COMMUNITY MODEL

Creating a community map of the most suitable path for MSTI using information from county officials in Montana and Idaho

MSTI REVIEW PROJECT

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Produced for MSTI Review Project
by Sonoran Institute.

ABOUT THE MSTI REVIEW PROJECT

The MSTI Review Project is a joint effort between three Montana counties and five non-governmental organizations along the Montana-Idaho border to conduct an independent analysis of the Mountain States Transmission Intertie (MSTI).

For more information, please visit the project web site: www.mstireviewproject.org

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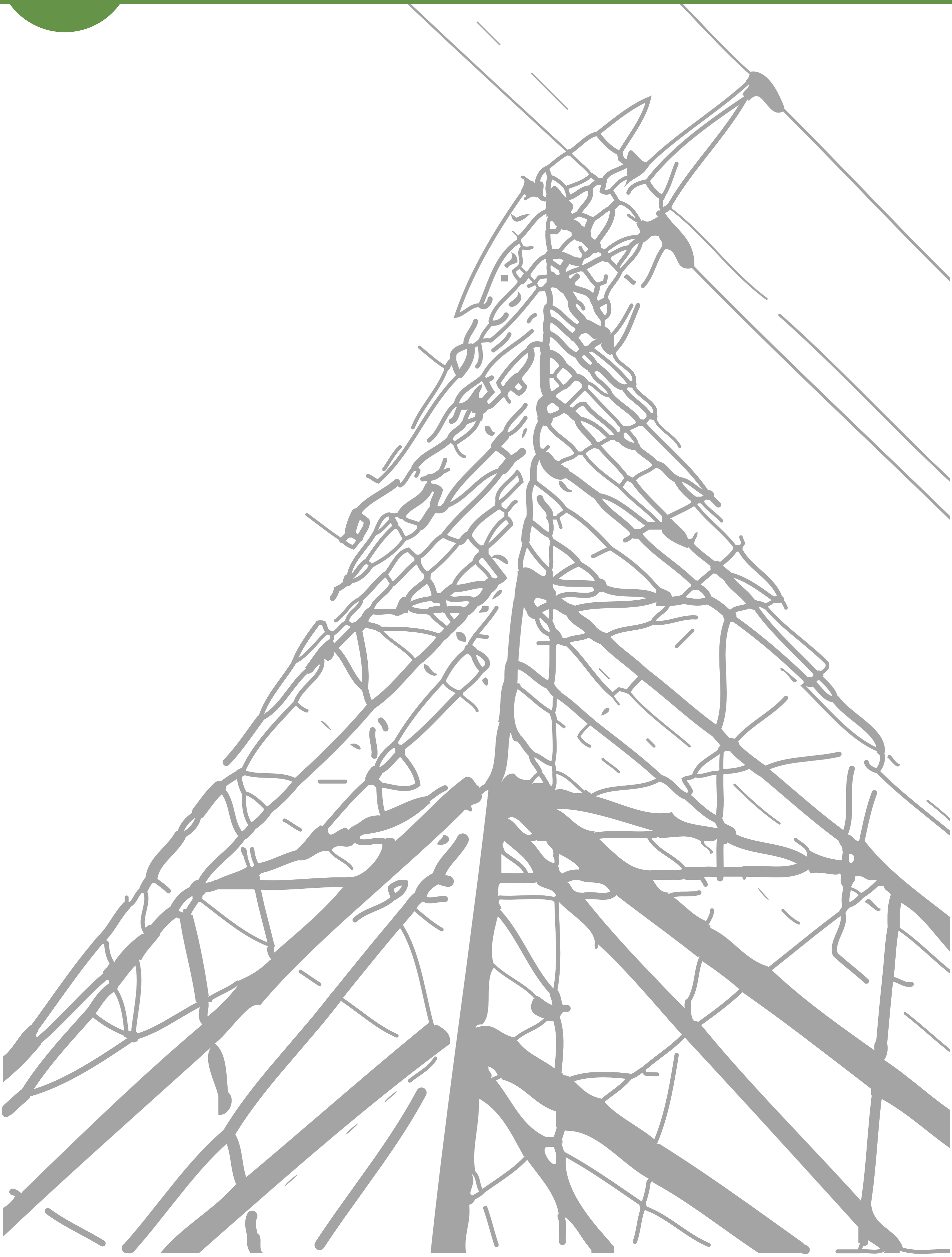


Introduction

The Mountain States Transmission Intertie (MSTI) proposed by NorthWestern Energy would be a 500 kV transmission line carrying energy from Townsend, Montana to Jerome, Idaho. The region of southwestern Montana and eastern Idaho this line would traverse is renowned for its abundant wildlife, scenic views, rural character, and outstanding outdoor recreation opportunities. A large transmission line in this area could potentially have significant impacts on communities and proper siting of the line will be essential to minimize those impacts.

To help inform siting decisions, the MSTI Review Project (MRP) developed a GIS-based community model. The model converts local values into maps, incorporating information on factors such as property, hunting and fishing, agriculture, scenic views, building density and recreation. The maps can be used to identify corridors and inform comments on routing options.

Concerns related to impacts on local community values from a 500 kV transmission line were quantified into maps, allowing us to objectively explore mapped community values.

The final products of the Community Model are:

1. A "*Values Surface*," which assigns locally scored community values to a map of the entire study area, at 90-meter intervals
2. A "*Community Values Corridor*," which represents a route from Townsend, Montana to Jerome, Idaho with the least possible impacts to the locally identified and prioritized community values along the way.

Limitations and Use Guidelines

This report details the methodology used to develop the MRP community values model as well as key findings of the analysis. As with any analysis of this nature, there are inherent limitations which should be borne in mind when interpreting results. These limitations include:

- **Spatial Resolution** – The model is intended to identify potential corridors but not specific routes. Route siting depends on the consideration of many local options at finer spatial scales than this model provides (90 meters or ~ 300 feet). Fine scale siting decisions could have significant impacts on community values and wildlife which are not reflected in this model. Therefore, the model should be interpreted at the corridor level for comparing one alternative to another with an assumption that the best route along any potential corridor will generally be toward the areas with the least accumulated impacts.
- **Regulatory Constraints** – To the extent practical, the model ignores regulatory constraints on transmission line siting in order to allow a better understanding of trade-offs involved in alternative routes. However, it was necessary to account for areas where transmission lines are explicitly or likely prohibited due to legal protections or management constraints. How these areas are treated in the model is described in detail under "Special Management Areas" below. Briefly, areas with legal designations which *might* restrict transmission lines were uniformly assigned maximum values and therefore are strongly avoided in the model. The degree to which transmission lines are *actually* restricted is site-specific and may be open to interpretation. The model therefore likely avoids some areas that on close examination do not restrict transmission lines and allows passing through some areas (although at maximum

cost) that in reality prohibit transmission lines. Where the model suggests routes that pass through or around designated Special Management Areas, users are cautioned to examine the specific restrictions that may apply.

- **Mitigation** – Some impacts of transmission can potentially be alleviated through mitigation measures. Mitigation options and costs are not incorporated in the MRP model. The model is designed to identify corridors that minimize potential impacts to locally identified and prioritized community values, which would theoretically minimize mitigation costs. The model may also aid with identifying areas where mitigation is necessary by examining areas where preferred routes intersect with high community values.

This report is divided into four sections: introduction, methods, results and discussion. The methods section includes an overview of our approach, a description of our pilot project, and an explanation of the community values spatial model. The results section details the outcome of the model and identifies our data sources. The discussion section describes the corridor identified by the community values model and addresses the consideration of this model in combination with the MRP wildlife model.

Methods

The community values model uses scores generated by local county officials to create a map of prioritized community values. This map can be used to identify high-value areas, and identify corridors with least possible cumulative community impact.

Overview of the Cost-Distance Modeling Approach

Cost-distance models are frequently used to identify paths or corridors of least resistance, highest efficiency, highest likelihood of use, or lowest impact between two or more locations on a landscape. In cost-distance modeling the term, "cost" is used generically to indicate areas that are difficult or undesirable to traverse. Costs can refer to any relative value such as monetary cost, energy expenditure, or impacts. With respect to the community model, "costs" refer to the perceived impacts to

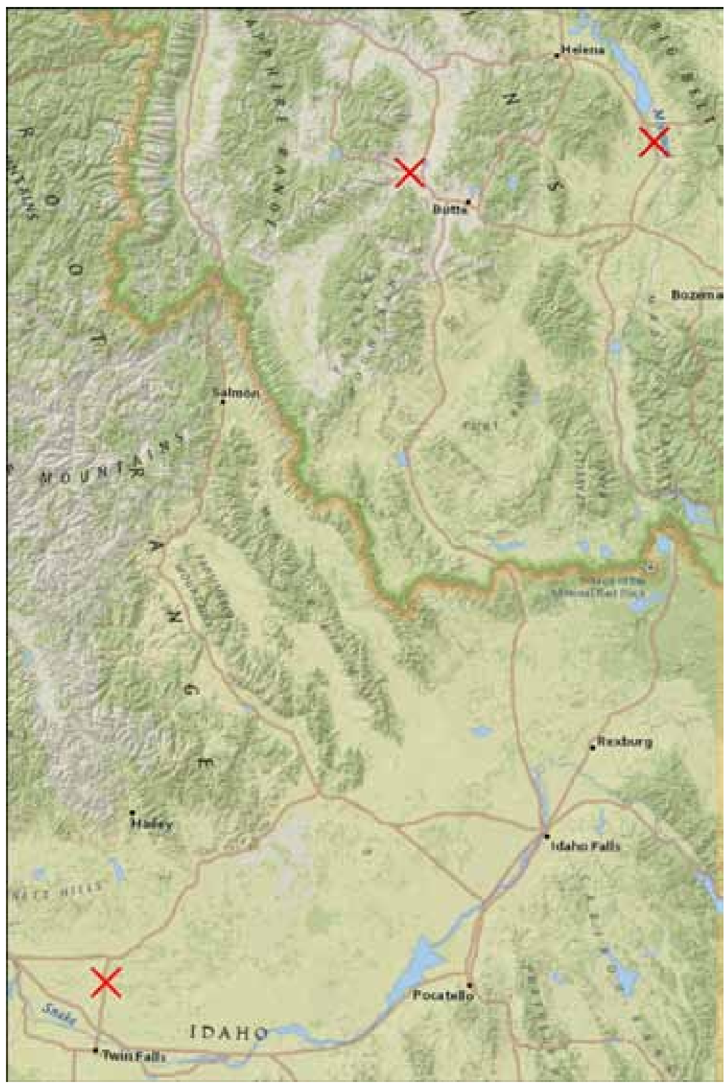


Figure 1: MRP study area, with start, finish and intermediate points

community value, as identified by community members, of a transmission line occurring in any particular 90-meter cell on the landscape.

The first step of cost-distance modeling is to divide the area of interest into gridded cells (90 meters or ~ 300 feet) and assign relative cost values to each cell. High costs represent areas to be avoided and low costs represent areas of low impact.

Next, a cost-distance map is generated from each source being modeled. A source is either an origin or destination for travel across the landscape. In other words, sources are the locations being traveled from or to.

The MRP community model was run in two variants with respect to sources. The first variation used a substation in Townsend, Montana as the starting point, and a substation in Jerome, Idaho as the destination of the proposed MSTI line. The second model used the same beginning and end points, but forced the model to the Mill Creek Substation near Anaconda, Montana.

A cost-distance map is created by multiplying the assigned cost of a cell by the distance of traveling across the cell. This is called the "cost-weighted distance." For example, the cost-weighted distance of traveling straight across a 90-meter cell with a cost value of 1 is:

$$1 \times 90 = 90$$

The cost-weighted distance of traveling across a 90-meter cell with a cost value of 2 is:

$$2 \times 90 = 180$$

Therefore, the effective distance of moving across the higher-cost cell is twice the distance of the lower-cost cell, whereas the actual distance is the same.

The least accumulated cost-weighted distance is then calculated by summing cost-weighted distances for all cells that are crossed to reach the source location. The cost-distance surface therefore represents the lowest possible effective distance between a cell and the source.

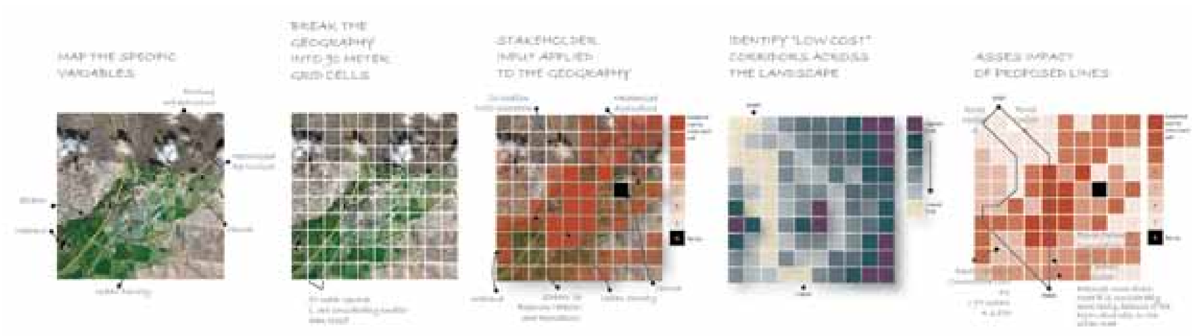


Figure 2: Cost distance modeling, conceptualized

MRP Pilot Project

In pilot phase of this project, we surveyed county commissioners from Jefferson and Madison Counties in Montana. The surveys were broken down into two parts: pair-wise ranking of broad themes, followed by weighting of more specific features within each theme. For example, the theme "land use" consisted of nine features: residential, conservation easement, irrigated

agriculture, commercial, agriculture, pasture, non-residential, industrial and undeveloped. “Land Use” was compared against other themes, such as “Recreation,” while the features within each theme were ranked individually from 1 to 9. The themes and features in the pilot project were developed with input from the Electric Power Research Institute, a non-profit organization based in Palo Alto, California.

Themes used in the MRP Pilot Project:

- *Major Property Lines*: No major property lines; Major property lines; Edge of field
- *Recreation*: Hiking – Lewis and Clark and Continental Divide Trails; Hunting and Angling; Other hiking/recreation; No recreational value
- *Historic Structures*: 0-1,500 feet; >1,500 feet
- *Viewshed*: Viewshed from recreational areas, historic areas, buildings, major roads; Viewshed already including buildings, major roads, transmission lines <100kV, transmission lines >100kV
- *Proximity to Buildings*: 0-300 feet; 300-600 feet; 600-900 feet; 900-1,200 feet; >1,200 feet
- *Building Density*: 4-25 buildings per acre; 1-4 buildings per acre; .2-1 buildings per acre; .05-.2 buildings per acre; 0-.05 buildings per acre
- *Land Use*: Residential; Conservation easement; Irrigated agriculture; Non-irrigated agriculture; Commercial; Pasture; Non-residential; Industrial; Undeveloped

Based on our work on the pilot project in Madison and Jefferson Counties, it was clear that the community values process needed to be adjusted to better fit our territory and respond to more detailed input. We also found we needed to make the survey easier to understand. Finally, we sought to reduce redundancy within the themes and features that could confound the survey process. For example, in the pilot project, residential values could be covered in any of three themes: *proximity to buildings*, *building density* and *land use*.

Moving forward into phase two of the community model, we worked to improve the variables going into the model, to refine and minimize the categorization of the variables, to improve the final scale of the model, and to make the survey process more intuitive for participants. We used feedback from the pilot project to reorganize the themes and features, and sought input from the MRP Project Liaison Group, both through meetings and through an informal survey.

Community Spatial Model – Description

The community values spatial model has two primary components:

1. The *survey component*, where community values are identified, weighted and scored (i.e., they are converted from internally held values, to quantifiable numeric scores)
2. The *mapping component*, where scores from the *survey component* are assigned to cells on a map, creating the community values map and least-cost corridors.

This methodology reflects our desire to accurately quantify local community values, and produce final maps that represent those values; and our desire to construct a completely transparent model that can be disassembled and examined component by component.

The variables used in the model, and the structure of the model, were determined by the Project Liaison Group—creating the model's *Features* and *Themes*.

- *Features* are the individual GIS layers that go into the model.
- *Themes* are groups of features that form a specific category, such as *land use* or *recreation*.

Community Values – Themes and Features

The first part of the survey structuring process was to identify the values that could potentially be impacted by a transmission line. These are the features and themes that ultimately become mapped variables in the spatial model. The values used in the pilot phase accurately captured the bulk of people's concerns. However, some variables were conspicuously missing from the pilot phase, and some variables were included in the pilot phase that were not deemed important and only added clutter to the model.

In order to obtain a definitive list of important variables that should be included in the model, we held several meetings with the Project Liaison Group, using their input to identify the most important variables for the community model. As much as possible, we incorporated all of their suggestions, within the constraints of data availability and the inherent limitations of spatial modeling.

Themes and features in the MRP community model:

- *Land Ownership: Public; Private* – This theme reflects the importance of private property values in Montana and Idaho. While the pilot phase of the project offered implicit ways to value private lands (i.e., residential, agricultural, and commercial land uses) the members of the Project Liaison Group felt that the importance of this subject merited its own category.
- *Land Use/Land Cover: Forest; Grassland; Riparian/Wetland; Sprinkler agriculture; Non-sprinkler agriculture; Residential areas; Commercial areas; Conservation easements; Industrial areas* – This theme is a hybrid of traditional "land use" and "land cover" GIS layers. "Land use" is typically applied to human-dominated environments where the land cover has been converted to anthropocentric uses, while "land cover" is typically applied to the vegetative cover on the ground. Given the large portions of non-converted vegetation in the study area, we felt that merging these two data types into a single theme would be the most appropriate and intuitive for workshop participants, while effectively incorporating such things as agriculture, which is both a *land use* and a *land cover*.
- *Residential/Commercial Density: More than 40 acres per house; 10 or more acres per house; 1-10 acres per house; Less than one acre per house; Downtown/City center; Historic residential or commercial areas* – Many people expressed the sentiment that a transmission line is an eyesore regardless of whether you live in the country or in the city; however, transmission lines in locations with higher population densities potentially constitute an eyesore to greater numbers of people. This theme allows workshop participants to value the difference between high and low population densities. It is also one of the categories where similar population-dependent concerns can be voiced, such as health concerns, electric and magnetic fields, and audible noise.
- *Existing Infrastructure or Industry (Co-location): High-voltage transmission lines (230kV or more); Low-voltage transmission lines (less than 230kV); Interstate highways; Highways*

other than interstates; Scenic Highways; Industrial facilities; Historic infrastructure or industry; Railroads; Existing rights-of-way – This theme reflects the fact that the study area already has major linear infrastructure crossing it, and the Project Liaison Group felt that workshop participants might prefer to place new infrastructure next to existing infrastructure. While there are engineering and regulatory limits on how close new infrastructure can be to old, this theme allows participants to place a value on clustering infrastructure.

- *<u>Recreation</u>: Motorized; Non-motorized; Creeks; Rivers; Lakes; Historic trails; Historic Districts; Hunting* – The MSTI study area is renowned for exceptional recreation opportunities, improving the quality of life for residents as well as the tourist appeal of the region. While recreation can be difficult to map, we attempted to include as many recreational features as possible.

- *<u>Scenic Views</u>: Natural/Pristine; Pastoral; Moderately impacted; Highly impacted* – Impacts to views are one of the primary criticisms of transmission lines, and the Project Liaison Group felt that it merited attention in the community values model. We broke views up into four basic classifications, based on feedback from the Project Liaison Group.

Variables Removed:

- *Major Property Lines* – This theme, addressing the potential advantage of placing transmission lines on property lines, rather than across the center of a property, caused sufficient confusion in the first version of the model to be deemed unhelpful and was removed from the final model.

- *Historic Structures* – Instead of having historic structures as an entire theme, they were incorporated as variables within other themes in our final model. We felt this more accurately reflected values represented in the area and inconsistencies associated with historic data.

- *Distance from Buildings* – This category confused many of the respondents in the pilot project. Many people commented that it was difficult to conceptualize distances in feet. Also, this category created some redundancy with respect to residential land uses. This theme was not entirely eliminated, but rather restructured into a residential/commercial density theme.

Unusable Variables:

- *Agricultural safety/pipe movers* – This was suggested by the Project Liaison Group because of electric and magnetic force concerns and reports that agricultural workers have been shocked while working with wet metal agricultural pipes in close proximity to high-voltage power lines. However, no GIS layer explicitly addresses agricultural safety. Instead, we asked that workshop participants consider safety issues when valuing agricultural land uses in the Land Use/Land Cover theme.

- *GPS interference/GPS agriculture/Aerial spraying safety* – This was suggested by the Project Liaison Group because of concerns over the logistical nuisances produced by transmission lines. No GIS layer explicitly tracks GPS-enabled agriculture or aerial spraying. Instead, we asked that workshop participants consider all logistical nuisances resulting from transmission lines when valuing agricultural land uses in the Land Use/Land Cover theme.

- *Lands Enrolled in the Conservation Reserve Program (CRP)* – We could not find reliable GIS layers to represent this feature.
- *Livestock* – Livestock and ranching are important to the economy of the study area and there are concerns about the impact of high-voltage transmission lines to livestock and livestock workers. However, there are no GIS-explicit layers addressing livestock, and because ranching in the study area depends on grazing allotments on public lands, we felt that it was best represented by grasslands in the Land Use/Land Cover theme.

Community Values Survey

In order to assign values to the features and themes, we surveyed county officials and county staff members at two workshops in Pocatello, Idaho and Butte, Montana. There were ten participants in Idaho, representing eight counties, and seven in Montana, representing five counties.

The strategic decision to rely on input from commissioners—rather than the general population or affected property owners—reflected our hope for protecting our results from the strong concerns of a few special interests. The commissioners were instructed to represent their constituents as a whole, not just a concerned few.

The goal of the survey was to quantify local opinions regarding transmission lines. While many people are comfortable describing in narrative or anecdotal form the types of places they feel should be protected from transmission lines, those descriptions cannot be used by spatial modeling software and they cannot be aggregated consistently to reflect the combined sentiment of several stakeholders.

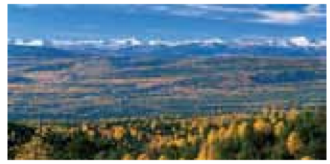
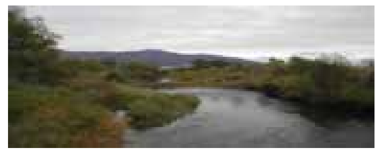
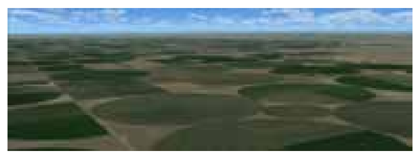
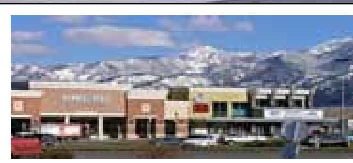
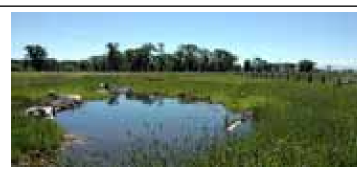
Our survey asked respondents to assign numerical values to various spatial characteristics in order to develop our community map. Based on the survey responses, we could calculate the relative importance of broad themes on the landscape—such as land ownership, land use, and scenic views. Within each theme, the survey results provided scores for more specific features—like private land vs. public land within the land ownership theme.

We used two question formats in our workshops:

1. *Pair-wise comparisons of themes:* We asked participants to compare the importance of one theme against another. This was done for all six themes. For example, the question below asks the respondent to place a relative value on residential/commercial density versus recreation.

	More Strongly					Equal				More Strongly	
Residential/ Commercial Density: rural, suburban, urban, downtown, historic	5	4	3	2	1	0	1	2	3	4	5	Recreation: Motorized, Non-Motorized, Creeks, Rivers, Lakes, Historic Trails, Historic Districts, Hunting

2. *Feature scoring:* We asked participants to score individual variables on a scale of one to nine, with one being the best place for a transmission line and nine being the worst. For example, respondents used a grid like the one shown below to score the features within the Land Use/ Land Cover theme. Pictures were provided for illustrative proposes.

Feature		Score (1 → 9)
Forest		
Grassland		
Riparian/ wetland		
Agriculture: without center pivots or wheel lines		
Agriculture: Center pivots & wheel-lines		
Residential areas		
Commercial areas		
Conservation easements		
Industrial areas		

This format of themes and features gives the model a hierarchical structure, where features are nested within themes. The broad themes drive the large-scale corridor choices, and more specific features help with finer scale decisions.

Data Processing

Six themes were ranked in order of importance using an analytic hierarchy process (AHP). The themes were Scenic Views, Land Use/Land Cover, Land Ownership, Recreation, and Existing Infrastructure/Industry. Respondents were asked to rank each theme against the others in a pair-wise comparison. A total of 15 comparisons were submitted by each of the 17 survey respondents.

Results from the survey were then entered into an Excel spreadsheet to perform the AHP. The AHP calculations convert the 15 pair-wise comparisons to a numerical ranking showing the relative importance of each of the six themes expressed as a percent. To calculate the overall ranking for the 17 respondents, the geometric mean of the responses was used. Literature on AHP indicates that the geometric mean provides a more accurate reflection of group preferences than the arithmetic mean, or average.[1]

The features within each theme were scored from 1 through 9, with 9 representing the features that should be most protected from transmission lines, and 1 representing the features that need the least protection from transmission lines. The scores for the features were averaged using the arithmetic mean.

In order to achieve a necessary degree of resolution for mapping, the average feature scores were then stretched to fit into a scale of 1 through 100. Within each theme, the feature with the lowest average score received a value of 1, and the highest average score received a value of 100. Intermediate values were stretched proportionately within the scale from 1 through 100.

In order to calculate the weighted score of each feature, the stretched score was multiplied by the percent influence of its respective theme, as follows:

[percent influence of theme] x [stretched score of feature] = weighted score for mapping

Each theme was processed by aggregating each respective set of features into a single layer, creating six unique and independent community value surfaces. The next section describes in detail the results for each feature and theme.

Results

GIS data were collected or created for each of the 38 features in Idaho and Montana. Due to differences in data availability and formatting between the two states, there are some slight differences in the data used to represent similar variables in each state. For example, in Montana, land irrigated by center pivot sprinkler has been comprehensively digitized, whereas center-pivot irrigation in Idaho must be inferred from crop-type datasets and cross-checked with aerial imagery. Therefore, we processed the results for Idaho and Montana separately before combining the results in the final model.

Feature scores are multiplied by the weight of their respective theme to create the individual cost surfaces

Features (for scoring)	MT Score	ID Score
Private	100	100
Public	1	1
Forest	9	62
Grassland	41	9
Riparian/wetland	62	64
Agriculture: without center pivots or wheel lines	89	86
Agriculture: center pivots and wheel lines	100	100
Residential areas	98	84
Commercial areas	68	82
Conservation easements	37	64
Industrial areas	1	1
More than 40 acres per house	1	1
10 or more acres per house	34	65
1-10 acres per house	53	84
Less than one acre per house	67	91
Downtown/city center	92	100
Historic areas: residential or commercial	100	100
High-voltage transmission lines (230 kV or more)	15	1
Low-voltage transmission lines (less than 230 kV)	29	8
Interstate highways	48	8
Highways other than interstates	53	38
Scenic highways	97	100
Industrial facilities	1	16
Historic infrastructure or industry	100	82
Railroads	20	10
Existing rights-of-way	20	3
Motorized (Front Country)	1	1
Non-motorized (Back Country)	70	82
Creeks/fishing (non-floatable)	78	93
Rivers/fishing (floatable)	81	100
Lakes	84	84
Historic trails	84	75
Historic districts	100	68
Hunting	23	42
Natural	100	91
Pastoral/agricultural	85	100
Moderately impacted	43	57
Highly impacted	1	1

Themes (for paired comparisons)	MT Weight	ID Weight
Land Ownership	46%	36%
Land Use/Land Cover	13%	16%
Residential/Commercial Density	10%	10%
Existing Infrastructure or Industry (Co-location)	17%	22%
Recreation	7%	9%
Scenic Views	8%	6%

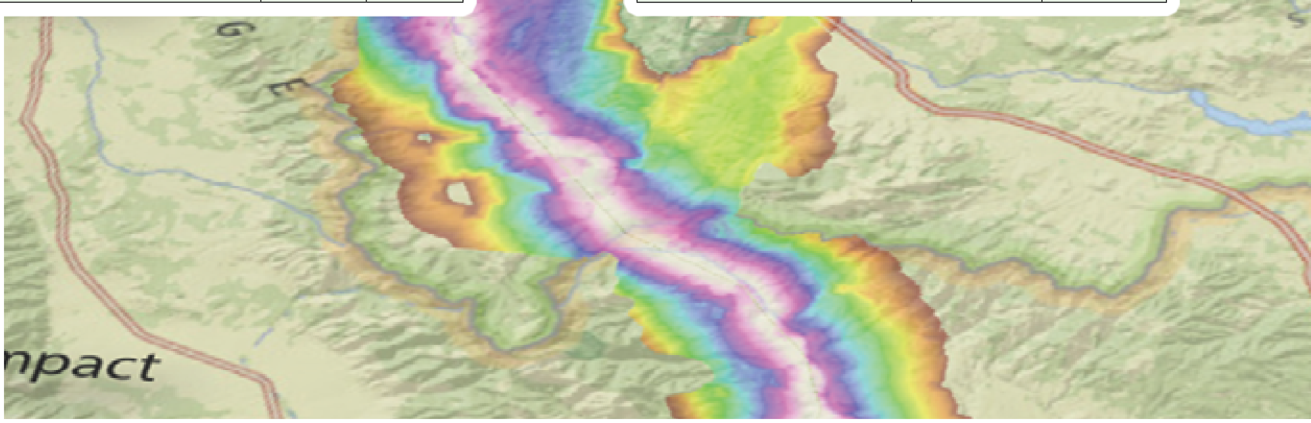
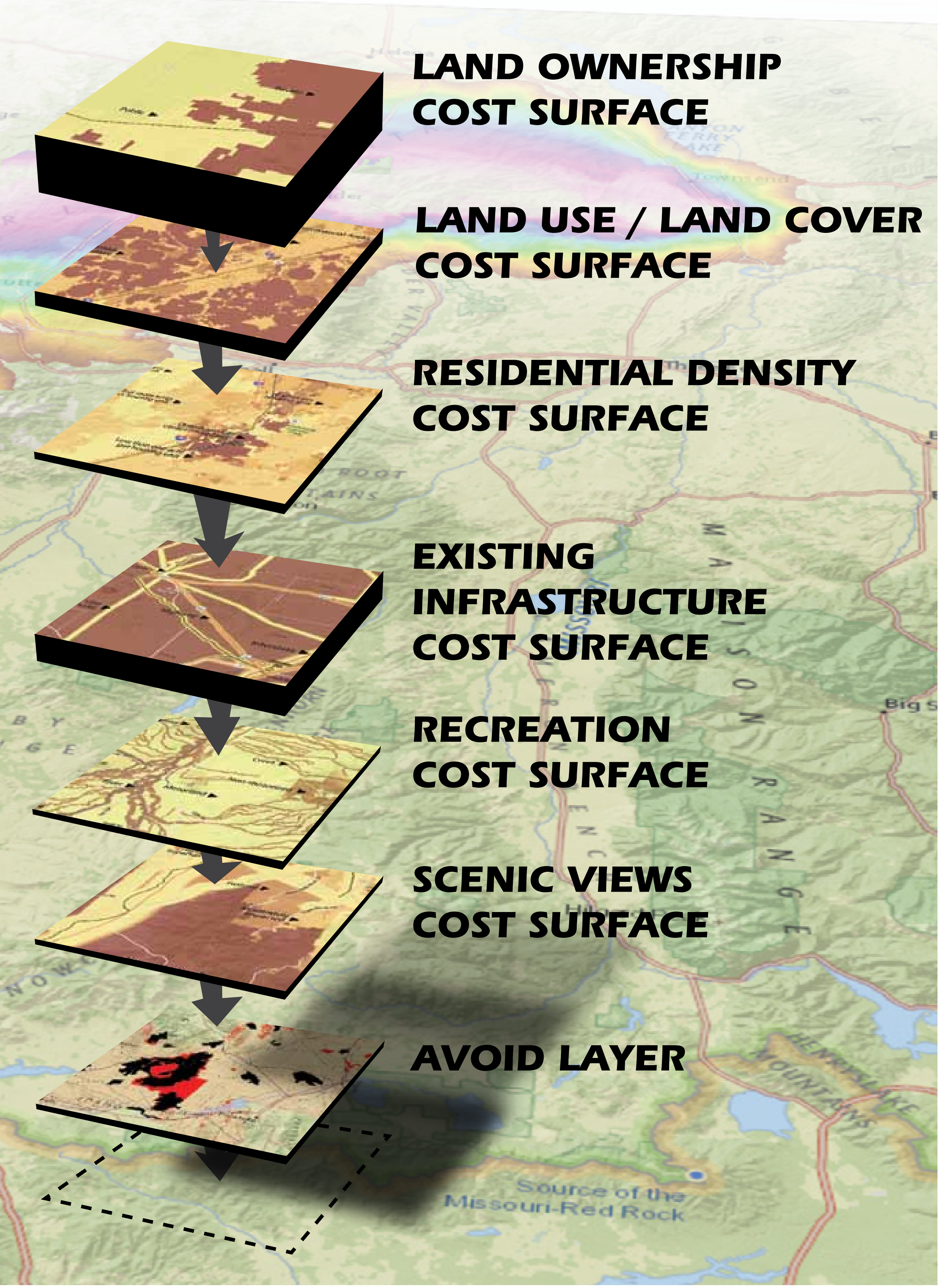


Figure 3: MRP community values model diagram



Summary: Results for Themes and Features

Land Ownership

In both states, based on the results of our survey, private land ownership is the most highly defended feature of the community values model. This means that the model tries to find corridors that maximize use of public lands, and minimize use of private lands, except where no public land is available. Land Ownership is a large driver of the model and also a comparatively simple theme to the model.

In Montana, Land Ownership information was derived from county cadastral data. In Idaho, Land Ownership information was derived from an online statewide surface management data layer.[2]

In Montana, these values were averaged and classified as follows:

LAND OWNERSHIP	Average Score	Stretched Score	Weighted Score
Private	8.71	100	46.00
Public	1.71	1	0.46

In Idaho, these values were averaged and classified as follows:

LAND OWNERSHIP	Average Score	Stretched Score	Weighted Score
Private	9.00	100	36
Public	1.11	1	0.36

LAND OWNERSHIP

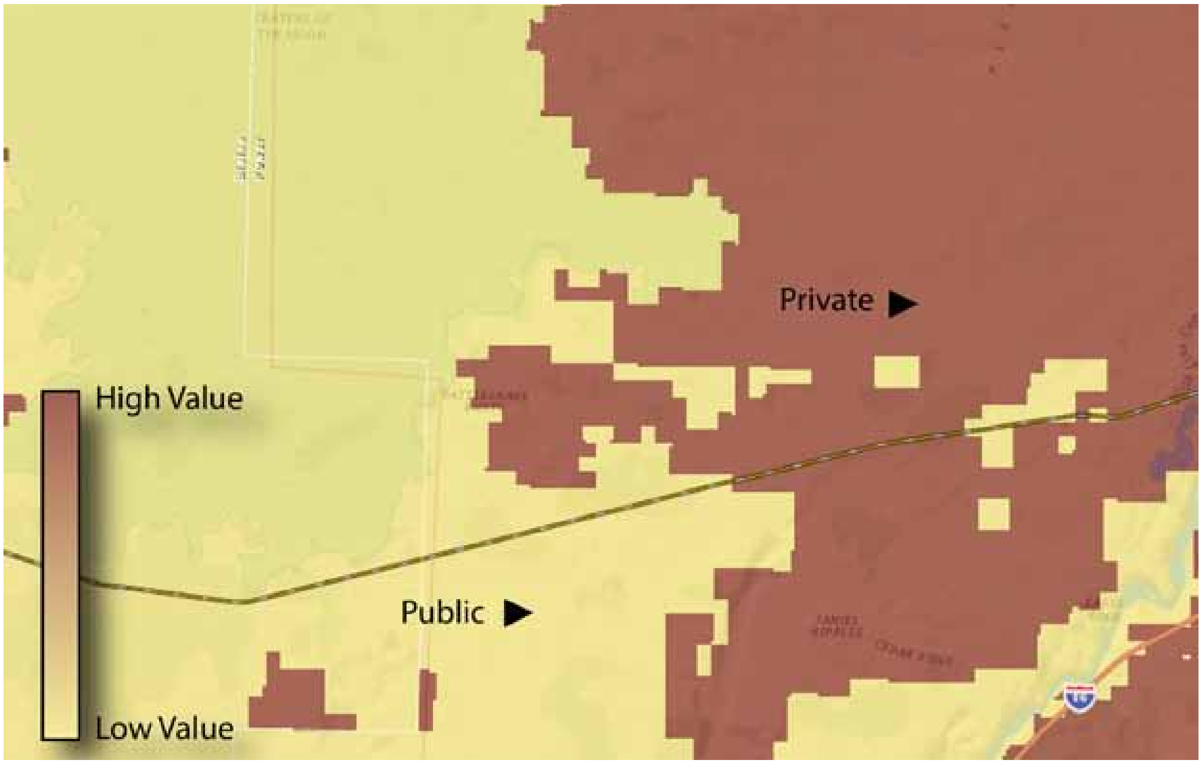


Figure 4: Land ownership example (please visit www.MSTIreviewproject.org for complete maps)

Land Use/Land Cover

Land use and land cover data comes from a variety of sources, constituting the most diverse theme in the model. The features in the Land Use/Land Cover theme are forest, grassland, riparian/wetland, agriculture: without center pivots or wheel lines, agriculture: center pivots and wheel lines, residential areas, commercial areas, conservation easements and industrial areas.

In Montana, *Forest*, *Grassland*, *Riparian* and *Wetland* layers are derived from the Montana Land Cover dataset .[3] The *Agriculture* features—both with and without center pivots and wheel lines—are derived from the Montana Revenue Final Land Use layer, which distinguishes between irrigation types on agricultural land for the purposes of property valuation.[4] *Commercial*, *Residential* and *Industrial* areas are derived from cadastral datasets for each county in the study area. *Conservation Easements* are derived from the Montana Conservation Easements layer, maintained at the Natural Resource Information System website.[5]

In Idaho, *Forest, Grassland, Riparian* and *Wetland* layers are derived from the Idaho Gap dataset.[6] *Agriculture* types are derived from the National Agricultural Statistics Service CropScape data .[7] *Commercial, Residential* and *Industrial* areas are derived from the NPScape data from the National Park Service. *Residential* areas were considered to be those areas with a residential density higher than 40 acres per dwelling and not considered as agricultural. The NPScape dataset combines commercial and industrial land uses; so, for the purposes of this model they were split by assuming that commercial/industrial cells adjacent to high residential density were in fact commercial centers (i.e., downtowns) and commercial/industrial cells not adjacent to any residential density were industrial areas. These assumptions were tested in Montana, where industrial and commercial land uses are recorded in the cadastral, and found to be sufficiently accurate for the purposes of this model. *Conservation Easements* are derived from proprietary layers from each of the land trusts operating in this portion of Idaho.

In Montana, these values were averaged and classified as follows:

LAND USE / LAND COVER	Average Score	Stretched Score	Weighted Score
Forest	2.29	9	1.23
Grassland	4.43	41	5.33
Riparian Wetland	5.86	62	8.07
Agriculture: Sprinkler	7.71	89	11.63
Agriculture: No Sprinkler	8.43	100	13.00
Residential Areas	8.29	98	12.73
Commercial Areas	6.29	68	8.89
Conservation Easements	4.14	37	4.79
Industrial Areas	1.71	1	0.13

In Idaho, these values were averaged and classified as follows:

LAND USE / LAND COVER	Average Score	Stretched Score	Weighted Score
Forest	5.44	62	9.98
Grassland	2.44	9	1.43
Riparian Wetland	5.56	64	10.30
Agriculture: Sprinkler	6.78	86	13.78
Agriculture: No Sprinkler	7.56	100	16.00
Residential Areas	6.67	84	13.47
Commercial Areas	6.56	82	13.15
Conservation Easements	5.56	64	10.30
Industrial Areas	2.00	1	0.16

LAND USE / LAND COVER

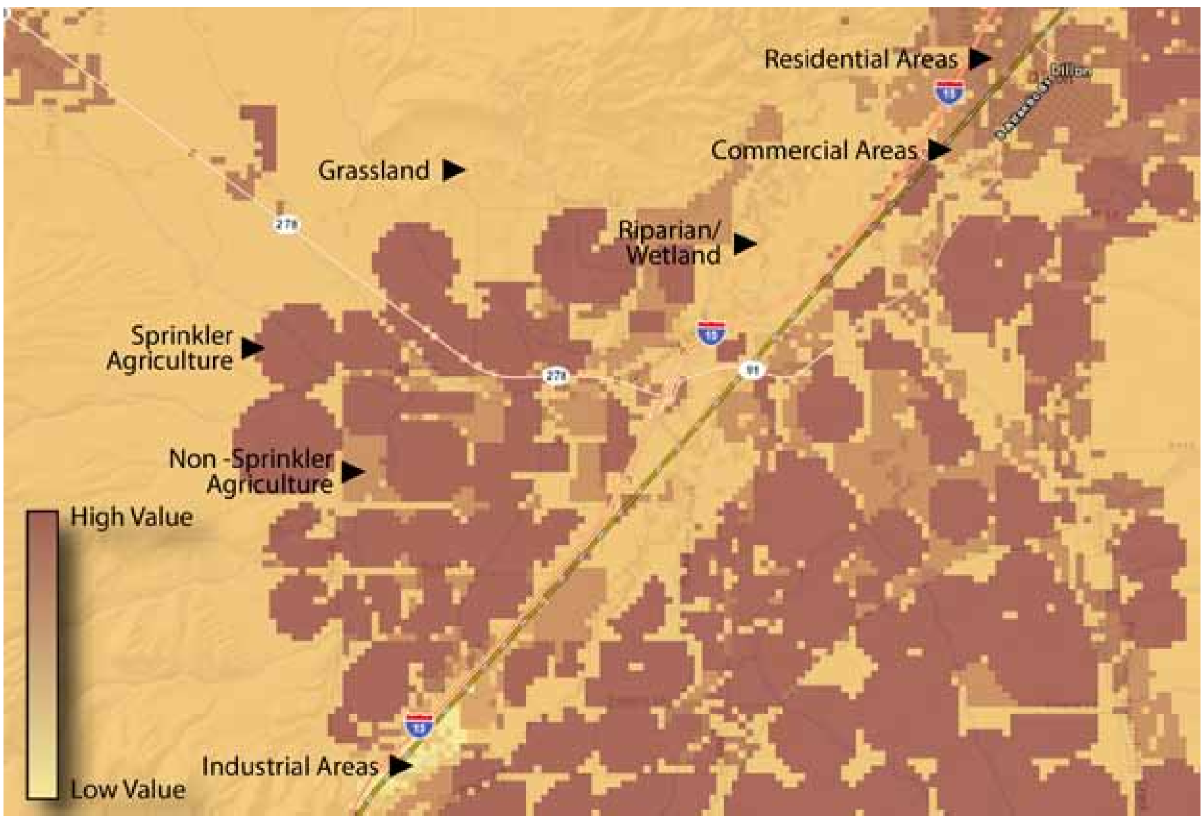


Figure 5: Land use/ Land Cover example (please visit www.MSTIreviewproject.org for complete maps)

Residential/Commercial Density

Residential housing density was estimated using NPScape data from the National Park Service. Because the MSTI study area straddles the Great Basin and Great Northern regions of the NPScape dataset, housing raster files were downloaded for both regions. These files were clipped to the MSTI area counties and then combined into a single raster file representing housing density for the area. [8]

This file forms a 100-meter grid, with each cell having a value between 0 and 12. Cells with a value of zero are classified as public land or private undeveloped land, and 12 represents commercial and industrial land. Values from 1 to 11 show increasing residential density from less than 1.5 units per square kilometer to more than 2,470 units per square kilometer. These categories were combined into six features for the purpose of our study (see tables below), and reclassified to 90-meter grid cells. We included residential housing density ranging from more than 40 acres per housing unit up to less than one acre per housing unit. We categorized areas with mixed residential and commercial properties as "downtown/city center."

In Montana, these values were averaged and classified as follows:

RESIDENTIAL/COMMERCIAL DENSITY	Average Score	Stretched Score	Weighted Score
More than 40 Acres per housing unit	3.14	1	0.10
10 or more Acres per housing unit	4.86	34	3.40
1-10 acres per housing unit	5.86	53	5.33
Less than one acre per housing unit	6.57	67	6.70
Downtown/city center (mixed commercial and residential)	7.86	92	9.18
Historic areas	8.29	100	10.00

In Idaho, these values were averaged and classified as follows:

RESIDENTIAL/COMMERCIAL DENSITY	Average Score	Stretched Score	Weighted Score
More than 40 Acres per housing unit	2.33	1	0.10
10 or more Acres per housing unit	5.44	65	6.55
1-10 acres per housing unit	6.33	84	8.39
Less than one acre per housing unit	6.67	91	9.08
Downtown/city center (mixed commercial and residential)	7.11	100	10.00
Historic areas	7.11	100	10.00

RESIDENTIAL/COMMERCIAL DENSITY

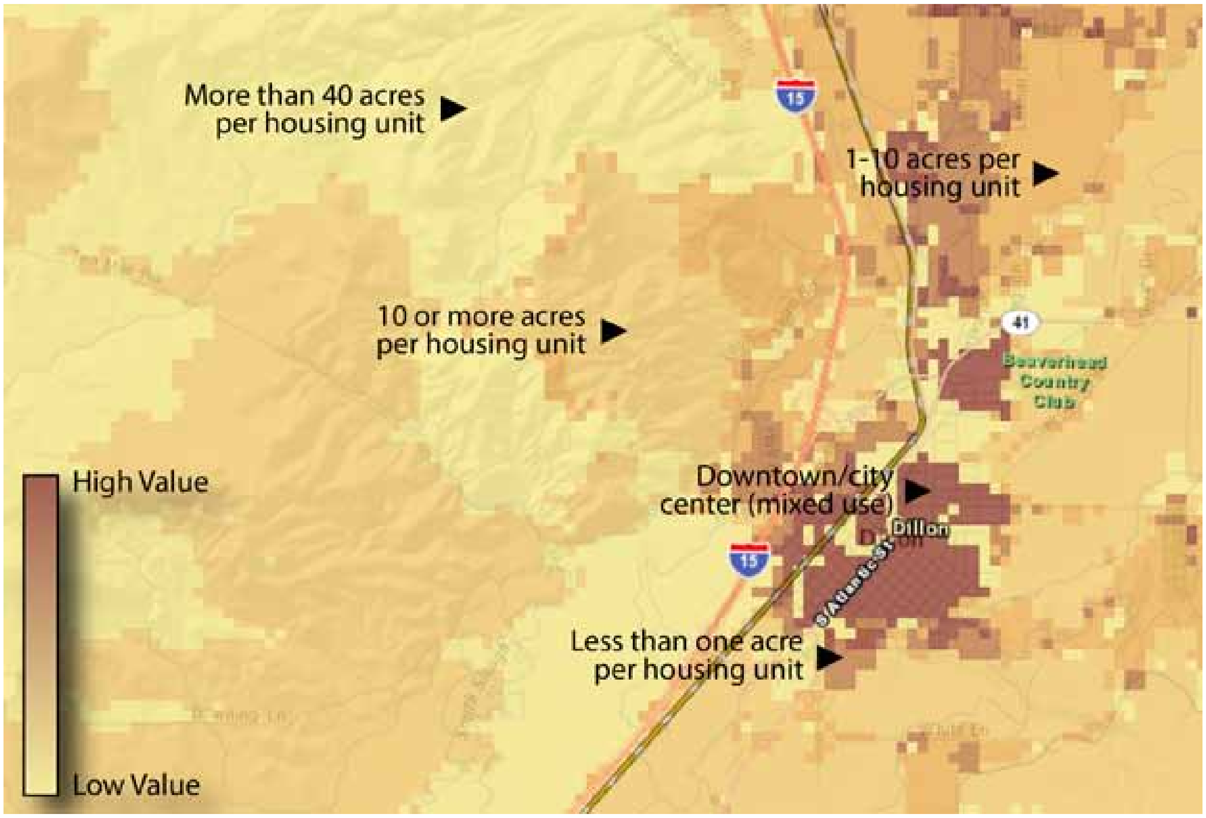


Figure 6: Residential/commercial density example (please visit www.MSTIreviewproject.org for complete maps)

Existing Infrastructure or Industry (Co-location)

At the workshops, existing infrastructure was considered one of the most important themes in the analysis. Many survey respondents favored siting new transmission lines in areas where infrastructure such as highways and power lines already exist. Given the strong influence awarded this theme, clusters of existing infrastructure on private lands are the only types of private lands that appear in the community values corridor.

GIS data on existing transmission lines was provided by NorthWestern Energy and separated into large and small transmission lines. Interstate highways, other highways and railroads were derived from TIGER data.[9] GIS data for historic infrastructure and industry, and industrial facilities (as distinguished from industrial land use) was not consistent enough across the study area to use. Scenic highways/byways data were derived from state and national organizations.[10]

In Montana, existing rights of way were derived from county cadastral datasets. In Idaho, a consistent right of way layer was not available, so none was used.

In Montana, these values were averaged and classified as follows:

EXISTING INFRASTRUCTURE	Average Score	Stretched Score	Weighted Score
High-voltage transmission lines (230kV or more)	1.67	1	0.22
Low-voltage transmission lines (less than 230kV)	2.00	8	1.67
Interstate highways	2.00	8	1.67
Highways other than interstates	3.56	38	8.45
Scenic Highways	6.67	100	22.00
Industrial facilities	2.44	16	3.61
Historic infrastructure or industry	5.78	82	18.13
Railroads	2.11	10	2.16
Existing rights-of-way	1.78	3	0.70

In Idaho, these values were averaged and classified as follows:

EXISTING INFRASTRUCTURE	Average Score	Stretched Score	Weighted Score
High-voltage transmission lines (230kV or more)	1.67	1	0.22
Low-voltage transmission lines (less than 230kV)	2.00	8	1.67
Interstate highways	2.00	8	1.67
Highways other than interstates	3.56	38	8.45
Scenic Highways	6.67	100	22.00
Industrial facilities	2.44	16	3.61
Historic infrastructure or industry	5.78	82	18.13
Railroads	2.11	10	2.16
Existing rights-of-way	1.78	3	0.70

Figure 7: Existing infrastructure example (please visit www.MSTIreviewproject.org for complete maps)

Recreation

The recreational opportunities in the study area are renowned. These opportunities add to the quality of life of local residents and are sources of income from tourism. It can be difficult to map high-quality recreation areas, because maps identifying important recreational areas are often not available in GIS.

The recreation theme is composed of eight features: motorized, non-motorized, creeks, rivers, lakes, historic trails, historic districts, and hunting. *Creeks* and *Rivers* were derived from the National Hydrology Dataset (NHD). *Rivers* were defined to be all "floatable" streams, while *Creeks* were "non-navigable."[11] Historic trails in the study area were the Nez Perce Trail, the Oregon Trail, the Lewis and Clark Trail, and the Continental Divide trail.

In Montana, motorized and non-motorized recreation was available from the travel management plan of the Beaverhead–Deerlodge National Forest. Data from this GIS layer covered nearly the entire Montana portion of the study area and was interpolated from lines on the map into a 90-meter grid. In portions of the study area where we could not obtain a travel management plan, motorized use was defined as within two miles of national forest boundary or mapped roads, while national forest lands occurring more than two miles from the boundary or mapped roads were considered non-motorized.

Hunting areas were determined using data from the Theodore Roosevelt Conservation Partnership (TRCP).[12] Historic districts were derived from the Montana NRIS historic districts dataset.[13]

In Idaho, travel management plans for the national forests were not available in GIS format, so motorized use was defined as within two miles of national forest boundary, while national forest lands occurring more than two miles from the boundary were considered non-motorized.

The TRCP hunting survey is not available for Idaho, so hunting areas were defined as state wildlife management areas, established to protect wildlife habitat and available for hunting, fishing, and other public enjoyment of wildlife.

Historic districts in Idaho were not available consistently across the study area and were not included in the analysis, because that would skew the results against areas without data to represent their historic districts.

In Montana, these values were averaged and classified as follows:

RECREATION	Average Score	Stretched Score	Weighted Score
Motorized	2.29	1	0.07
Non-Motorized	5.86	70	4.88
Creeks	6.29	78	5.46
Rivers	6.43	81	5.65
Lakes	6.57	84	5.85
Historic Trails	6.57	84	5.85
Historic Districts	7.43	100	7.00
Hunting	3.43	23	1.61

In Idaho, these values were averaged and classified as follows:

RECREATION	Average Score	Stretched Score	Weighted Score
Motorized	2.67	1	0.09
Non-Motorized	6.56	82	7.34
Creeks	7.11	93	8.38
Rivers	7.44	100	9.00
Lakes	6.67	84	7.55
Historic Trails	6.22	75	6.72
Historic Districts	5.89	68	6.10
Hunting	4.67	42	3.82

RECREATION

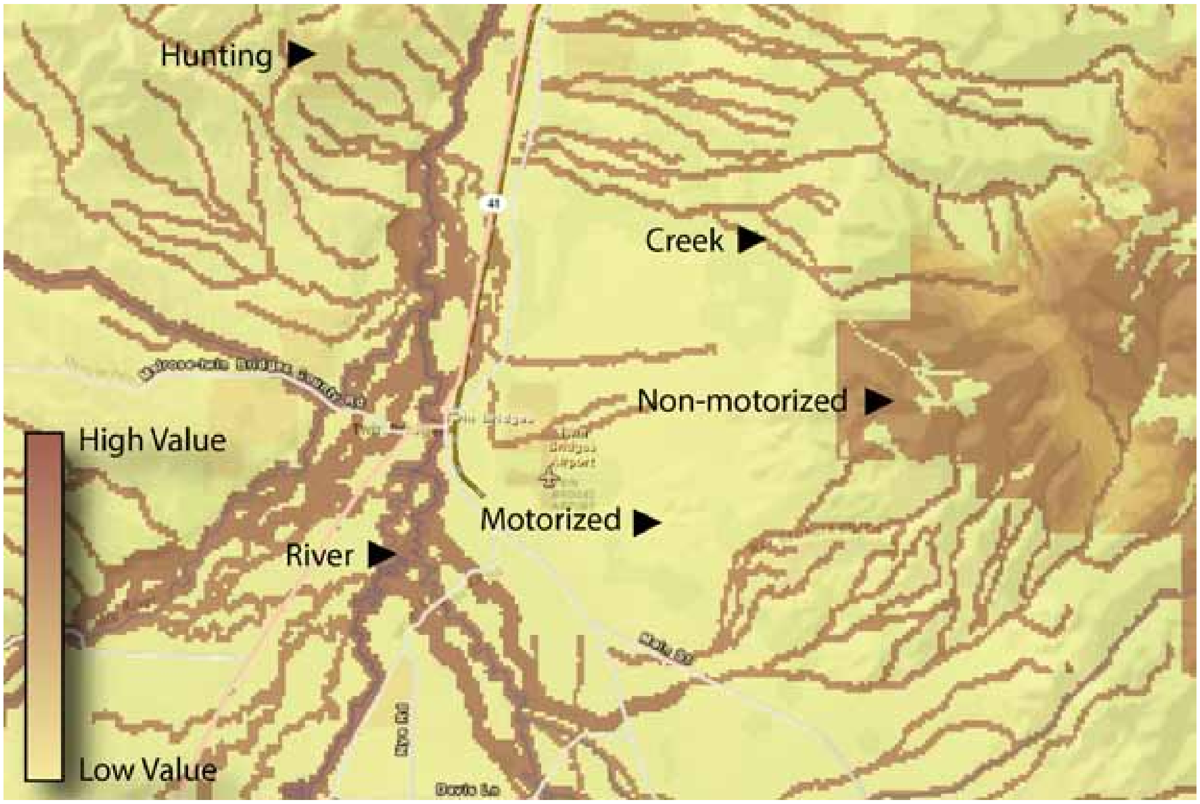


Figure 8: Recreation example (please visit www.MSTIreviewproject.org for complete maps)

Scenic Views

The Scenic Views theme was broken into four features, reflecting view type and view quality. The features were: Natural/Pristine Views, Pastoral Views, Moderately Impacted Views, and Highly Impacted Views.

Although GIS software includes "viewshed" tools which can determine how views might be impacted, we chose not to use these tools, for several reasons. The GIS software requires the specification of whether we are considering views from a certain point, views to a certain point, or views with a certain feature in the background. This complexity, while valuable, was beyond what we could include in our survey due to time constraints. Instead, we used a simple categorical approach.

- ***Natural/Pristine*** views occur in those places that are unaltered by human activity, including roads, structures and agricultural activity.
- ***Pastoral*** views occur in places with low residential density and scenic agricultural landscapes.
- ***Moderately Impacted*** views occur in places with moderate residential densities and all forms of agriculture.
- ***Highly Impacted*** views occur in places with existing infrastructure and high commercial or residential densities.

In Montana, these values were averaged and classified as follows:

SCENIC VIEWS	Average Score	Stretched Score	Weighted Score
Natural/Pristine	7.43	100	8.00
Pastoral	6.71	85	6.80
Moderately Impacted	4.71	43	3.44
Highly Impacted	2.71	1	0.08

In Idaho, these values were averaged and classified as follows:

SCENIC VIEWS	Average Score	Stretched Score	Weighted Score
Natural/Pristine	6.44	91	5.48
Pastoral	6.89	100	6.00
Moderately Impacted	4.67	57	3.42
Highly Impacted	1.78	1	0.06

SCENIC VIEWS

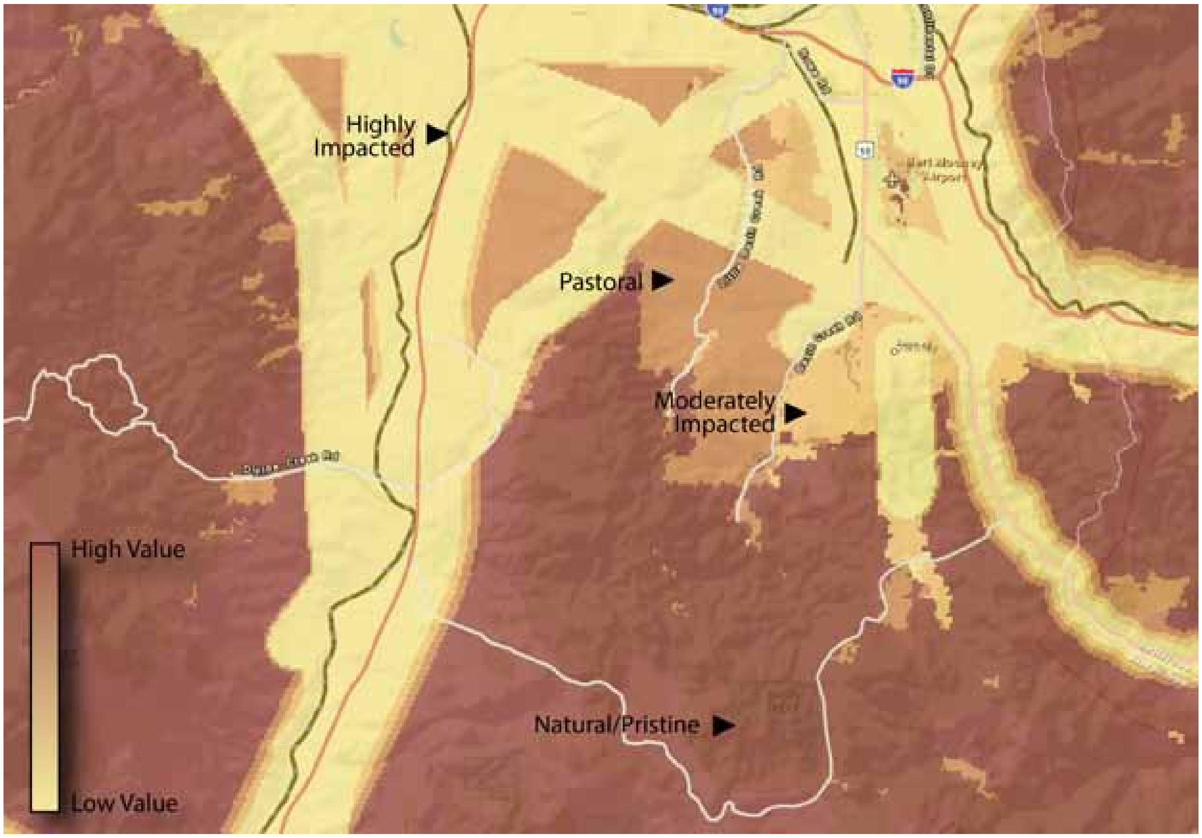


Figure 9: Scenic views example (please visit www.MSTIreviewproject.org for complete maps)

Avoidance Areas

To the extent possible, land management and engineering constraints identified by the Bureau of Land Management (BLM) and NorthWestern Energy were incorporated to reflect challenges that should be expected along any potential route. These are represented by *hard* and *soft avoidance areas,* indicating management designations and engineering constraints that make construction of a transmission line either *impossible* or *likely difficult,* respectively. *Hard avoidance areas,* such as designated wilderness areas or interstate highways, explicitly or physically prohibit construction of transmission lines. These areas are removed from the model entirely.

Soft avoidance areas include management designations and geographic features that do not explicitly exclude transmission, but place general restrictions on development, such as national monuments and areas with extremely high slope. Thorough review of each of these special management areas was not possible in our scope of work, so these areas were uniformly assigned a maximum cost.

Avoidance scores were assigned to Special Management Areas and engineering constraints as follows:

Special Management Areas (SMA)

A layer of public lands with special management designations was provided by the BLM. This layer included 24 types of designations that provide various degrees of management restrictions relevant to transmission line siting. With the assistance of Western Environmental Law Center, the management restrictions of each SMA type were reviewed. This review was limited to 24 relatively broad categories. We did not review legislation, management plans, or other documents for each of the 1,196 individual units represented in the SMA layer. Each type was assigned an avoidance category (see table below). Hard avoidance areas are SMA types where siting a transmission line would be prohibited, very difficult, or highly unlikely due to legal constraints. Soft avoidance areas include types where siting a transmission line is not necessarily prohibited, but siting may be difficult depending on the individual SMA unit (e.g., purpose of designation, resource management plans, etc.). A soft avoidance designation indicates there is potential for significant legal difficulty in siting a line across the area.

SMA Type	Avoidance Category
proposed Area of Critical Environmental Concern	Soft
National Natural Landmarks	Soft
Proposed Research Natural Areas	Soft
Special recreation management areas	Soft
State recreation areas	Soft
State wildlife management areas	Soft
Nature Conservation Areas	Soft
Areas of Critical Environmental Concern	Soft
National Conservation Areas	Soft
National Historic Site	Soft
National Monuments	Soft
National Recreation Areas	Soft
State parks	Soft
Other Congressional Designations	Soft
National Parks	Hard
National Heritage Park	Hard
National Wildlife Refuges	Hard
Proposed wilderness	Hard
Recommended wilderness	Hard
Research natural areas	Hard
Wilderness and IRAs (Inventoried Roadless Areas)	Hard
Wilderness study area	Hard
Wild and scenic rivers	Hard
National Wildlife Refuge in Wilderness	Hard

Engineering Constraints

Two categories of engineering avoidance are included in the model. In order to reflect the impossibility of building new transmission lines immediately on top of existing infrastructure, areas within rights-of-ways of existing roads, railroads, and transmission lines were assigned as hard avoidance areas. Areas with slopes greater than 30 degrees were assigned soft avoidance scores to reflect the extreme cost and difficulty of building a line over rugged terrain.

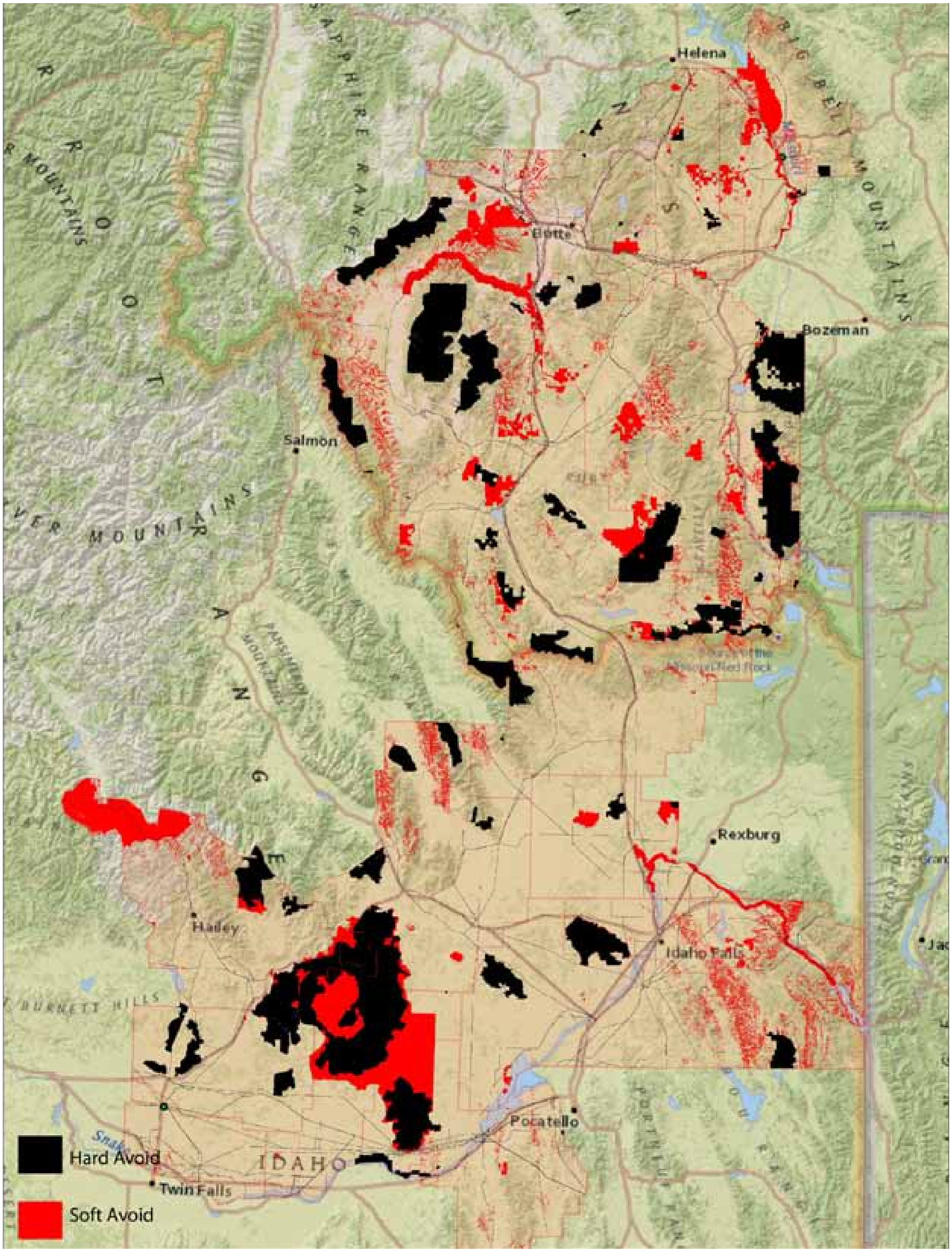


Figure 10: Special management areas provided by the BLM

Discussion

The Community Values Model portion of the MSTI Review Project has successfully demonstrated that it is possible to collect and use stakeholder input in a robust, transparent, and meaningful way.

The results of the community model process accurately reflect local community values and place a heavy emphasis on defending private property, agricultural land uses, and residential land uses. The model reflects these emphases by assigning high values to the cells in which they occur, and lower values to cells without these features. The results also reflect a high priority for co-location with existing infrastructure. The model incentivizes co-location through lower scores to the cells with existing infrastructure.

The model tries to balance a trade-off between distance and impacts to community values.

The least impact corridor identified across the value maps has a strong affinity for public land, while circumnavigating avoidance areas and attempting to co-locate with existing infrastructure where possible. Since there is no contiguous patch of public land between Townsend, Montana and Jerome, Idaho, there are portions of the corridor that occur on private land. In those instances, the corridor attempts to co-locate with existing infrastructure and avoid agricultural and residential land uses.

In Montana, the corridor identified by the community values model travels west from its origin near Townsend, staying on public lands and skirting just to the north of the Elkhorn Area of Critical Environmental Concern. From there, it dives south, following the public lands between Butte and Pipestone, threading between the Humbug Spires to the West and the Butte Highlands to the East.

The second variant of the community values model is forced through the Mill Creek Substation, just south of Anaconda. This results in a different corridor in the northern portion of the study area, which travels west from Townsend, north of Butte, through Mill Creek and then south along Interstate 15.

Both variants of the model converge just south of the Humbug Spires, where they co-locate with Interstate 15 and several existing power lines, traveling south while staying on public lands.

At Clark Canyon reservoir, the joined corridor diverges from Interstate 15, opting for the Medicine Lodge Valley. While not an official special management area, the Medicine Lodge Valley is probably not an appropriate place for a transmission line due to cultural resources in the area and a strong objection to further infrastructure in that area expressed by several tribes.

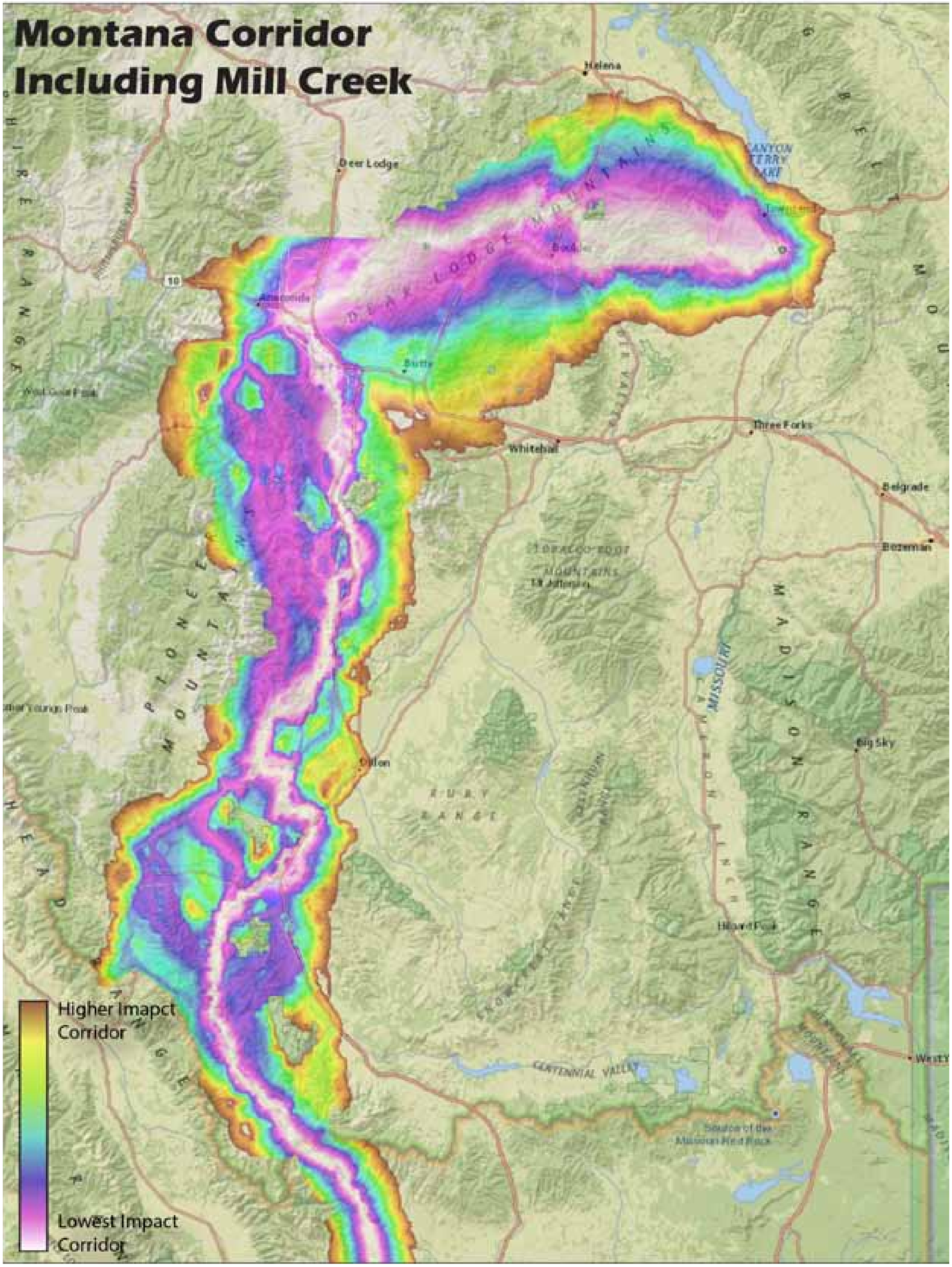


Figure 11: Final corridor in Montana, forced through Mill Creek

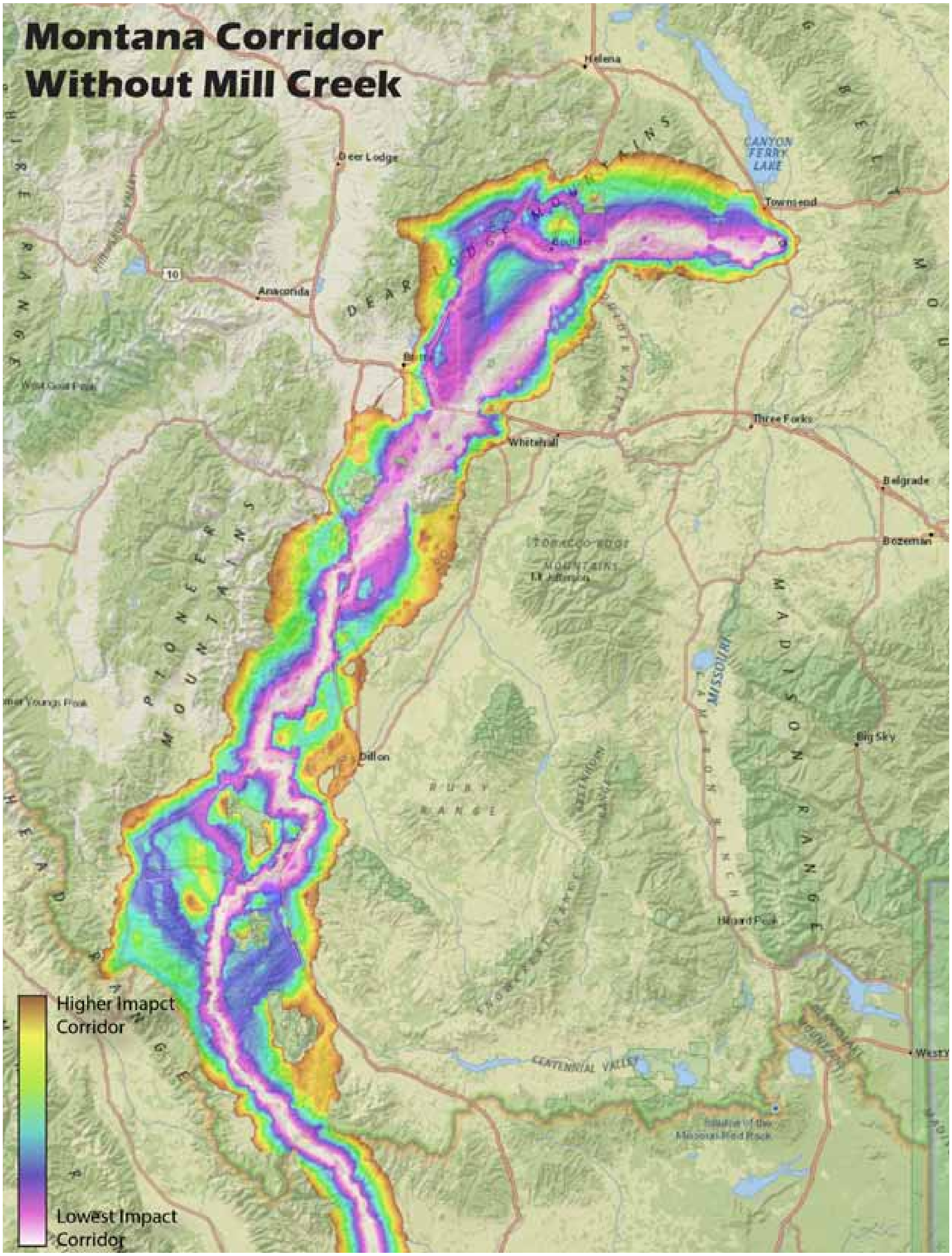


Figure 12: Final corridor in Montana, not forced through Mill Creek

After crossing into Idaho over Bannock Pass, the community values corridor continues south though public lands, co-locating with existing infrastructure in the region, including infrastructure located on Idaho National Laboratory land. From there, the corridor threads between the American Falls reservoir and Craters of the Moon National Monument.

The model identifies two primary routes through the private agricultural lands in south-central Idaho. The first co-locates with an existing transmission line running due south through the center of these agricultural lands. The second option identifies a very narrow route between the agricultural lands and the National Monument. A third route, visible only at slightly wider versions of the corridor, crosses the Craters of the Moon National Monument and "soft avoid" special management area, threading between the two primary "hard avoid" Wilderness Study Areas in the vicinity. That this option appears within any corridors, given that it is a "soft avoid" area and scored at the maximum possible value, is testament to the high density of community values in that region.

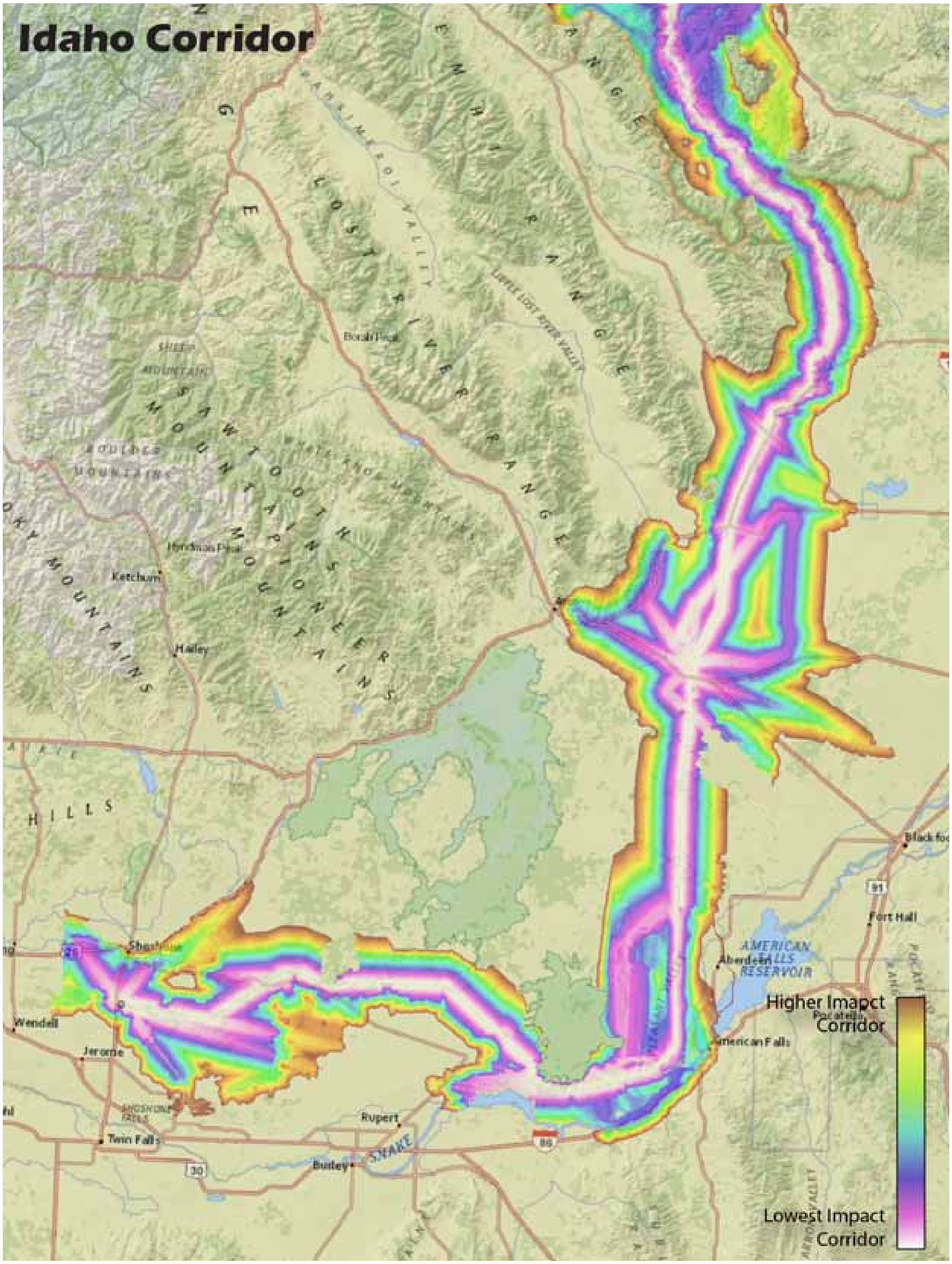


Figure 13: Final corridor in Idaho

Combined Wildlife and Community Values Analysis

Within the MSTI Review Project, the community values model and the wildlife model were designed to stand on their own, in order to be considered separately. This enables clear spatial identification of the unique potential impacts to both wildlife and community values from the MSTI line.

However, it is possible to overlay the two models in order to analyze combined impacts to wildlife and community values. In overlaying the two models, it is necessary to assign a relative weight—or percent influence—to each one. We combined the two models using the following weightings: 25 percent wildlife to 75 percent community, 50 percent wildlife to 50 percent community, and 75 percent wildlife to 25 percent community. These comparisons were quantified by calculating least-cost paths for each combined model and comparing the total accumulated costs with the original models using methods described above.

As the percent influence of the community values model increases relative to the percent influence of the wildlife model, the impacts to community values decreases, while the impacts to wildlife increase. The opposite is also true: impacts to community values increase as the percent influence of that model decreases.

A second comparison was made by calculating a new cost surface using the maximum value of either the final wildlife or community cost surfaces at each cell location. This produces a corridor model that avoids high-cost areas of both models. This combination resulted in the least added impacts to both the community values model and the wildlife model. It produced a 113 percent increase in impacts to community values and a 80 percent increase in impacts to wildlife. In contrast, a combination that weighted each model equally (50 percent wildlife, 50 percent community values) resulted in a 172 percent increase in community impacts and a 103 percent increase in impacts to wildlife.

Using the maximum costs combination, the resulting corridor alternates between the least-cost corridors for wildlife and community values, avoiding the highest cost areas of both models. Notably, none of the compromise alternatives would connect the Mill Creek substation to the MSTI line. If the line is to be forced through Mill Creek, additional impacts would result.

Endnotes

1 Saaty, T. L. (1994). How to Make a Decision: The Analytic Hierarchy Process. Interfaces, 24, 19-43.

2 Idaho Geospatial Office, www.insideidaho.org

3 National Land Cover Data Set (NLCD) for Montana, http://nris.mt.gov/nsdi/nris/nlcd/nlcdgrid.asp

4 National Revenue Final Land Unit (FLU) Classification, http://nris.mt.gov/nsdi/nris/mdb/revenue_flu.zip

5 Montana Natural Resource Information System (NRIS), www.nris.mt.gov

6 Northwest GAP Analysis Project, http://gap.uidaho.edu/index.php/gap-home/Northwest-GAP/landcover/download-data-by-state

7 National Agricultural Statistics Service, CropScape - Cropland Data Layer, http://nassgeodata.gmu.edu/CropScape/

8 Theobald, D.M. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecology and Society 10:32. (online) http://www.ecologyandsociety.org

9 U.S. Census Bureau. 2012. 2010 TIGER/Line Shapefiles [machine-readable data files]/ prepared by the U.S. Census Bureau, 2012

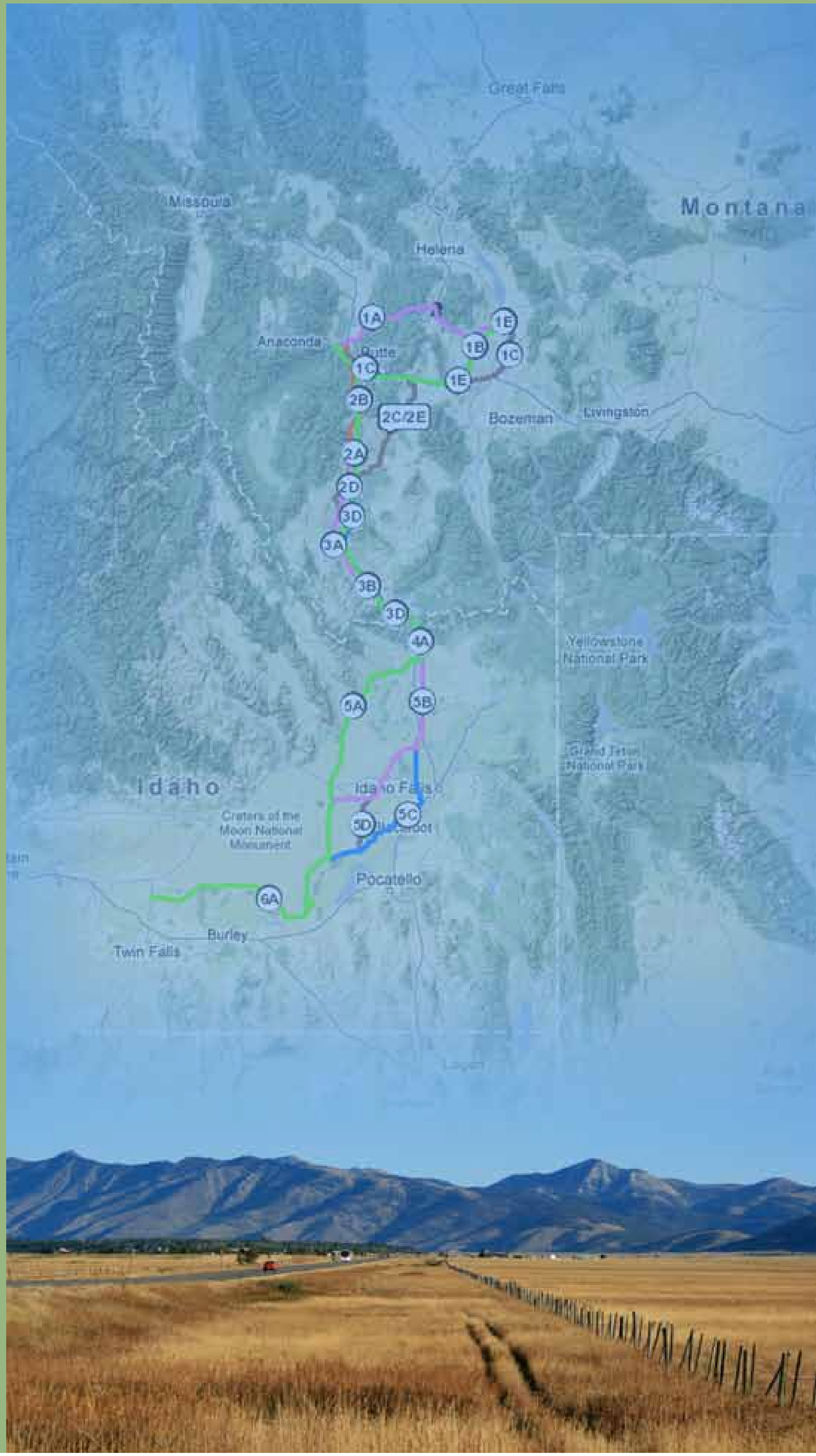
10 Idaho's Scenic Byways, http://www.idahobyways.gov/

11 National Hydrography Dataset (Plus), http://www.horizon-systems.com/nhdplus/data.php

12 Montana Sportsmen Value Map, William Geer, Theodore Roosevelt Conservation Partnership

13 Montana Natural Resource Information System (NRIS), www.nris.mt.gov


9 Golden Rules
of Conduct
"Can You" "Do You" "Will You"
1. Discuss without Arguing
2. Listen w/o Interrupting
3. Question w/o Criticizing
4. Amuse w/o Embarrassing
5. Evaluate w/o Rejecting
6. Encourage w/o Pressuring
7. Recall w/o Blaming
8. Smile w/o Sneering
9. Agree w/o Undermining



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