Appendix D. GIS Data Layer Development and Data Sources

This appendix describes the GIS layers used in the *Washington Connected Landscapes Project: Analysis of the Columbia Plateau Ecoregion*. Table D.1 lists the data layer themes and classes. GIS processing was performed using ArcGIS versions 9.3/10.0/10.1 (ESRI 2010). The data are cast on a custom Albers projection and the projection specifications are provided after the data descriptions in this appendix.

Columbia Plateau Ecoregion Analysis Area Boundary

The source of the project area boundary is the Columbia Plateau ecoregional boundary as defined by the U.S. Environmental Protection Agency (2003). This boundary encompasses common patterns of geology, physiography, vegetation, climate, soils, land use, wildlife, water quality, and hydrology. We added a 25 km buffer around the ecoregion to allow for habitat concentration areas and linkages up to and beyond the ecoregional boundary, without artificial or arbitrary breaks due to boundary selection. Because of time and capacity limitations, we excluded the portion of the ecoregion that extends north through the Okanogan Valley into British Columbia, Canada. Although study participants recognized the importance the valley holds in providing connectivity between Washington's arid lands and key areas in south-central B.C., compiling and "stitching" together disparate data sources across the international boundary would have consumed a disproportionate share of resources available for the project, and since this area covered a very small portion of the ecoregion, we decided to omit the B.C. portion. In the Idaho portion of the study area, we compiled a polygon to join a disjunct ecoregion polygon to the main Columbia Plateau Ecoregion polygon. Our final analysis area encompassed 132,190 km^2.

Columbia Plateau Project Area Boundary Compilation Source

Theme: Level 3 Ecoregions
Source: U.S. Environmental Protection Agency
Format: Vector polygon
Publication date: 2003
Online linkage: http://www.epa.gov/wed/pages/ecoregions/level_iii_iv.htm

Land Cover/Land Use

Synopsis

The land cover/land use (LC/LU) raster was assembled from several data sources. The LC/LU raster published by the Northwest Gap Project provided the foundation layer (downloaded March 2010). This layer was modified using the steps shown in Figure D.1. The Northwest Gap raster was recoded into preliminary LC/LU classes (Table D.2). The Cropland Data Layer (CDL) from the 2010 growing year was used to augment agriculture mapping. The CDL agriculture classes were recoded to "Highly Structured Agriculture," "Irrigated Cropland," "Non-irrigated Cropland," and "Pasture-Hay" (Table D.3), and subsequently overlaid on the Cultivated Cropland and Pasture/Hay classes in the preliminary map. The preliminary map contained classes indicating fire or forest harvest disturbance. Areas in Recently Burned Forest were recoded to “Grassland-Mountain” (these areas were primarily within the 25 km project area buffer). The remaining disturbance areas in the preliminary map were overlaid by Landfire Existing Vegetation Type to associate disturbance areas with an ecosystem class. For areas in disturbance without a Landfire ecosystem class, the Landfire category was maintained and subsequently recoded to the appropriate map class in the preliminary map. The Landfire Riparian class and classes from the National Wetlands Inventory were used in selective overlay steps on the preliminary map (Figure D.1). The preliminary map was plagued by errant Developed pixels in areas of sparse land development. The AcresPerDwelling Unit layer was used to isolate potentially misclassed pixels in areas of low development. Additional processing addressed errors in the Developed class using the ArcGIS Shrink tool (Figure D.1). Additional ad hoc automated and manual clean-up steps were required before completion of the final LC/LU final map.

Buffers were conditionally embedded in agriculture types: Pasture/Hay, Non-irrigated Cropland, Irrigated Cropland, and Cultivated Cropland from RegapNLCD. If these agriculture types were within 500 m of a core habitat type equal to Grassland Basin, Shrubsteppe, Scabland, or Shrubland Basin, then a buffer class was created. The buffer zone was split in two classes: 0–250 m and 250–500 m (Figure D.1, Table D.1).

Ecological Systems Reclassification

Ecological systems, which represent native habitat, were grouped into 14 classes (See Table D.2). These classes were meant to capture the variations in habitat needs and variations in resistance to movement posed by native systems across the Columbia Plateau Ecoregion. We developed the classes based on expert opinion of focal species leads, description of ecological systems (See *Draft Field Guide to Washington’s Ecological Systems*, Rocchio & Crawford 2008), and review by one of the authors of the field guide (Rex Crawford, Washington Natural Heritage Program, Dept. of Natural Resources). Some systems were not described in the field guide for Washington State. In these cases, their similarity to systems described for Washington State was used as a guide in categorizing them.

We grouped into grassland classes those upland systems dominated by graminoids (>20% cover) and with low woody cover (<10%; Rocchio & Crawford 2008). These were then split into two classes. Ecological systems characteristic or found predominantly in the Columbia Plateau were categorized as “Grassland-Basin,” and systems characteristic of higher elevation areas surrounding the Plateau were categorized as “Grassland-Mountain.”

We grouped into four classes those upland systems with a predominant shrub component. Vegetation structure and abundance of specific functional groups drove the distinctions between these four classes. Ecological systems where woody vegetation was dominated by tall shrubs (e.g., big sagebrush—*Artemisia tridentata*, antelope bitterbrush—*Purshia tridentata*, serviceberry—*Amelanchier alnifolia*) were separated from ecological systems with low or dwarf shrubs, usually due to soil limitations (e.g., stiff sagebrush—*Artemisia rigida*, buckwheat—*Eriogonum* spp.). Low shrub systems were categorized as “Scabland.” Tall shrub systems were further distinguished based on herbaceous cover, such that systems with abundant herbaceous cover were categorized as “Shrubsteppe,” while those with sparser herbaceous cover were categorized as shrubland. As with grassland systems, shrublands were split into two categories: “Shrubland-Basin” captures systems predominantly found in the hotter, drier areas of the

Columbia Plateau, while the "Shrubland-Mountain" class captures systems characteristic of higher elevation areas surrounding the Columbia Plateau.

Sparsely vegetated ecological systems were grouped into the "Cliffs, Rocks, Barren" class. The only exception to this was the "Dunes," which were considered a stand-alone class, due to the potential for being moderately vegetated, and their importance within the Columbia Plateau as habitat for certain species (e.g., sagebrush lizard—*Sceloporus graciosus*). This importance was highlighted in the focal species selection process, where we decided to consider the connectivity needs of the species that depend on dune complexes by evaluating the connectivity of the dune systems themselves.

Wetland and riparian systems were grouped into three classes. The "Riparian" class includes those ecological systems where woody species (trees or shrubs) are a defining characteristic of the system. Systems without woody species were categorized into two separate classes: "Herbaceous wetland" includes systems where soil saturation—either permanent or seasonal—is a driver of the structure and composition of the vegetation, while "Meadow" captures systems with similar characteristics to "grassland" classes, but where greater availability of water allows more mesic species to define these systems.

Upland ecological systems characterized by an overstory composed of tree species were grouped into three classes, based mainly on canopy cover. Systems with closed canopies (generally greater than 60% cover, Rocchio & Crawford 2008) were categorized as "Forest." Systems with open canopies were considered "Woodland" systems. Two ecological systems with abundant aspen were separated out as a stand-alone "Aspen" class, based on the expectation that these systems could fulfill particular habitat needs for some species, such as Sharp-tailed Grouse (*Tympanuchus phasianellus*).

The land cover/land use data layer includes multiple classes no longer dominated by native vegetation (Table D.1). These include vegetation classes dominated by non-native species. In some cases these classes were included in stand-alone categories of introduced vegetation, and in others, where there was significant uncertainty as to what was being classified as "introduced vegetation" (based on expert opinion and comparison with high resolution images), they were grouped under some of the native vegetation classes described above. The stand-alone categories for non-native systems are "Introduced upland vegetation-annual grassland," likely capturing areas with significant cheatgrass (*Bromus tectorum*) infestation, and "Introduced riparian and wetland vegetation," associated with water courses or depressions.

An additional "Water" class captures major water bodies occurring within the study area (Table D.2). Areas classified in the land cover/land use data layer as developed (Table D.2), be it low, medium, high intensity, and also open space in developed areas, were grouped into a "Developed" category. Additional areas that are highly disturbed, such as mines and quarries, were grouped into a separate "Disturbed" class (Table D.2).

In areas where the dwelling unit density is low (i.e., >80 acres per dwelling unit), the "Developed" category was partitioned into edit_Developed. This class typically contains road features compiled by Regap, either from direct remote sensing procedures or from road overlays. The raster road features do not always form fully-adjacent cell proximity as we typically get from converting vector road layers to raster. The linkage model processing can be influenced by the gaps in the "Developed" (road features). These areas were typically set to zero during resistance processing, thus letting other GIS base layers dominate in the edit_Developed areas.

The Northwest Gap LC/LU layer distinguishes six classes of either harvested forests or recently burned areas. Given that the results of this connectivity analysis will be used to guide long-term conservation planning, we agreed that the dynamics of harvest or fire and their impacts on wildlife should not be included unless they led to complete conversion (Note, "Recently burned forest," primarily located in the project buffer area, was re-coded to "Grassland-Mountain"). We assumed that the harvested and recently burned areas would be classified as a different land cover/land use if they had led to this conversion. Therefore, we used the classification for each harvested or burned pixel provided in the Landfire EVT data layer to replace these categories in the final Land Cover/Land Use layer.

Land Cover/Land Use Data Sources

Theme: Gap Analysis Program Land Cover
Source: Northwest Gap Analysis Project
Format: raster
Cell size: 30 meters
Publication date: February 2010 (with July 1, 2009 revisions).
Landsat acquisition period between 1999 and 2001
Online linkage: http://gapanalysis.usgs.gov/gaplandcover/featured-post-1/

Theme: Cropland Data Layer
Source: USDA, National Agricultural Statistics Service, 2010
Format: raster
Cell size: 30 meters
Publication date: January 10, 2011
Landsat/RESOURCESAT-1 satellite acquisition period: 2010
Online linkage: http://nassgeodata.gmu.edu/CropScape/
Online linkage: http://www.nass.usda.gov/research/Cropland/metadata/metadata_wa10.htm

Theme: Landfire Existing Vegetation Type
Source: Landfire (Landscape Fire and Resource Management Planning Tools Project)
Format: raster
Cell size: 30 meters
Publication date: version 1.1 Refresh 2008
Landsat acquisition period: ca. 2001 and multiple acquisitions 1984–2008 for disturbance update.
Online linkage: http://www.landfire.gov/

Theme: Classification of Wetlands and Deepwater Habitats of the United States
Source: U.S. Fish and Wildlife Service, Division of Habitat and Resource Conservation
Format: vector polygon
Publication date: 1977 to present
Online linkage: http://www.fws.gov/wetlands/

Acres per Dwelling Unit

The housing density data were compiled from U.S. Census 2000 block and block-group sources using methods described by the U.S. Environmental Protection Agency (U.S. EPA; 2009). Dwelling unit projection data (e.g., from year 2000 to year 2010) were not used in the habitat connectivity project. An additional class was added to the raster to contain sparsely populated areas not mapped in the published 11-class map. The published cell size for this layer is 100 meters and it did not match the 30-meter cell size of the other base layers. Unfortunately an alternative dwelling unit layer was not available; therefore, the raster was resampled to 30-meter cell size, using the nearest neighbor technique, to match the cell size of the other base layers. The modified housing density raster was recoded from 12 classes to five classes.

Acres per Dwelling Unit Data Source

Theme: Housing Density 2000
Source: Natural Resource Ecology Lab, Colorado State University, Fort Collins, CO
Format: raster
Cell size: 100 meters
Publication date: production circa 2008; U.S. census year 2000.
Online linkage: www.nrel.colostate.edu

Roads and Railroads

Roads

Separate road layers were compiled for the focal species and landscape integrity (LI) analyses. The focal species layer was compiled first. The US TIGER/Line Census 2010 transportation lines were the basis for the road classes "Freeway," "Major Highway," and "Secondary Highway." We attempted to use the TIGER/Line MTFCC attribute for road class assignments; however, for the purposes of this study the selections failed to provide useful outputs. As a result, we relied on manual selection and assignment of the road types. Roads with less traffic volume—Non-State Arterials and Collector routes—were more problematic to characterize. For these roads a Functional Road Class layer containing attributes linked to the Federal Functional Classification System was used to identify "Local" roads (Table D.4). Completion of the final line layer required considerable manual editing and clean-up.

Each road class was extracted from the focal species line layer and converted to a raster format (30-meter cell) using Polyline to Raster. From each road "centerline" raster (30-meter cell), two buffers were generated away from the centerline using the Euclidean Distance tool. Each raster road class contains four zones: Centerline, Inner buffer 0–500 m, Outer buffer 500–1000 m, and Area not containing road features (Table D.1).

The LI road layer incorporates all road classes in the focal species version plus one additional class, "Low Use." "Low Use" roads typically have less traffic volume than the "Local" road category and often are not paved. The "Low Use" class was derived from a raster buffer cross tabulation procedure (ArcGIS Combine) between focal species Local roads and a buffer layer containing a selection of roads not in Interstate, Major, and Secondary road classes. This was an imperfect process and some manual editing was required. The TIGER/Line roads without a buffer match were assigned to the "Low Use" category.

The focal species and landscape integrity line layers were supplemented with a road layer covering the U.S. Department of Energy Hanford Site. Hanford site roads with names containing "Route" were appended to the Local class. All other roads in the Hanford site were categorized as Low Use and integrated with the LI roads layer.

Resistance parameters were applied to each road zone prior to resistance surface processing (30-meter cell). A single road effect value contributed to each species' resistance cell values. In instances of overlapping road influences, a cell was assigned the highest resistance represented in the competing categories.

Railroads

The TIGER/Line 2010 Census layer was the source of Active and Inactive Railroad features. All railroad features were selected using the attribute "RAILFLG" = 'Y'. These features include: Main, Spur, Yard, Unknown, US Government. If FullName included Abandoned RR, then the line was placed in the Inactive map category, otherwise the line was placed in the Active class. Manual editing of railroad line features was performed to connect lines associated with overpass structures. Inactive Railroads may or may not have rails present. The Active and Inactive line features were converted to raster format (30-meter cell). Raster buffers were generated using Euclidean Distance. The Active and Inactive railroad rasters contained four zones: Centerline, Inner buffer 0–500 m, and Outer buffer 500–1000 m (Table D.1).

Road and Railroad Data Sources

Theme: Roads and Railroads Census 2010
Source: US Census Bureau 2010 TIGER/Line
Format: vector line
Scale of mapping: 1:100,000
Publication date: 2010
Online linkage: http://www.census.gov/geo/www/tiger/

Theme: Functional Road Classification
Source: Statewide Travel Data Office - HPMS Section, Washington State Department of Transportation
Format: vector line
Scale of mapping: 1:24,000
Publication date: 2010
Online linkage: http://www.wsdot.wa.gov/mapsdata.htm

Theme: Department of Energy, Hanford Site Roads
Source: Updated and maintained by Fluor Hanford, Inc., Hanford Central Mapping Services for DOE-RL.
Format: vector line
Publication date: 2010
Online linkage: not available

Elevation

Elevation was extracted from the National Elevation Dataset (NED) 1 arc-second/30-meter raster and projected to the WHCWG Albers using bilinear interpolation. Nine elevation classes were created (Table D.1).

Elevation Source

Theme: Elevation
Source: US Geological Survey
Format: raster
Cell size: 30 meters
Publication date: ongoing
Online linkage: http://ned.usgs.gov/

Slope

The slope raster was generated from a National Elevation Dataset (NED) 1 arc-second/30-meter raster. Degree slope values were categorized into three slope ranges (Table D.1).

Ruggedness

The source DEM for the ruggedness raster was the National Elevation Dataset (NED) 1 arc-second/30-meter raster. The ruggedness raster was produced using methods by Sappington et al. (2007). The ruggedness tool used in generation of the initial output was downloaded from http://arcscripts.esri.com/details.asp?dbid=15423, the processing neighborhood size was 11 cells. The output ruggedness raster was recoded to five classes (Tables D.1, D.5).

Landform

Landform was generated using the Topographic Position Index tool (Weiss 2001; Jenness 2006). An initial 10-class landform raster was generated from a National Elevation Dataset (NED) 1 arc-second/30-meter raster using tool default parameters. A five-class map was recoded from the initial map (Tables D.1, D.6).

Compound Topographic Index

The Compound Topographic Index (CTI) was generated from a National Elevation Dataset (NED) 1 arc-second/30-meter raster. Processing was performed using the CTI script available from http://arcscripts.esri.com/details.asp?dbid=11863. The continuous CTI raster was visually interpreted into three coarse "wetness" categories relevant to focal species connectivity analysis: "Dry zone," "Potential dry to moist zone," "Potential wet zone" (Table D.1). In areas of low topographic relief/indeterminate flow direction, the CTI produced a "feather pattern" visible in the two wettest map categories; however, no further work was performed on the raster.

Insolation

Insolation was created using the ArcGIS v10.0 Area Solar Function. Due to computer processing time limitations, the input DEM was resampled to 90 m cell size prior to running the tool. The insolation tool input parameters were: Latitude—47 degrees, skysize—200 x 200 raster, hour interval—4, radiation and topographic settings—default. The output insolation raster was resampled to 30-meter cell size using bilinear interpolation. The raster was recoded into five classes (Tables D.1, D.7).

Soil

Soil Texture

Soil texture was compiled using data from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database and, for areas where SSURGO data are not available, from the US General Soil Map (STATSGO2). Texture is the relative amounts of sand, silt, and clay in the <2 mm fraction of a component (soil series) layer (horizon). As texture is reported by layer and as there are up to six layers in a component and up to three components within a map unit (vector polygon), the relative amounts of sand, silt, and clay were calculated by aggregating their respective value by layer depth and then by component percent. (See USDA SSURGO – Data Use Information, publication number 1527, for more details data on aggregation). Representative values (RV), when available, were used for all soil variables. The aggregated soil fraction percentages were classified into one of the 12 standard USDA texture classes (Table D.8).

Map units that did not report fractional data were classified as "No Soil." The texture categories were joined to the map unit polygons and were converted into a 30-meter raster using the texture category as the value field.

Soil Depth

Soil depth was compiled using data from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database and, for areas where SSURGO data were not available, from the US General Soil Map (STATSGO2). Depth for this project is identified as the depth to the first restrictive layer (horizon) or, if there is no restrictive layer, the depth to the "Cr" if present or "R" horizon if not. For each soil component (series), depth was calculated by summing the difference of the bottom depth and top depth of each layer. As there are up to three components within a map unit (vector polygon), depth was aggregated by component percent (See USDA SSURGO – Data Use Information, publication number 1527, for more details data on aggregation). Representative values (RV), when available, were used for all soil variables. The aggregated soil depths were classified into five categories and joined to the map unit polygons. The polygons were converted into a 30-meter raster using the depth class as the value field (Table D.1).

Soil Available Water Capacity

Soil available water capacity (AWC) was compiled using data from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database and, for areas where SSURGO data are not available, from the US General Soil Map (STATSGO2). AWC for this project is the amount of water that the soil profile, inclusive of fragments, can store that is available to plants. AWC is expressed as a volume fraction, and is commonly estimated as the difference between the water contents at 1/10 or 1/3 bar (field capacity) and 15 bars (permanent wilting point) tension and adjusted for salinity, and fragments. As AWC is reported by layer and as there are up to six layers in a component and up to three components within a map unit (vector polygon), the soil profile AWC was calculated by aggregating the reported fraction by layer depth and then by component percent (See USDA SSURGO – Data Use Information, publication number 1527, for more details data on aggregation). Representative values (RV), when available, were used for all soil variables. The AWC results were joined to the map unit polygons and converted into a 30-meter continuous raster using the AWC as the value field.

Soils Data Source

Theme: Soil Survey Geographic Database and the US General Soil Map
Source: United States Department of Agriculture Natural Resources Conservation Service
Format: Vector polygon and Microsoft Access database
Publication date: May and June, 2012
Online linkage: soildatamart.nrcs.usda.gov

Irrigation Canals

Irrigation canals were compiled from the National Hydrographic Dataset (NHD) NHDArea vector polygon layer, which provides consistent coverage throughout the project area. The NHDArea polygon contains regions representing NHD hydrographic waterbody features. Irrigation canals were isolated by selecting the feature type (FTYPE) CanalDitch (SubType Code 336). CanalDitch is defined as an artificial open waterway constructed to transport water, to irrigate or drain land, to connect two or more bodies of water, or to serve as a waterway for watercraft. The NHDArea was chosen instead of the NHDFlowline vector line layer because it excluded small narrow structures (See the NHD feature catalog for more details on the delineation rule set). A limited review of CanalDitch polygons revealed that some structures lacked continuous coverage due to narrowing, splitting, or overcrossings. The attribute data for NHDArea does not contain width, depth, or flow information and therefore sub-classification was not possible. CanalDitch features were converted from a polygon into a 30-meter raster. A second 30-meter raster was created from the boundary line of the original polygon to insure that the predominantly linear polygon features were fully transposed into a 30-meter grid cell. The polygon and line rasters were combined to create the 30-meter irrigation canal raster.

Irrigation Canals Data Source

Theme: National Hydrographic Dataset
Source: US Geological Survey
Format: Vector polygon
Scale of mapping: 1:24,000
Publication date: 2010-04-21 (NHD version 1.07)
Online linkage: nhd.usgs.gov

Transmission Lines

The transmission line rasters were derived from the Ventyx Electric Transmission Lines Intelligent Map layer, a proprietary line vector layer distributed with Ventyx's EV Energy Map. The layer consists of market significant transmission lines in North America. Depicted lines are generally greater than 115 kV and tie major power plants to the electrical grid. Some feature lines represent more than one transmission line of the same voltage. The footprints of other elements of the power grid, such as sub-stations, are not identified in this layer. Based on perceived impact, four categories of transmission lines were selected and converted to 30-meter rasters: Less than 230 kV with 1 line, Less than 230 kV with 2 or more lines, Greater than 230 kV with 1 line, and Greater than 230 kV with 2 or more lines. For each category, a raster buffer was generated using Euclidean distance from the raster line. Euclidean distances 0–500 m and 500–100 m were assigned to the "Inner buffer" and "Outer buffer" classes respectively (Table D.1).

Transmission Lines Data Source

Theme: Electric Transmission Lines (e_transln_polyline)
Source: EV Energy Map, a component of Ventyx Velocity Suite
Format: Vector line
Publication date: November, 2012
Online linkage: ventyx.com/en/enterprise/business-operations/business-products/velocity-suite

Wind Turbines

The wind turbine raster was derived from Ventyx's existing FAA Windmills Intelligent Map Layer, a proprietary point vector layer distributed with Ventyx's EV Energy Map. The layer represents the location of the obstacle type windmill reported by the Federal Aviation Administration in its Digital Obstacle File. It does not characterize other wind energy related infrastructure, such as roads or sub-stations. To represent the footprint of a typical wind turbine installation, a 45-meter buffer polygon was created from the point layer. The buffer polygon was converted to a 30-meter raster. To appropriate presence/absence within a raster cell along the buffer boundary, a second 30-meter raster was created from the boundary line of the original polygon. The two rasters were merged into a single raster with one class—Wind turbine point buffer 45-meter radius. To add additional buffer classes of 500 and 1000 m, a Euclidean distance raster was generated from the 45-meter raster. These buffer distances were assigned to buffer classes 0–500 m and 500–1000 m respectively (Table D.1).

Wind Turbine Data Source

Theme: FAA Windmills (FAA_wind_font_point)
Source: EV Energy Map, a component of Ventyx Velocity Suite
Format: Vector point
Publication date: November, 2012
Online linkage: ventyx.com/en/enterprise/business-operations/business-products/velocity-suite

WHCWG Map Projection Specifications

Projected coordinate system name:
HabConnectProjectArea_North_America_Albers_Equal_Area_Conic
Geographic coordinate system name: GCS_North_American_1983

Map_Projection_Name: Albers Conical Equal Area
Albers_Conical_Equal_Area:
Standard_Parallel: 43.000000
Standard_Parallel: 48.000000
Longitude_of_Central_Meridian: -120.000000
Latitude_of_Projection_Origin: 41.000000
False_Easting: 700000.000000
False_Northing: 0.000000

Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 0.000100
Ordinate_Resolution: 0.000100
Planar_Distance_Units: meters

Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1983
Ellipsoid_Name: Geodetic Reference System 80
Semi-major_Axis: 6378137.000000
Denominator_of_Flattening_Ratio: 298.257222

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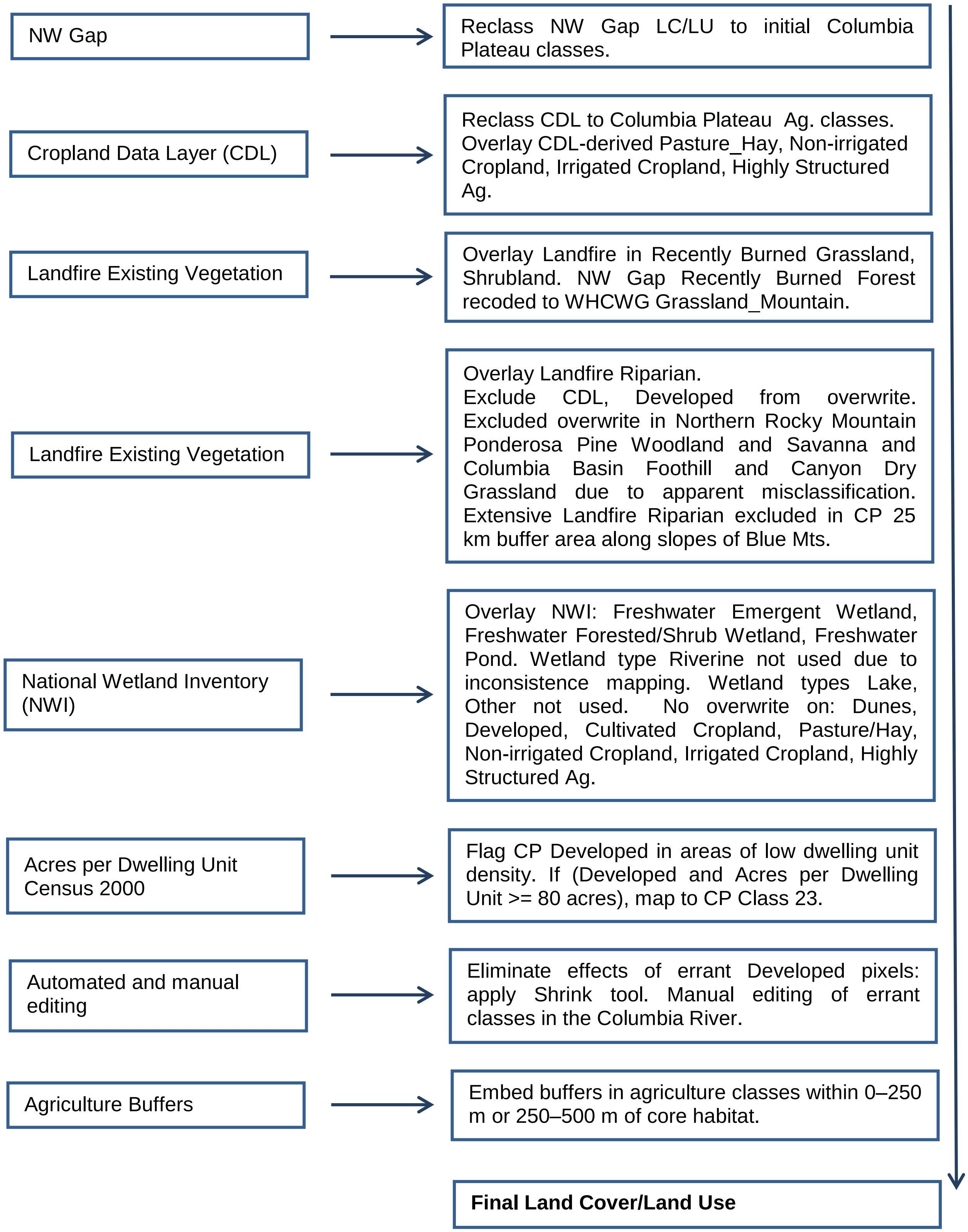

Figure D.1. Land cover/land use layer sources and compilation steps.

Table D.1. Data layer themes and classes for the Columbia Plateau Ecoregion connectivity analysis.

Theme	*Class name*
Landcover_Landuse	Grassland_Basin
Landcover_Landuse	Grassland_Mountain
Landcover_Landuse	Shrubsteppe
Landcover_Landuse	Dunes
Landcover_Landuse	Shrubland_Basin
Landcover_Landuse	Shrubland_Mountain
Landcover_Landuse	Scabland
Landcover_Landuse	Introduced upland vegetation_Annual grassland
Landcover_Landuse	Cliffs_Rocks_Barren
Landcover_Landuse	Meadow
Landcover_Landuse	Herbaceous wetland
Landcover_Landuse	Riparian
Landcover_Landuse	Introduced riparian and wetland vegetation
Landcover_Landuse	Water
Landcover_Landuse	Aspen
Landcover_Landuse	Woodland
Landcover_Landuse	Forest
Landcover_Landuse	Disturbed
Landcover_Landuse	Cultivated cropland from RegapNLCD
Landcover_Landuse	Pasture_Hay from CDL
Landcover_Landuse	Non-irrigated cropland from CDL
Landcover_Landuse	Irrigated cropland from CDL
Landcover_Landuse	Highly structured agriculture from CDL
Landcover_Landuse	Irr Not Irr Cult Ag buffer 0 - 250m from native habitat
Landcover_Landuse	Irr Not Irr Cult Ag buffer 250 - 500m from native habitat
Landcover_Landuse	Pasture Hay Ag buffer 0 - 250m from native habitat.
Landcover_Landuse	Pasture Hay Ag buffer 250 - 500m from native habitat
Elevation	0 - 250m
Elevation	250 - 500m
Elevation	500 - 750m
Elevation	750 - 1000m
Elevation	1000 - 1250m
Elevation	1250 - 1500m
Elevation	1500 - 2000m
Elevation	2000 - 2500m
Elevation	2500 - 3300m
Slope	Gentle slope: ≤20 degrees
Slope	Moderate slope: >20 to ≤40 degrees
Slope	Steep slope: >40 degrees
Soil Texture	Sand
Soil Texture	Loamy sand

Table D.1. Continued.

Theme	*Class name*
Soil Texture	Sandy loam
Soil Texture	Silt loam
Soil Texture	Loam
Soil Texture	Sandy clay loam
Soil Texture	Silty clay loam
Soil Texture	Clay loam
Soil Texture	Silty clay
Soil Texture	Clay
Soil Texture	No soil
Soil Depth to First Restrictive Layer	0 - 20cm
Soil Depth to First Restrictive Layer	20 - 50cm
Soil Depth to First Restrictive Layer	50 - 100cm
Soil Depth to First Restrictive Layer	>100cm
Soil Depth to First Restrictive Layer	No soil
Ruggedness Measure	Very gentle terrain (or surface water)
Ruggedness Measure	Gentle terrain
Ruggedness Measure	Moderate terrain
Ruggedness Measure	Rough terrain
Ruggedness Measure	Very rough terrain or escarpment
Landform	Drainage
Landform	U-shaped valley
Landform	Plain (or surface water)
Landform	Midslope
Landform	Ridge or mountain top
Compound Topo Index	Dry zone
Compound Topo Index	Potential dry to moist zone
Compound Topo Index	Potential wet zone
Insolation	Very low insolation
Insolation	Low insolation
Insolation	Moderate insolation
Insolation	High insolation
Insolation	Very high insolation
Housing Density Census 2000	>80 acres per dwelling unit
Housing Density Census 2000	>40 and ≤80 acres per dwelling unit
Housing Density Census 2000	>20 and ≤40 acres per dwelling unit
Housing Density Census 2000	>10 and ≤20 acres per dwelling unit
Housing Density Census 2000	≤10 acres per dwelling unit
Roads Freeway	Centerline
Roads Freeway	Inner buffer 0 - 500m
Roads Freeway	Outer buffer 500 - 1000m
Roads Major Highway	Centerline
Roads Major Highway	Inner buffer 0 - 500m

Table D.1. Continued.

Theme	*Class name*
Roads Major Highway	Outer buffer 500 - 1000m
Roads Secondary Highway	Centerline
Roads Secondary Highway	Inner buffer 0 - 500m
Roads Secondary Highway	Outer buffer 500 - 1000m
Roads Local	Centerline
Roads Local	Inner buffer 0 - 500m
Roads Local	Outer buffer 500 - 1000m
Railroads Active	Centerline
Railroads Active	Inner buffer 0 - 500m
Railroads Active	Outer buffer 500 - 1000m
Railroads Inactive	Centerline
Railroads Inactive	Inner buffer 0 - 500m
Railroads Inactive	Outer buffer 500 - 1000m
Transmission lines LessThan 230KV Single Line	Centerline
Transmission lines LessThan 230KV Single Line	Inner buffer 0 - 500m
Transmission lines LessThan 230KV Single Line	Outer buffer 500 - 1000m
Transmission lines LessThan 230KV Two or More Lines	Centerline
Transmission lines LessThan 230KV Two or More Lines	Inner buffer 0 - 500m
Transmission lines LessThan 230KV Two or More Lines	Outer buffer 500 - 1000m
Transmission lines Greater Than or Equal 230KV Single Line	Centerline
Transmission lines Greater Than or Equal 230KV Single Line	Inner buffer 0 - 500m
Transmission lines Greater Than or Equal 230KV Single Line	Outer buffer 500 - 1000m
Transmission lines Greater Than or Equal 230KV Two Lines	Centerline
Transmission lines Greater Than or Equal 230KV Two Lines	Inner buffer 0 - 500m
Transmission lines Greater Than or Equal 230KV Two Lines	Outer buffer 500 - 1000m
Wind Turbine	Wind turbine point buffer 45m radius
Wind Turbine	Buffer zone beyond point buffer 0 - 500m
Wind Turbine	Buffer zone beyond point buffer 500 - 1000m
Irrigation Infrastructure	Irrigation canals

Table D.2. Ecosystems and land use reclassification for the Columbia Plateau Ecoregion.

NW GAP class	*Columbia Plateau land cover/land use class name*
Columbia Basin Foothill and Canyon Dry Grassland	Grassland - Basin
Columbia Basin Palouse Prairie	Grassland - Basin
Columbia Plateau Steppe and Grassland	Grassland - Basin
Inter-Mountain Basins Semi-Desert Grassland	Grassland - Basin
Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland	Grassland - Basin
North Pacific Alpine and Subalpine Dry Grassland	Grassland - Mountain
North Pacific Dry and Mesic Alpine Dwarf-Shrubland, Fell-field and Meadow	Grassland - Mountain
North Pacific Herbaceous Bald and Bluff	Grassland - Mountain
North Pacific Montane Grassland	Grassland - Mountain
Northern Rocky Mountain Subalpine-Upper Montane Grassland	Grassland - Mountain
Rocky Mountain Alpine Fell-Field	Grassland - Mountain
Rocky Mountain Alpine Tundra/Fell-field/Dwarf-shrub Map Unit	Grassland - Mountain
Columbia Plateau Low Sagebrush Steppe	Shrubsteppe
Columbia Plateau Silver Sagebrush Seasonally Flooded Shrub-Steppe	Shrubsteppe
Inter-Mountain Basins Big Sagebrush Steppe	Shrubsteppe
Inter-Mountain Basins Montane Sagebrush Steppe	Shrubsteppe
Inter-Mountain Basins Semi-Desert Shrub Steppe	Shrubsteppe
Inter-Mountain Basins Active and Stabilized Dune	Dunes
Great Basin Xeric Mixed Sagebrush Shrubland	Shrubland - Basin
Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland - Basin
Inter-Mountain Basins Mixed Salt Desert Scrub	Shrubland - Basin
Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	Shrubland - Mountain
North Pacific Avalanche Chute Shrubland	Shrubland - Mountain
North Pacific Montane Shrubland	Shrubland - Mountain
Northern and Central California Dry-Mesic Chaparral	Shrubland - Mountain
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	Shrubland - Mountain
Northern Rocky Mountain Subalpine Deciduous Shrubland	Shrubland - Mountain
Columbia Plateau Ash and Tuff Badland	Scabland
Columbia Plateau Scabland Shrubland	Scabland
Introduced Upland Vegetation - Annual Grassland	Introduced Upland Vegetation - Annual Grassland
Inter-Mountain Basins Cliff and Canyon	Cliffs,rocks,barren
North American Alpine Ice Field	Cliffs,rocks,barren
North Pacific Alpine and Subalpine Bedrock and Scree	Cliffs,rocks,barren
North Pacific Montane Massive Bedrock, Cliff and Talus	Cliffs,rocks,barren
North Pacific Serpentine Barren	Cliffs,rocks,barren
North Pacific Volcanic Rock and Cinder Land	Cliffs,rocks,barren
Rocky Mountain Alpine Bedrock and Scree	Cliffs,rocks,barren
Rocky Mountain Cliff, Canyon and Massive Bedrock	Cliffs,rocks,barren
Unconsolidated Shore	Cliffs,rocks,barren
North Pacific Bog and Fen	Meadow
Rocky Mountain Alpine-Montane Wet Meadow	Meadow

Table D.2. Continued.

NW GAP class	*Columbia Plateau land cover/land use class name*
Rocky Mountain Subalpine-Montane Fen	Meadow
Rocky Mountain Subalpine-Montane Mesic Meadow	Meadow
Temperate Pacific Montane Wet Meadow	Meadow
Willamette Valley Wet Prairie	Meadow
Columbia Plateau Vernal Pool	Herbaceous Wetland
Inter-Mountain Basins Alkaline Closed Depression	Herbaceous Wetland
Inter-Mountain Basins Playa	Herbaceous Wetland
North American Arid West Emergent Marsh	Herbaceous Wetland
Temperate Pacific Freshwater Aquatic Bed	Herbaceous Wetland
Temperate Pacific Freshwater Emergent Marsh	Herbaceous Wetland
Columbia Basin Foothill Riparian Woodland and Shrubland	Riparian
Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland	Riparian
Inter-Mountain Basins Greasewood Flat	Riparian
Inter-Mountain Basins Montane Riparian Systems	Riparian
Introduced Upland Vegetation - Shrub	Riparian
Introduced Upland Vegetation - Treed	Riparian
Mediterranean California Foothill and Lower Montane Riparian Woodland	Riparian
North Pacific Lowland Riparian Forest and Shrubland	Riparian
North Pacific Montane Riparian Woodland and Shrubland	Riparian
North Pacific Shrub Swamp	Riparian
Northern Rocky Mountain Conifer Swamp	Riparian
Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland	Riparian
Rocky Mountain Lower Montane Riparian Woodland and Shrubland	Riparian
Rocky Mountain Subalpine-Montane Riparian Shrubland	Riparian
Rocky Mountain Subalpine-Montane Riparian Woodland	Riparian
Introduced Riparian and Wetland Vegetation	Introduced Riparian and Wetland Vegetation
Open Water (Fresh)	Water
Temperate Pacific Freshwater Mudflat	Water
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	Aspen
Rocky Mountain Aspen Forest and Woodland	Aspen
Columbia Plateau Western Juniper Woodland and Savanna	Woodland
Introduced Upland Vegetation - Perennial Grassland and Forbland	Woodland
North Pacific Broadleaf Landslide Forest and Shrubland	Woodland
North Pacific Maritime Mesic Subalpine Parkland	Woodland
North Pacific Oak Woodland	Woodland
North Pacific Wooded Volcanic Flowage	Woodland
Northern California Mesic Subalpine Woodland	Woodland
Northern Rocky Mountain Ponderosa Pine Woodland and Savanna	Woodland
Northern Rocky Mountain Subalpine Woodland and Parkland	Woodland
Northern Rocky Mountain Western Larch Savanna	Woodland
Willamette Valley Upland Prairie and Savanna	Woodland

Table D.2. Continued.

NW GAP class	*Columbia Plateau land cover/land use class name*
East Cascades Mesic Montane Mixed-Conifer Forest and Woodland	Forest
East Cascades Oak-Ponderosa Pine Forest and Woodland	Forest
Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland	Forest
Mediterranean California Red Fir Forest	Forest
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Forest
North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland	Forest
North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest	Forest
North Pacific Lowland Mixed Hardwood-Conifer Forest and Woodland	Forest
North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest	Forest
North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest	Forest
North Pacific Mesic Western Hemlock-Silver Fir Forest	Forest
North Pacific Mountain Hemlock Forest	Forest
Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest	Forest
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest	Forest
Rocky Mountain Lodgepole Pine Forest	Forest
Rocky Mountain Poor-Site Lodgepole Pine Forest	Forest
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	Forest
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland	Forest
Developed, High Intensity	Developed
Developed, Low Intensity	Developed
Developed, Medium Intensity	Developed
Developed, Open Space	Developed
Disturbed, Non-specific	Disturbed
Quarries, Mines, Gravel Pits and Oil Wells	Disturbed
Harvested Forest - Grass/Forb Regeneration	Harvested Forest - Grass/Forb Regeneration
Harvested Forest - Northwestern Conifer Regeneration	Harvested Forest - Northwestern Conifer Regeneration
Harvested forest-Shrub Regeneration	Harvested forest-Shrub Regeneration
Recently burned forest	Recently burned forest
Recently burned grassland	Recently burned grassland
Recently burned shrubland	Recently burned shrubland
Cultivated Cropland	Cultivated Cropland
Pasture/Hay	Pasture/Hay

Table D.3. Cropland data layer (CDL) classes.

CDL class name	*Columbia Plateau class name*
Caneberries	Highly Structured Agriculture
Hops	Highly Structured Agriculture
Cherries	Highly Structured Agriculture
Peaches	Highly Structured Agriculture
Apples	Highly Structured Agriculture
Grapes	Highly Structured Agriculture
Christmas Trees	Highly Structured Agriculture
Other Tree Nuts	Highly Structured Agriculture
Other Tree Fruits	Highly Structured Agriculture
Walnuts	Highly Structured Agriculture
Pears	Highly Structured Agriculture
Nectarines	Highly Structured Agriculture
Plums	Highly Structured Agriculture
Apricots	Highly Structured Agriculture
Blueberries	Highly Structured Agriculture
Corn	Irrigated Cropland
Soybeans	Irrigated Cropland
Sunflower	Irrigated Cropland
Sweet Corn	Irrigated Cropland
Mint	Irrigated Cropland
Flaxseed	Irrigated Cropland
Mustard	Irrigated Cropland
Sugarbeets	Irrigated Cropland
Potatoes	Irrigated Cropland
Other Crops	Irrigated Cropland
Misc. Vegs. & Fruits	Irrigated Cropland
Watermelons	Irrigated Cropland
Onions	Irrigated Cropland
Peas	Irrigated Cropland
Tomatoes	Irrigated Cropland
Herbs	Irrigated Cropland
Carrots	Irrigated Cropland
Asparagus	Irrigated Cropland
Greens	Irrigated Cropland
Strawberries	Irrigated Cropland
Squash	Irrigated Cropland
Dbl. Crop WinWht/Corn	Irrigated Cropland
Dbl. Crop Oats/Corn	Irrigated Cropland
Lettuce	Irrigated Cropland
Cucumbers	Irrigated Cropland

Table D.3. Continued.

CDL class name	*Columbia Plateau class name*
Pumpkins	Irrigated Cropland
Cabbage	Irrigated Cropland
Radishes	Irrigated Cropland
Sorghum	Nonirrigated Cropland
Barley	Nonirrigated Cropland
Spring Wheat	Nonirrigated Cropland
Winter Wheat	Nonirrigated Cropland
Rye	Nonirrigated Cropland
Oats	Nonirrigated Cropland
Speltz	Nonirrigated Cropland
Canola	Nonirrigated Cropland
Safflower	Nonirrigated Cropland
Rape Seed	Nonirrigated Cropland
Camelina	Nonirrigated Cropland
Dry Beans	Nonirrigated Cropland
Lentils	Nonirrigated Cropland
Sod/Grass Seed	Nonirrigated Cropland
Fallow/Idle Cropland	Nonirrigated Cropland
Triticale	Nonirrigated Cropland
Woodland	other land cover
Wetlands	other land cover
Open Water	other land cover
Perennial Ice/Snow	other land cover
Developed/Open Space	other land cover
Developed/Low Intensity	other land cover
Developed/Medium Intensity	other land cover
Developed/High Intensity	other land cover
Barren	other land cover
Deciduous Forest	other land cover
Evergreen Forest	other land cover
Mixed Forest	other land cover
Shrubland	other land cover
Grassland Herbaceous	other land cover
Woody Wetlands	other land cover
Herbaceous Wetlands	other land cover
Alfalfa	Pasture_Hay
Other Hay	Pasture_Hay
Clover/Wildflowers	Pasture_Hay
Pasture/Grass	Pasture_Hay

Table D.4. Focal species roads.

Initial road classes	*Columbia Plateau class name*
Freeway	Freeway
Major Highway	Major Highway
Secondary Highway	Secondary Highway
Rural Minor Arterial	Local
Rural Major Collector	Local
Rural Minor Collector	Local
Urban Other Principal Arterial	Local
Urban Minor Arterial	Local
Urban Collector	Local

Table D.5. Ruggedness range assignments.

Range	*Columbia Plateau class name*
-1.000 – 0.0001	Very Gentle Terrain or Surface Water
0.0001 – 0.002879	Gentle Terrain
0.002879 – 0.008637	Moderate Terrain
0.008637 – 0.046119	Rough Terrain
0.046119 – 0.367053	Very Rough Terrain or Escarpment

Table D.6. Landform.

Landform class name	*Columbia Plateau class name*
Canyons, Deeply Incised Streams	Drainages
Midslope Drainages, Shallow Valleys	Drainages
Upland Drainages, Headwaters	Drainages
U-shaped Valleys	U-shaped valleys
Plains Small	Plains
Open Slopes	Midslope
Upper Slopes, Mesas	Midslope
Local Ridges_Hills in Valleys	Midslope
Midslope Ridges, Small Hills in Plains	Midslope
Mountain Tops, High Ridges	Ridge,mountain top

Table D.7. Insolation range assignments.

Insolation range	*Columbia Plateau class name*
790–3000	Very low insolation
3000–3400	Low insolation
3400–3550	Moderate insolation
3550–3700	High insolation
3700–5025	Very high insolation

Table D.8. Soil texture class composition.

Soil texture class	*% Sand*	*% Silt*	*% Clay*
Sand	92	5	3
Loamy Sand	82	12	6
Sandy Loam	58	32	10
Silt Loam	17	70	13
Silt*	10	85	5
Loam	43	39	18
Sandy Clay Loam	58	15	27
Silty Clay Loam	10	56	34
Clay Loam	32	34	34
Sandy Clay	52	6	42
Silty Clay	6	47	47
Clay	22	20	58
No Soil	NA	NA	NA

**Silt class not in final soil texture map (Table D.1).*