more accurately determine the division of energy usage, the area occupancy must first be determined.

The ratio of population in Ketchum and Sun Valley, relative to all cities and towns within Blaine County is 27.4%. Assuming a proportional amount of people reside near towns, but not within city limits, the total permanent residences within the study area can be calculated.

The average household size in Ketchum is 1.88 people. In Sun Valley it is 1.95, and in Blaine Co. as a whole it is 2.40. Comparing the number of permanent residences, as determined above, to the number of IPC meters in the same area, the number of vacation homes can be determined.

The occupancy rate of vacation homes is assumed to be the same as the occupancy rate of hotel rooms and cabins from rental agencies. Adding the number of permanent residents to the number of temporary residents gives an approximation of the occupancy for any given month.

The vacant homes are assumed to have base loads of heating and water heating, but no appliance or AC usage. The number of vacant homes is the difference between number of residential IPC customers and the number of occupied homes in the area. Along with the number of occupants present, the extreme day kWh usage data can then be used to calculate the amount of load for different times of the year. Comparing the peak day kWh average to a typical summer day, an approximation for heat loading can be made by assuming that loading (other than heat) is the same for both days. The difference between the two energy usages is the amount of heat energy being used, which can be used to find the percentage of energy used for heating.

See Appendix B for these calculations.

Based on occupancy data, and 2014 power usage statistics, the percentage of electrical demand at peak that is due to heat load is approximately 69.32%.

Method 3: Energy Usage Based Calculations

Seasonal variations in energy usage and knowledge of the area can give some measure of how energy is used. The area of study is a winter peaking area, with much larger load demand in the colder months. A load duration curve is shown in Figure 1. The Ketchum and Elkhorn energy usage is measured hourly, and then sorted from highest (winter peak load) to lowest. Using the calculations in Method 1, 161 days of the year (44.11%) are considered cold weather, which leaves 55.89% of days as non-heating days. Therefore, the points between 0% and 44.11% are considered to have occurred during heating periods, and any between 44.11% and 100% occurred during non-heating periods.

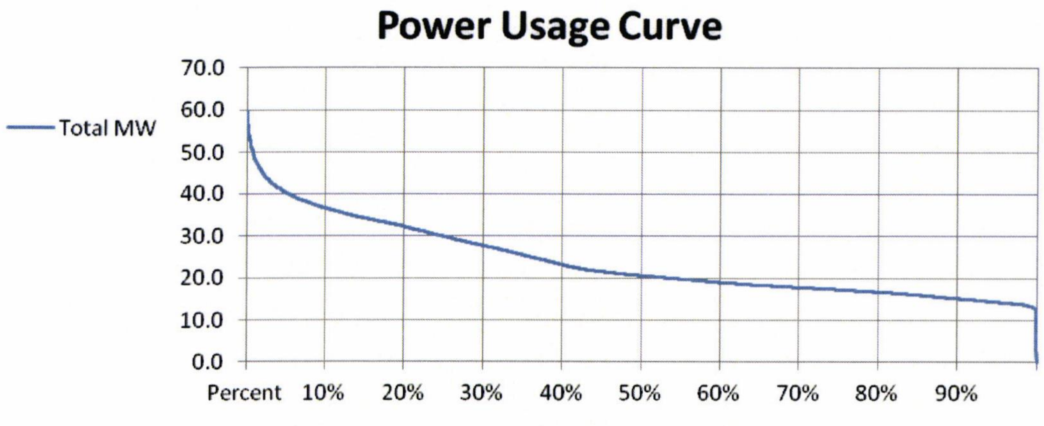

Figure 1

Hourly Energy Consumption

The estimated non-heating load was determined from the load duration curve. This value was summed with other known non-heating loads that occur during winter peak conditions. This totals approximately 23.0 MW. The difference between this sum and the total load was determined to be heating load. A peak demand heating contribution percentage was then calculated.

See Appendix C for these calculations.

During the periods heating is used, 45.0% of the total energy is used to heat buildings. The heating load represents about 61.4% of the total peak electrical demand.

Results from the Three Methods

For the Ketchum and Sun Valley area, heating load for homes is approximately 45% of total load during the majority of the winter peak with the percentage of peak electrical demand for heating being:

Method 1	70.25%
Method 2	69.32%
Method 3	61.4%

All three independently derived methods resulted in similar results. Method 3, which is based on actual measured electrical usage data will be used in the heat load reduction application.

APPLICATION: HEAT LOAD REDUCTION

Using the Results

A method for determining the heat load of a home based on indoor and outdoor temperature was determined in the report "Property Protection Analysis Report" (PPAR).[2] This method can be used to determine the percentage of heating load that can be reduced by lowering thermostats from a comfortable setting to an emergency setting.

On an extreme winter day, using the assumptions and methodology contained in the PPAR, it takes 20.32 kWh to heat a home to 70 degrees, compared to the 16.97 kWh required to heat the home to 55 degrees. There is a 16.5% reduction in heat load usage.

Taking the peak demand in the Ketchum/Sun Valley area, less the non-heating load, we can then calculate the reduced heating load. Using that value, the energy savings, or net reduction can be

[2] *Property Protection Analysis Report*, Jared Hansen. Idaho Power Company. October 2016.

calculated as well. Reducing the thermostat setting from 70 degrees to 55 degrees can result in a peak electrical load reduction of 10.1%.

See Appendix D for these calculations.

Conclusions

It is possible to reduce the demand in the area by a maximum of 10.1% with a reduction in thermostat settings on an extreme winter day.

The peak demand breakdown by percentage contribution before and after energy reduction has been determined:

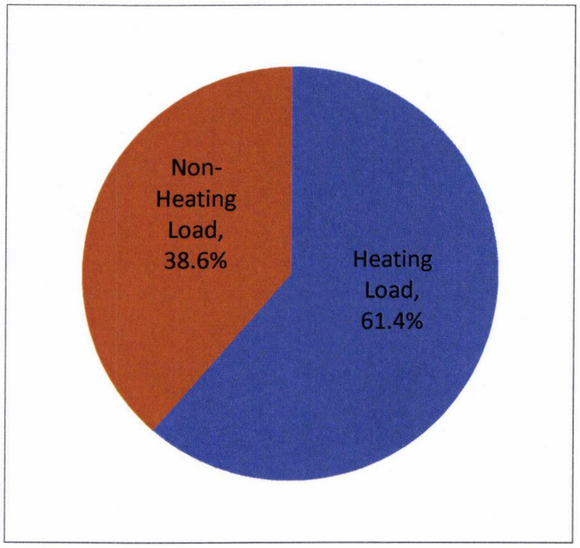

Figure 2

Peak electrical demand before load reduction

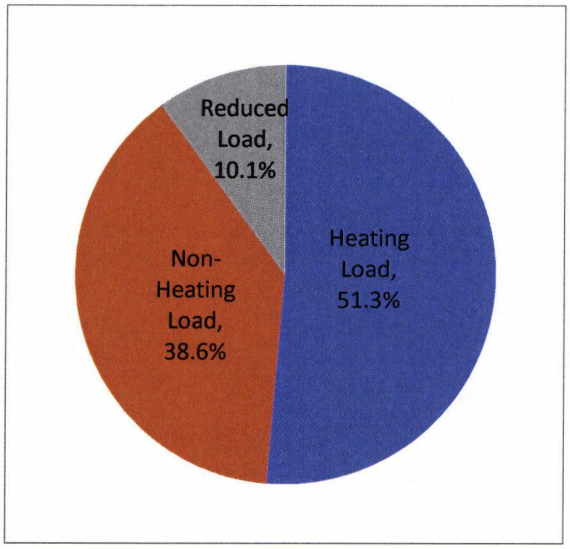

Figure 3

Peak electrical demand after load reduction

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Review/Revision History

This document has been approved and revised according to the revision history recorded below.

Review Date	Revisions
08/14/2015	Initial issue.
10/27/2016	Revised for re-issue.
11/02/2016	Add large customer load to non-heating load.

Appendix B.A

Method 1 Calculations

Temperature Based Energy Usage Calculation

The first method for determining system loading utilizes statistics to determine peak demand from annual energy usage and temperature data. According to the US Energy Information Administration (EIA) *Residential Energy Consumption Survey*,[3] annual energy usage in the Mountain North region of the United States (which includes Idaho) can be broken down as follows:

- 50% heating
- 29% appliances
- 19% water heating
- 2% air conditioning (AC)

The EIA survey is for energy in general. This study focuses on electric energy only.

The following calculations determine the ratio based on whole year energy use then calculates a factor to convert them to HDD seasonal ratios.

Daily temperature values were used to calculate the number of Heating Degree Days (HDD) or Cooling Degree Days (CDD).[4] One HDD (or CDD) represents a need to raise (or lower) the inside temperature one degree on that day. Days with a small HDD (under 20) were not considered to have a significant portion of energy dedicated to heating. This resulted in a total of 161 days during the year where heating was considered to be a significant portion of energy usage. Assigning all of the heating energy to those 161 days yields cold weather energy ratios.

[3] *Residential Energy Consumption Survey*, US Energy Information Administration. Retrieved July 13, 2015 from http://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/co.pdf.

[4] Degree Day Data. Velma, Vilnis. Degree Days Direct Limited. Retrieved August 6, 2015 from http://www.vesma.com/ddd/ddcalcs.htm.

Table 1

Acronyms used in temperature based energy usage: daily heating calculations

Variable Name	Meaning
HDD	Heating degree days
SWR	Seasonal water heater energy usage ratio
SAR	Seasonal appliances energy usage ratio
YWR	Yearly water heater energy usage ratio
YAR	Yearly appliance energy usage ratio
NWP	New water heating energy usage percentage ratio
NAP	New appliance energy usage percentage ratio
STR	Scaling factor to convert yearly energy usage to cold weather energy usage
HR	Heating Energy Ratio
NHR	New adjusted heat energy ratio

The base household load (water heaters, appliances, etc.) are considered to be consistent from season to season. Based on the percentages above, the amount of energy used by hot water heaters during the cold weather period considered was calculated.

$$SWR = YWR * \frac{HDD}{365\ days}$$

$$SWR = 19\% * \frac{161}{365} = 8.38\%$$

The amount of energy used by appliances and lighting was also calculated.

$$SAR = YAR * \frac{HDD}{365\ days}$$

$$SAR = 29\% * \frac{161}{365} = 12.79\%$$

A percentage of energy used during the cold weather period relative to the year was calculated to derive a scaling factor.

$$STR = SWR + SAR + HR$$

$$STR = 8.38\% + 12.79\% + 50\% = 71.17\% = 0.7117$$

$$NWP = \frac{SWR}{STR}$$

$$NWP = 8.38\% * \frac{1}{.7117} = 11.77\%$$

$$NAP = \frac{SAR}{STR}$$

$$NAP = 12.79\% * \frac{1}{.7117} = 17.97\%$$

$$NHR = \frac{HR}{STR}$$

$$NHR = 50\% \frac{1}{.7117} = 70.25\%$$

With this method, winter loading was estimated to be 70.25% heating, 17.97% appliances, and 11.77% water heating.

Appendix B.B

Method 2 Calculations

Occupancy Calculation

The ratio of population in Ketchum and Sun Valley, relative to all cities and towns within Blaine County is 27.4%. Assuming a proportional amount of people reside near towns, but not within city limits, the total permanent residences within the service area can be calculated.

Table 2

Acronyms used for occupancy calculations

Variable Name	Meaning
PPT	Percentage of population in Ketchum and Sun Valley
KCHM	The population of the town Ketchum
SV	The population of the town of Sun Valley
Towns	The population of all towns in Blaine County
NPT	Total population near, but not in, Ketchum or Sun Valley
TR	Temporary residences (I.E. Rentals, vacation homes)
PRP	Permanent resident population in or near Ketchum or Sun Valley
IPC	Idaho Power customer points
NPOR	Number of permanently occupied residences
CRO	Current residences occupied
MOR	Monthly Occupancy Rate
VH	Vacant homes or residences
EPVH	Number of vacant homes at energy peak
EPOR	Energy peak occupancy rate
ERKWH	Extreme year residential Kilowatt hours (kWh)
ESCKWH	Extreme year small commercial customer kWh
ELCKWH	Extreme year large commercial customer kWh
EVH	Energy use in vacant homes (not appliances, lighting or AC)

$$PPT = \frac{KCHM + SV}{\sum Towns}$$

$$PPT = \frac{2706 + 1408}{15019} = 27.39\%$$

$$NPT = (PPT) * (Blaine\ Co\ Pop - \sum Towns)$$

$$NPT = (27.39\%) * (21376 - 15019) = 1741$$

In Ketchum, the average household size is 1.88, in Sun Valley, 1.95, and in Blaine Co. as a whole, 2.40.

$$NPOR = {}^{NPT}/_{2.40} + {}^{KCHM}/_{1.88} + {}^{SV}/_{1.95} = 2887$$

Comparing the number of permanent residences to number of IPC meters in the same area, the number of vacation homes can be determined.

$$TR = IPC - NPOR = 7575 - 2887 = 4688$$

The occupancy rate of vacation homes is assumed to be the same as the occupancy rate of hotel rooms and cabins from rental agencies. Adding the number of permanent residents to the number of temporary residents gives an approximation of the occupancy for any given month.

$$CRO = NPOR + (MOR * TR)$$

$$CRO(January\ 2014) = 2887 + (42\% * 4688) = 4856$$

The vacant homes are assumed to have base loads of heating and water heating, but no appliance or AC usage. The number of vacant homes is the difference between number of residential IPC customers and the number of occupied homes in the area.

$$VH = IPC - CRO = 7575 - 4856 = 2719$$

Loading Calculations Based on Occupancy

Along with the number of occupants present, the extreme day kWh usage data can then be used to calculate the amount of load for different times of the year. Comparing the peak day kWh average to a typical summer day, an approximation for heat loading can be made by assuming that loading (other than heat) is the same for both days. For the peak day, the calculation is as follows:

$$Peak\ Load = ERKWH * [EPOR + EVH\% * EPVH] + ESCKWH * (\#Small\ Customers) + ELCKWH * (Large\ Customers)$$

$$Peak\ Load = (3.92kWh) * [5372 + 83\% * 2203] + (1.99kWh * 767) + (13.67kWh * 838) = Peak\ Load = 41207.71$$

On a normal summer day, where there would be no heating or AC load, the calculation is:

$$Loading = ERKWH * \left[\frac{CRO}{\left(CRO/_{EPOR}\right)} + (EVH\ \%) * \left(\frac{VH}{VH/_{EPVH}} \right) \right] + ESCKWH * (\#\ Small\ Customers) + ELCKWH * (\#Large\ Customers)$$

$$Loading = (.91\ kWh) * \left[\frac{4856}{4856/_{5372}} + \left(38\% * \frac{2719}{2719/_{2203}} \right) \right] + 0.65 * 767 + 7.75 * 838 = 12643.37\ kWh$$

The difference between the two energy usages is the amount of heat energy being used, which can be used to find the percentage of energy used for heating:

$$Heat\ energy = \frac{Peak\ Usage\ Day - Similar\ Day}{Peak\ Usage\ Day}$$

$$Heat\ Energy\ Percentage = \frac{41207.71 - 12643.37}{41207.71} = 69.32\%$$

Based on occupancy data, and 2014 power usage statistics, the percentage of demand at peak that is due to heat load is 69.32%.

Appendix B.C

Method 3 Calculations

Energy Usage Based Calculations

The estimated non-heating load was determined from the load duration curve. This value was summed with other known non-heating loads that occur during winter peak conditions. The difference between this sum and the total load was determined to be heating load. A heating contribution percentage was then calculated.

$$Heating\ Load\ Percentage = \frac{Total\ Energy\ during\ Heating - Total\ Energy\ of\ non\ heating\ loads}{Total\ Energy\ during\ Heating}$$

$$Cold\ weather\ period\ heating\ load = \frac{122850.4 - (67620.0)}{122850.4} = 45.0\%$$

$$Peak\ Demand\ heating\ contribution = \frac{Peak\ Demand\ during\ Heating - (sum\ of\ non\ heating\ loads\ during\ Peak\ Demand)}{Peak\ Demand\ during\ Heating}$$

$$Peak\ Demand\ heating\ contribution = \frac{59.6 - 23.0}{59.6} = 61.4\%$$

During the periods heating is used, approximately 45.0% of the total energy is used to heat buildings. The heating load is 61.4% of the peak demand.

1221 W. Idaho St. (83702)
P.O. Box 70
Boise, ID 83707

Appendix B.D

Application Calculations

Heat Load Reduction

On an extreme winter day, the PPAR determined that it takes 20.32 kWh to heat an average home to 70 degrees, compared to the 16.97 kWh required to heat the same home to 55 degrees. There is a 16.5% reduction in heat load usage.

$$Reduction = \frac{20.32\ kWh - 16.97\ kWh}{20.32\ kwH} = 16.5\%$$

Taking the peak demand in the Ketchum/Sun Valley area, less the summed non-heating load, we can then calculate the reduced heating load. Using that value, the energy savings, or net reduction can be calculated as well.

$$Heat\ Load = Peak\ Load * Heating\ Percentage$$

$$Heat\ Load = 59.6\ MW * 61.4\% = 36.6\ MW$$

$$Other\ Loads = Peak\ Load - Heat\ Load$$

$$Other\ Loads = 59.6\ MW - 36.6\ MW = 23.0\ MW$$

$$Reduced\ Heat\ Load = Heat\ Load * (1 - Reduction)$$

$$Reduced\ Heat\ Load = 36.6 * (1 - 16.5\%) = 36.6 * (83.5\%) = 30.6\ MW$$

$$Reduced\ Peak\ Load = Reduced\ Heat\ Load + Other\ Loads = 30.6MW + 23.0\ MW = 53.6\ MW$$

$$Load\ Reduction = Heat\ Load * Reduction = 36.6\ MW * 16.5\% = 6.0\ MW$$

$$Total\ Peak\ Load\ Reduction\ Percentage = \frac{Load\ Reduction}{Peak\ Load} = \frac{6.0\ MW}{59.6\ MW} = 10.1\%$$

Appendix C

City of Ketchum Solar Generation Assessment

August 11, 2015

Ketchum e-Lab Team Members

Subject: City of Ketchum Solar Generation Assessment
Dear e-Lab Team Member:

I directed members of the Idaho Power Customer Operations Planning staff to undertake a high-level assessment of the photovoltaic resource within the city limits of Ketchum, Idaho. In order to estimate this solar photovoltaic (PV) resource capacity, Idaho Power developed a sampling technique to approximate the amount of residential and commercial roof area suitable for photovoltaic installation. This sampling is based on the existing land use which is comprised of 52.87% residential, 7.85% commercial and 39.28% undeveloped area. A sample area of 0.28 square miles, which matched the city land use, was selected as shown in Figure 1. The roof area within the area was computed.

This available area was reduced by roof geometry, near shading, orientation, and other considerations following guidelines outlined by the National Renewable Energy Laboratory (NREL) (http://www.nrel.gov/docs/fy14osti/60593.pdf) to determine the roof area suitable for PV installation. This NREL document identifies 25% of residential and 60% of commercial roof area is suitable for PV installation. The area was further reduced by 50% to match the average net-metering installation in the area. This resultant roof area was scaled to the area of the Ketchum City limits and produced 112,578 m² of PV suitable roof area.

Figure 1: Sample Area

An estimate of the daily energy produced by the suitable roof area was calculated using the solar intensity data from the NREL PVWatts program (http://pvwatts.nrel.gov/). Standard efficiencies for the PV panels and inverter were applied, 16% and 95.6% respectively.

During December and January, there are only eight hours of sun light in the Ketchum area which produces an average daily solar radiation of 2.54 kWh/m² and 1.64 kWh/m², respectively, as reported in the typical meteorological year (TMY3) data from NREL for the Hailey, ID area. This solar irradiance, estimated roof area and the efficiencies result in December and January daily generation ranging from10-30 MWh. The city's daily load during this time period ranges from 300-790 MWh.

Figure 2 provides a winter example of the PVWatts data for December 23. The average solar irradiance for that day is 1.27 kWh/m². This irradiance coupled with estimated roof PV coverage would produce 21.64 MWh of PV Generation. In comparison, the December 23, 2014 Ketchum city customer consumption was 519.75 MWh.

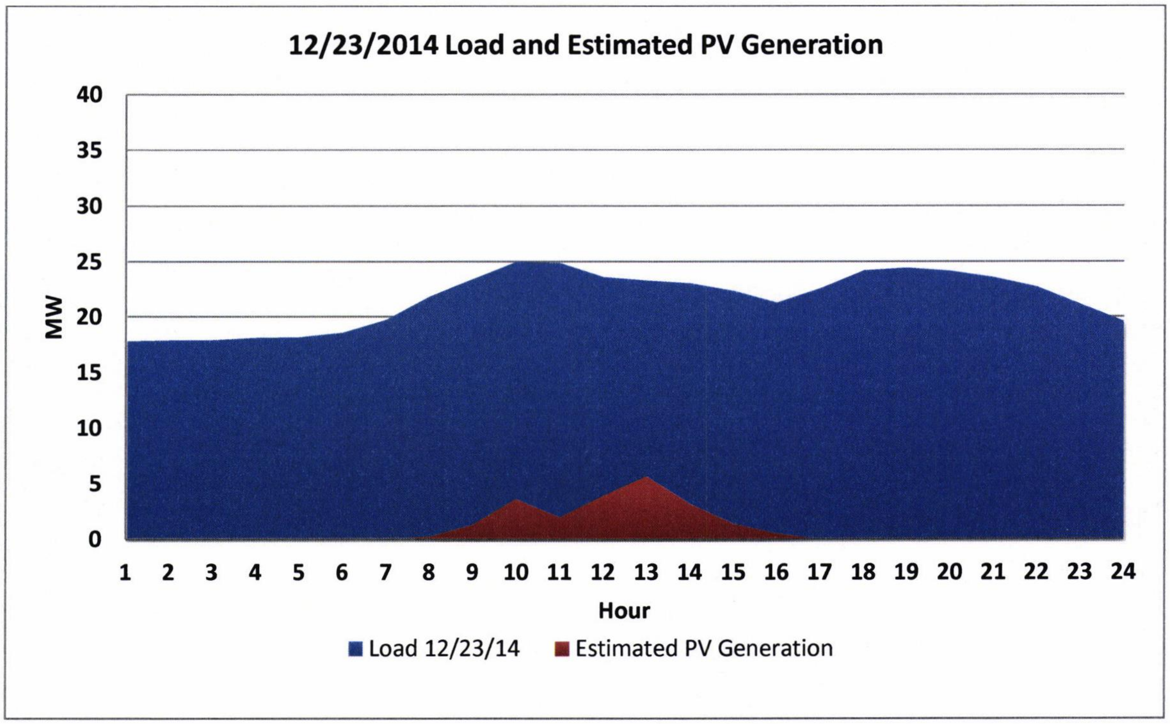

Figure 2: Load and Estimated PV Generation

Figure 3 provides a summer example of the PVWatts data for June 21st. The average solar irradiance for that day is 7.71 kWh/m². This irradiance coupled with estimated roof PV coverage would produce 131.23 MWh of PV Generation. On this day in 2014, the Ketchum city customer consumption was 187.35 MWh.

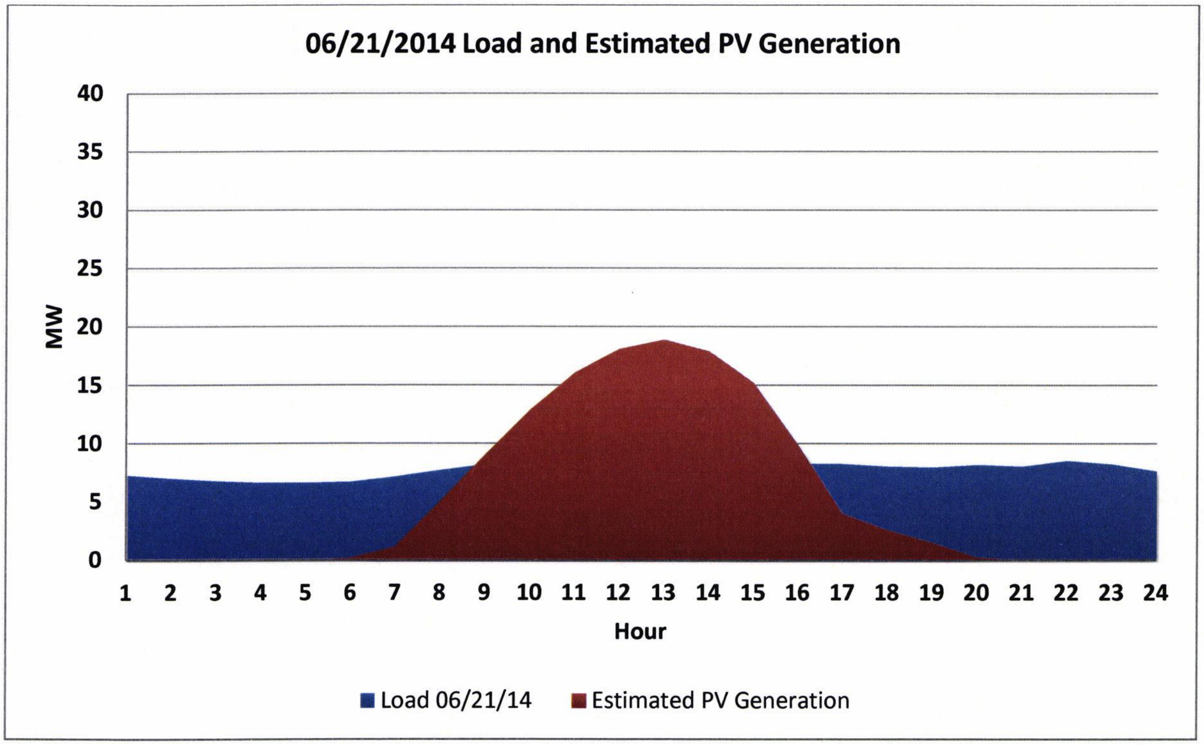

Figure 3: 6/21/2014 Load and Estimated PV Generation

In conclusion, the estimated roof PV generation will not produce sufficient energy to meet the electrical consumption by customers within the city of Ketchum. The winter generation is not able to support the property protection energy level and the summer output cannot meet the summer energy requirement. Additional resources will be required to meet the service levels above critical life safety (police, fire and hospital).

You are welcome to contact me at 208-388-2701 or dangell@idahopower if you have questions or wish to discuss this analysis.

Sincerely,

David M Angell

Manager, Customer Operations Planning

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Appendix D

Microgrid Study Results

Diesel Generator results

The results for a one-day transmission line outage with diesel engine generators providing backup power are shown in Tables 1 through 5.

Table 1 Energy Provided

Component	*Production (kWh/yr)*	*Fraction (%)*
Generator	1,150,000	1
Grid Purchases	223,611,531	99
Total	224,761,540	100

Table 2 Diesel Generator Parameters

Quantity	*Value*	*Units*
Hours of operation	24	Hrs/yr
Number of starts	1	Starts/yr
Fixed generation cost	4,677	$/hr
Marginal generation cost	0.13	$/kWh
Electrical production	1,150,000	kWh/yr
Mean electrical output	51,095	kW
Min. electrical output	43,938	kW
Max electrical output	58,506	kW
Fuel consumption	302,597	L/yr
Specific fuel consumption	0.26	L/kWh
Fuel energy input	2,977,557	kWh/yr
Mean electrical efficiency	39	%

Table 3 Diesel Generator Emissions

Pollutant	*Emissions*	*Units*
Carbon dioxide	142,119,326	Kg/yr
Carbon monoxide	1,967	Kg/yr
Unburned hydrocarbons	218	Kg/yr
Particulate matter	148	Kg/yr
Sulfur dioxide	614,296	Kg/yr
Nitrogen oxides	317,190	Kg/yr

Table 4 Diesel Generator Capital cost sensitivity analysis

Capital Cost ($/kW)	*Total Capital Cost (Millions of dollars)*
$500	$33,400,000
$750	$50,100,000
$1,000	$66,800,000
$1,250	$83,500,000
$1,500	$100,200,000

Table 5 Diesel Fuel Cost Sensitivity Analysis

Fuel price ($/gal)	*Total fuel cost*
$2.00	$159,800
$2.25	$179,700
$2.50	$199,700
$2.75	$219,700
$3.00	$239,600

Table 5 was computed with a 1-day outage during the peak months.

Gas Turbine Results

The results for a one-day transmission line outage with gas combustion turbines providing backup power are shown in tables 6 to 10.

Table 6 Energy Provided by Gas Turbine

Component	*Production (kWh/yr)*	*Fraction (%)*
Generator	1,150,000	1
Grid Purchases	223,611,531	99
Total	224,761,540	100

Table 7 Gas Turbine Parameters

Quantity	*Value*	*Units*
Hours of operation	24	Hrs/yr
Number of starts	1	Starts/yr
Fixed generation cost	2,802	$/hr
Marginal generation cost	0.02	$/kWh
Electrical production	1,150,000	kWh/yr
Mean electrical output	51,095	kW
Min. electrical output	43,938	kW
Max electrical output	58,506	kW
Fuel consumption	333,503	m^3/yr
Specific fuel consumption	0.29	m^3/kWh
Fuel energy input	3,293,338	kWh/yr
Mean electrical efficiency	35	%

Table 8 Gas Turbine Emissions

Pollutant	*Emissions*	*Units*
Carbon dioxide	141,968,690	Kg/yr
Carbon monoxide	667	Kg/yr
Unburned hydrocarbons	0	Kg/yr
Particulate matter	0	Kg/yr
Sulfur dioxide	614,434	Kg/yr
Nitrogen oxides	300,056	Kg/yr

Table 9 Gas Turbine Capital Cost Sensitivity Analysis

Capital Cost ($/kW)	*Total Capital Cost*
$750	$48,800,000
$1,125	$73,100,000
$1,500	$97,500,000
$1,875	$121,900,000
$2,250	$146,300,000

Table 10 Natural Gas Cost Sensitivity Analysis

Fuel price ($/m³)	*Total fuel cost*
$0.075	$25,000
$0.10	$33,400
$0.124	$41,400
$0.15	$50,000
$0.175	$58,400

Battery System Results

The sensitivity analysis to the price of the battery for a one-day transmission line outage with the use of PV plus battery to provide backup power is shown in table 11.

Table 11 Battery Cost Sensitivity Analysis

Battery Price ($/kWh)	*Total Cost*
$372	$45,600,000
$486	$595,000,000
$516	$632,000,000
$636	$779,000,000
$1,115	$1,367,000,000
$1,236	$1,515,000,000

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CASE NO. IPC-E-16-28

IDAHO POWER COMPANY

ANGELL, DI TESTIMONY

EXHIBIT NO. 4

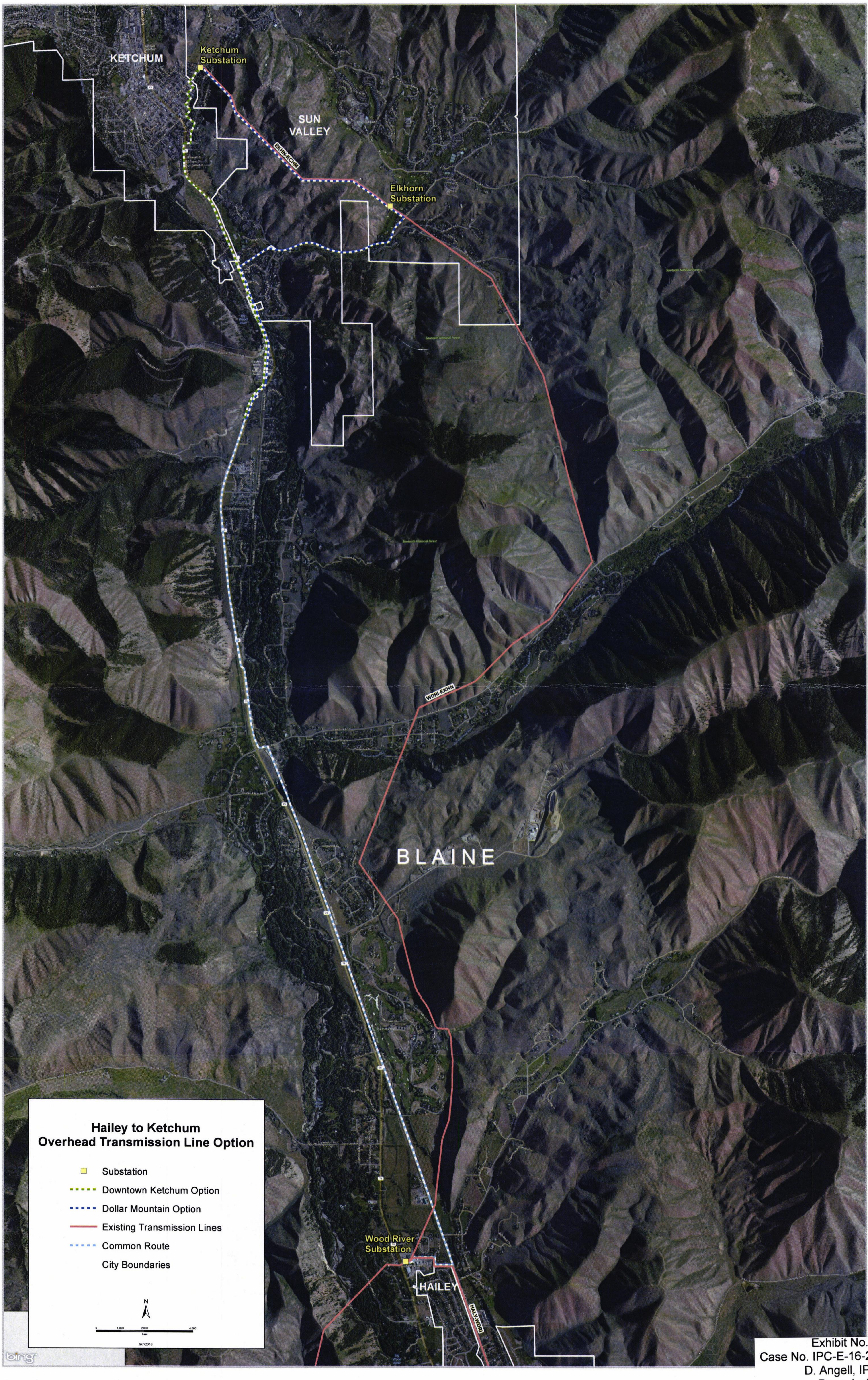

Exhibit No. 4
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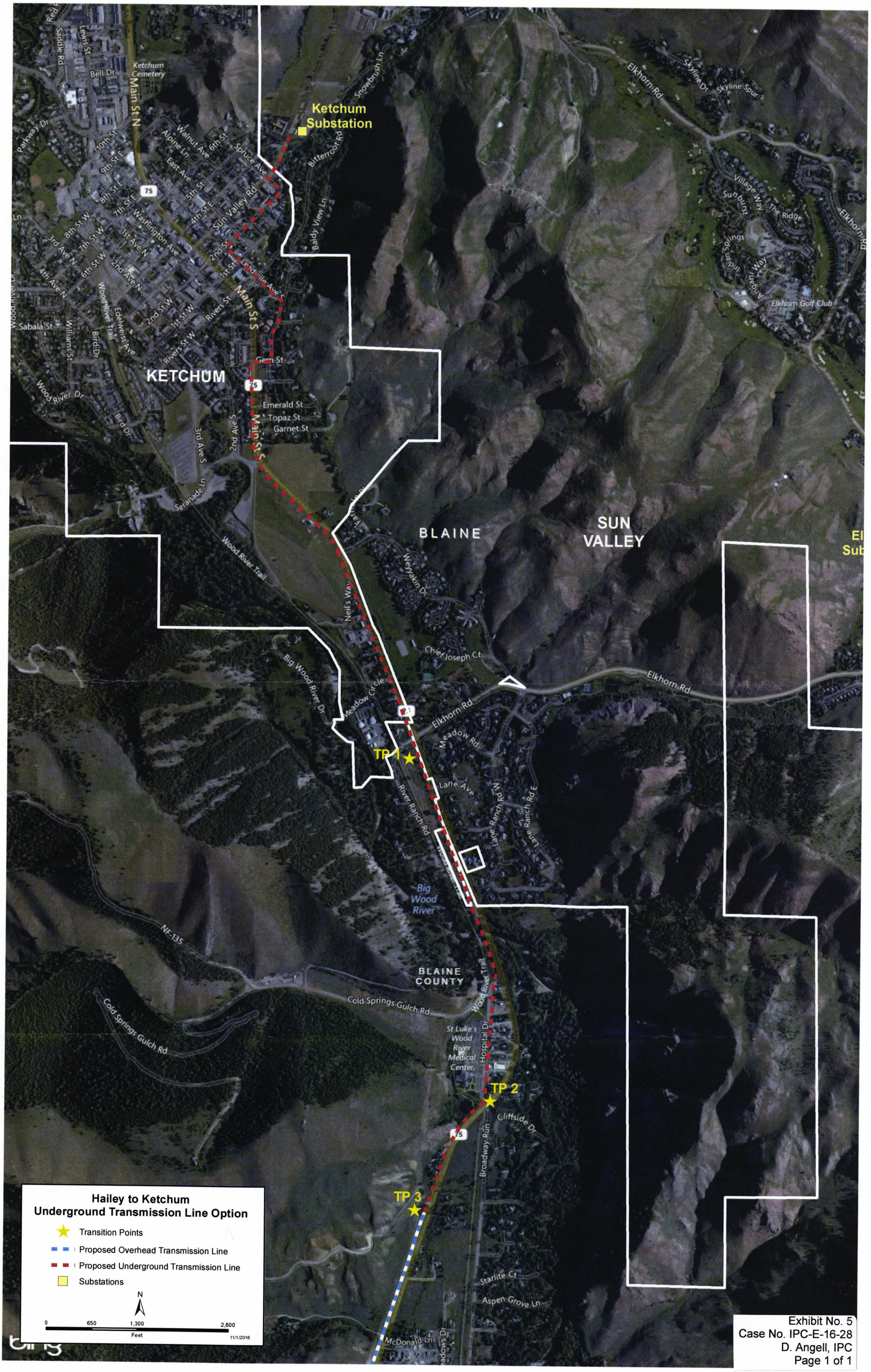

Exhibit No. 5
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EXHIBIT NO. 6

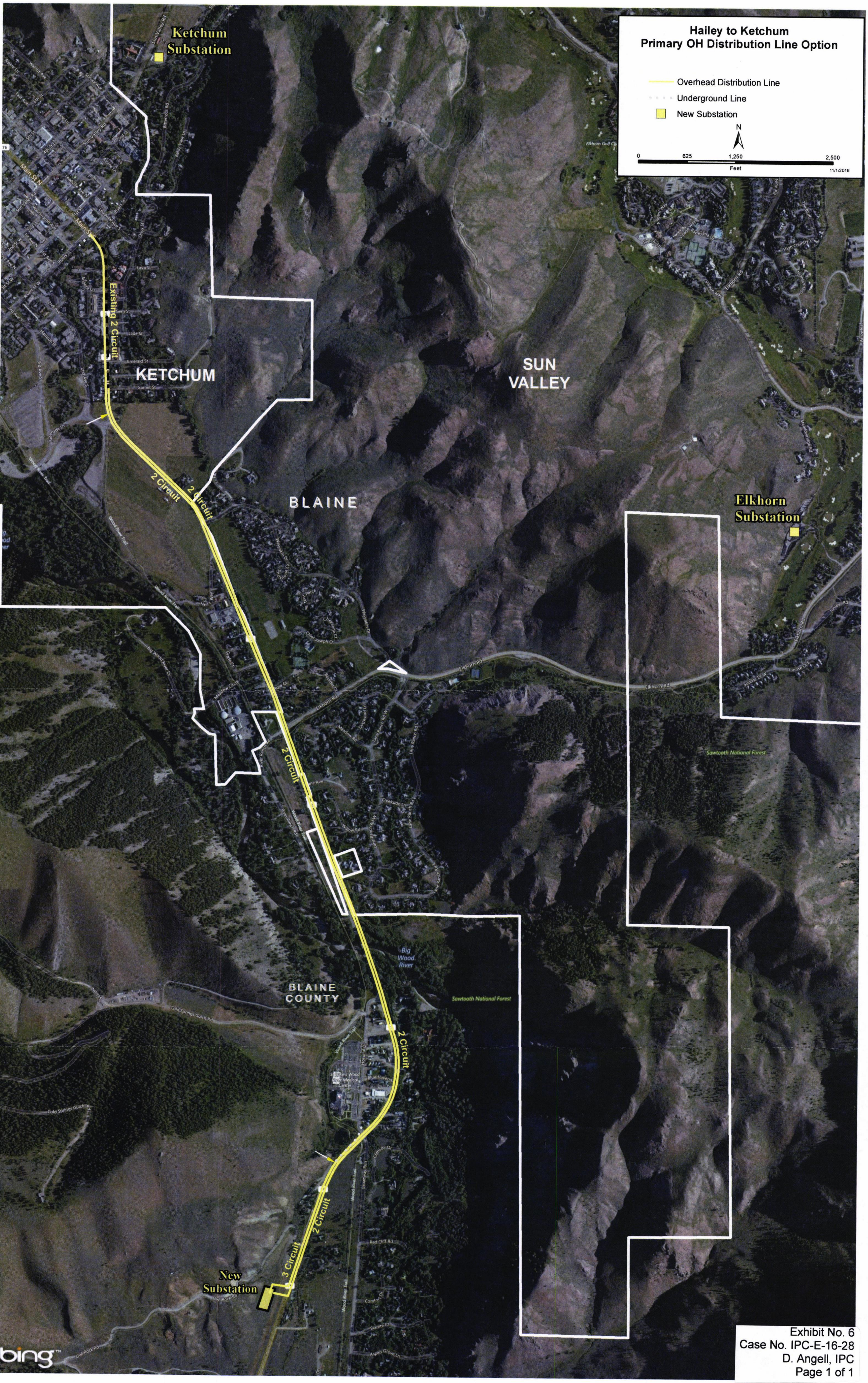

Exhibit No. 6
Case No. IPC-E-16-28
D. Angell, IPC