

LAND SUITABILITY ANALYSIS: WALLOWA COUNTY

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GEOSCIENCES 453/553: RESOURCE EVALUATION METHODS

OREGON STATE UNIVERSITY

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You can now get back to your thesis work.

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PART 1: LAND SUITABILITY ANALYSIS FOR WALLOWA COUNTY

INTRODUCTION AND BACKGROUND:

PROJECT DESCRIPTION:

The Wallowa County Land Suitability Analysis (LSA) and Technical Manual in this document utilize Geographic Information System (GIS) tools for evaluating the relative suitability of land for development in Wallowa County, Oregon. It was developed as part of Geosciences 453/553 *Resource Evaluation Methods*, a Service Learning class offered at Oregon State University. The project was intended to contribute to two synchronistic goals, providing “real world” applications of the concepts of land-use planning to the students in the class while also providing Wallowa County with tools for furthering county planning efforts.

The ultimate goal of this analysis is to identify the most appropriate geographic locations for future land uses according to specific requirements. In Land Suitability Analyses these generally include physical limitations, existing regulatory restrictions, habitat requirements for plants and animal species, geologic suitability, suitability of agricultural lands, and community values. Because this has the potential to be infinitely complex, land-use suitability (and the criteria for determining it) must be defined by the communities using them.

For the Wallowa County LSA decisions regarding what types of data and how to weight them were made based on information gathered by the class on a field trip to Wallowa County, discussions with community leaders and planners, documents such as the existing county comprehensive plan and the Rural Design Assistance Team (RDAT) report, case studies in similar areas, and the availability of existing data. The Wallowa County LSA is designed to show areas more or less suitable for residential development based on the following categories: (1) Open Spaces; (2) Public Health and Safety; (3) Water Resources; (4) Soils and Agricultural Suitability; (5) Community Values. They are intended to capture development challenges specific to Wallowa County, including increased demand for small-acreage “ranchettes”, a desire to preserve viable agriculture land (in accordance with Oregon Statewide Planning Laws) and critical ecological resources.

LIMITATIONS:

Because this LSA is a class project with limited scope and minimal community input into the decision making process, its use in its current form is limited. This document is intended to be a starting point for a LSA in Wallowa County and provide the community with some preliminary information on the suitability of land for development based on existing GIS layers. The following are some of the major limitations of this LSA:

- **Lack of Community and Expert input:** The largest limitation of this analysis is that it was created by a group of students with minimal input from Wallowa County. The selection of submodels, development of criteria and many other value-laden decisions were made based on existing case studies or our personal opinions. We documented these decisions with the

hope that the county will be able to use local experts and public participation (when appropriate) to strengthen the LSA.

- Amateur GIS knowledge: While our team did have students with previous experience using GIS, none of our team members were GIS experts. The process of developing the LSA involved some creative problem solving and advanced GIS skills. We utilized tools familiar to us for these tasks, but feel that there may be more appropriate methods for accomplishing these tasks. In Part 2 of this document, the “technical manual” and in Appendix A and B we attempt to document our processes with as much transparency as possible.
- Limited Data: The data used in this analysis had been pre-processed by Jeff Baker and Myrica McCune as part of another project between Oregon State University and Wallowa County. The data had been retrieved and clipped to the county boundary. Because of the limited timeframe for this analysis, we weren’t able to identify any additional data sources or further customize data for the LSA. Irrigation data was originally included in the “Soils submodel” to form a “Working Landscapes Submodel” but was removed from the project due to the lack of existing data to accurately represent that category.
- Coarse Scale: This LSA is intended to be a coarse scale analysis. It should not be used to provide site specific planning. Furthermore, it does not make recommendations about zoning, or how individual landowners may or may not use their land.
- Equal Weight of Submodels: Each submodel is given equal weight in the final analysis. The method to create submodels included some submodels that contained a value of zero to represent areas that should not be included in the final LSA (for example, the public lands data in the Soils layer). Our final model was created by adding the LSA classes from each category therefore these zeros do not have an impact the final LSA map. However, in the future, if a raster calculator were used to weigh the submodels, this method would generate inaccurate results since this method uses multiplication.

SUBMODELS:

In each submodel below we will list the data used, the criteria and rational used to classify the data into LSA classes. The LSA classes include (1) Least Suitable for Development, (2) Less Suitable for Development, (3) More Suitable for Development and (4) Most Suitable for development. These classes are intended to provide information on the *relative* suitability of a location. That is, it provides information on how suitable it is relative to other locations within the county.

OPEN SPACES SUBMODEL

DESCRIPTION:

The Open Spaces Submodel includes public land, large tracts of private land of the same ownership, and lands protected by conservation easements in Wallowa County. The criteria in this model is based on parcel size only. The location of public land and easements was not considered. The parcel size used for classification is partly based on current minimum acreage sizes for Exclusive Farm Use (EFU) and Timber Grazing (T/G) zones but can easily be modified to suit the county's needs. The decision was made not to separate parcels by zone in order to facilitate the possibility of re-zoning in the future.

PARCELS DATA LAYER:

Provides information about size and ownership.

Criteria Selection:

Rational:

The decision was made to base the open lands submodel strictly on acreage size. This could allow for a new baseline zoning map. Most public lands and private land protected by conservation easement (i.e. The Nature Conservancy) have acreage sizes in moderately suitable to least suitable class because of their size. Residential development upon smaller acreage parcels would have le

Suitability Criteria:

Class 1 (Least Suitable)

Parcels greater than 400 acres are considered least suitable for development.

Class 2 (Less Suitable)

Parcels between 160 and 400 acres in size are considered less suitable for development.

Class 3 (Moderately Suitable)

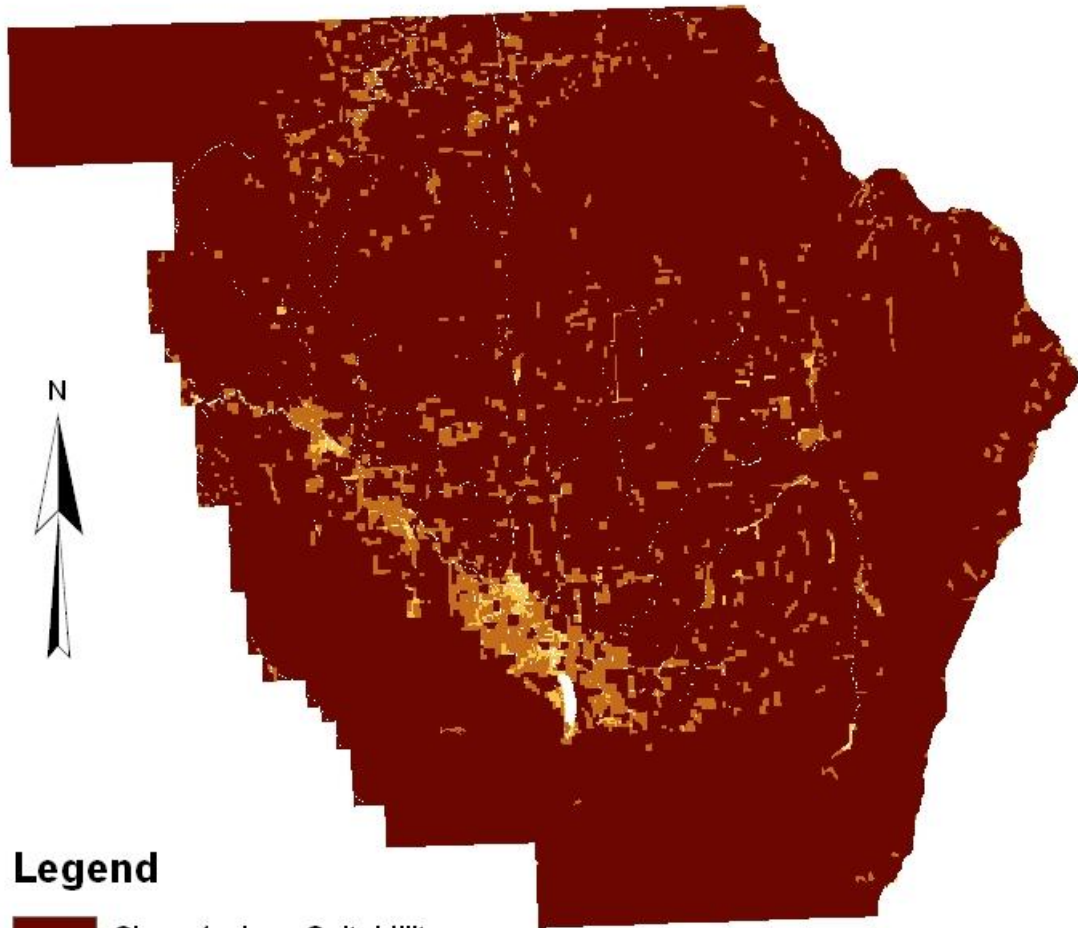
Parcels between 25 and 160 acres in size are considered moderately suitable for development.

Class 4 (Most Suitable)





Parcels less than 25 acres in size are considered most suitable to development.

MAP:

Open Lands Submodel



Legend

-  Class 1 - Low Suitability
-  Class 2 - Less Suitability
-  Class 3 - Moderate Suitability
-  Class 4 - High Suitability

0 5 10 20 30 Miles

Compiled by: Sam Thomas
Oregon State University
Geography 553

Projection: Lambert Conic Conformal, NAD 83

PUBLIC HEALTH AND SAFETY SUBMODEL

DESCRIPTION:

The Public Health and Safety submodel uses available data to identify areas which are less susceptible to natural hazards such as floods or landslides. It also includes a highway buffer which is meant to represent corridors of efficient emergency vehicle response time. Finally, it takes existing infrastructure into account, identifying these areas as beneficial development sites.

SLOPE DATA LAYER:

Criteria Selection:

Rational:

Slope data was derived from available DEM of Wallowa County. These data were then classified based on the percentage rise or fall of those surfaces. Due to lack county specific slope requirements, classifications were based on the Polk County, NC case study (Appendix C).

Suitability Criteria:

Class 1 (Least Suitable)

Areas with slope percentages greater than 30%

Class 2 (Less Suitable)

Areas with slope percentages between 20 and 30%

Class 3 (Moderately Suitable)

Areas with slope percentages between 10 and 20%

Class 4 (Most Suitable)

Areas with slope percentage less than 10%

FLOODPLAIN DATA LAYER:

Criteria Selection:

Rational:

Floodplain data was obtained from FEMA. This data was then processed and interpreted to identify points within the 100 and 500 year floodplains.

Suitability Criteria:

Class 1 (Least Suitable)

Points within FEMA's 100 year floodplain designation

Class 2 (Less Suitable)

Points within FEMA's 500 year floodplain designation

Class 3 (Moderately Suitable)

This classification was not used for this layer

Class 4 (Most Suitable)

Points that did not fall within either of the FEMA floodplain designations

EXISTING INFRASTRUCTURE AND ROADS DATA LAYER:

Criteria Selection:

Rational:

This layer combines existing infrastructure layers which represent city limits, UGB's, and major roads. City boundaries and UGB's were left as is and designated as highly suitable for development. Two buffers (half-mile and one mile) were created along major roads to represent emergency response corridors.

Suitability Criteria:

Class 1 (Least Suitable)

All Points that are not classified with one of the values above

Class 2 (Less Suitable)

Points within a one mile major road buffer

Class 3 (Moderately Suitable)

Points within a half-mile major road buffer

Class 4 (Most Suitable)

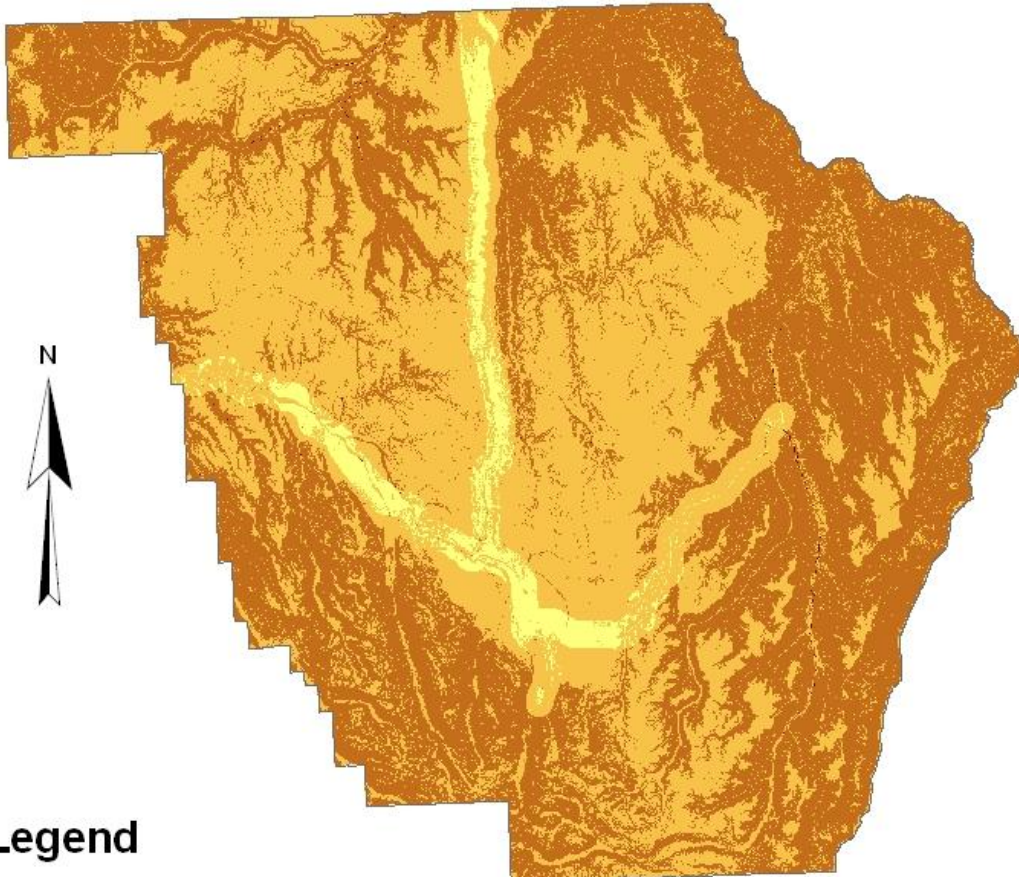
Points within the existing city limits or UGB

COMBINING LAYERS:





All three of the above layers were combined to create the final Public Health and Safety map. This required that each map was converted to raster format. The Raster Calculator tool was used to add the LSA suitability classes. This calculation resulted in a final map with nine values which were then reclassified to four.

MAP:

Public Safety Submodel



Legend

-  Class 1 - Low Suitability
-  Class 2 - Less Suitability
-  Class 3 - Moderate Suitability
-  Class 4 - High Suitability

0 5 10 20 30
Miles

Compiled by: Jason Collver
Oregon State University
Geography 553

Projection: Lambert Conic Conformal, NAD 83

WATER RESOURCES SUBMODEL

DESCRIPTION:

The water resources submodel was used to identify water resources that may be valuable for various reasons. It consists of surface water data including rivers, lakes, reservoirs, wetlands, the Enterprise watershed protection area, streams listed as required by the Clean Water Act, Section 303(d).

DATA LAYERS:

- 303dStreams – Streams listed as impaired as required by the guidelines of the Clean Water Act, Section 303(d)
- Rivers – 1:250,000 scale rivers as indicated by the Oregon Department of Energy.
- Wetlands – Locations of wetlands as indicated in the National Wetland Inventory (NWI) of the U.S. Fish and Wildlife Service.
- Lakes_and_Reservoirs – Locations of lakes and reservoirs provided by the Oregon State University Oregon Explorer project.
- Ent_wtshed – Location of the Enterprise watershed protection area.

Criteria Selection:

Rational:

Suitability classifications were selected based on whether or not water was present at any given location. Therefore, only “Low” and “High” Suitability were used.

Suitability Criteria:

Class 1 (Least Suitable)

The areas least suitable for development include the waterway extending to a 100 ft. buffer from the center of the stream or river. This classification also includes lakes, reservoirs, and wetlands.

Class 2 (Less Suitable)

This classification was not used in this submodel.

Class 3 (Moderately Suitable)

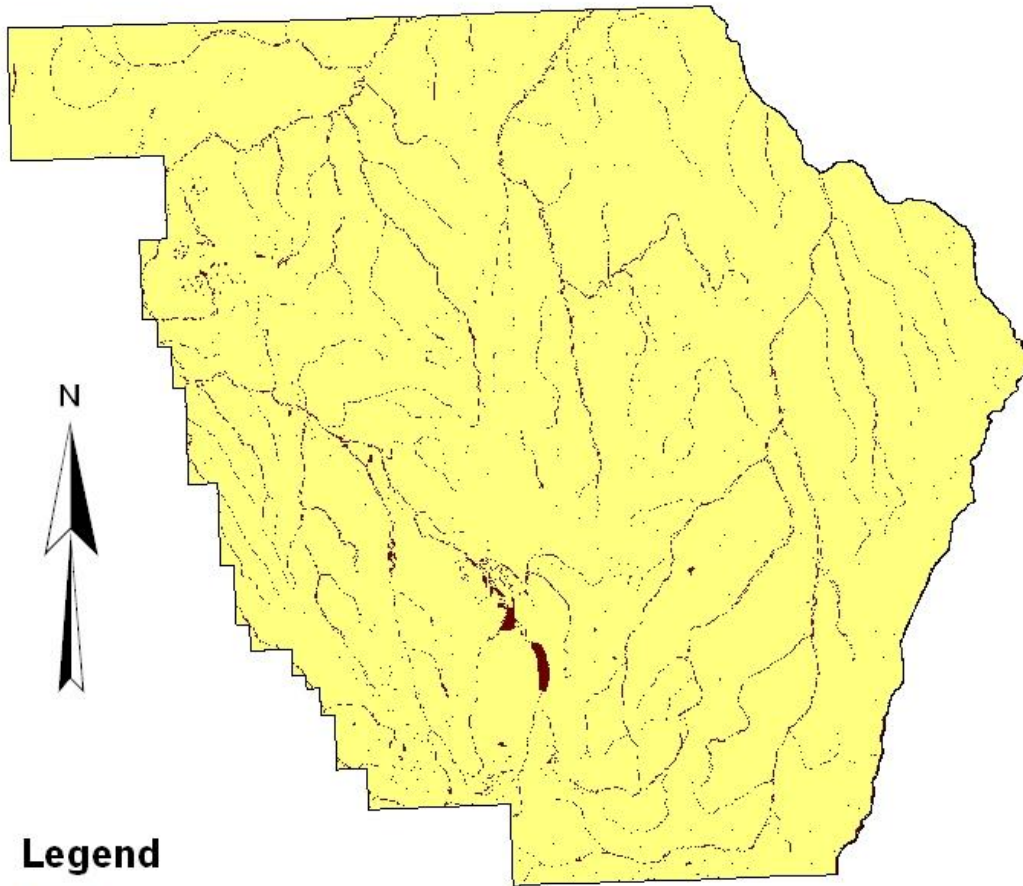
This classification was not used in this submodel. N/A

Class 4 (Most Suitable)

Areas outside of the 100 ft. buffer with respect to surface water are most suitable for development.

MAP:

Water Resources Submodel



Legend

-  Class 1 - Low Suitability
-  Class 4 - High Suitability

0 5 10 20 30
Miles

Compiled by: Jason Colver
Oregon State University
Geography 553

Projection: Lambert Conic Conformal

WILDLIFE SUBMODEL

DESCRIPTION:

The Wildlife submodel uses known habitat distribution to determine multiple levels of development suitability. In this case, available data consisted of elk and deer range along with streams and rivers recognized as valuable salmon and steelhead habitat. These layers were combined to identify areas of greater ecological importance.

WILDLIFE SUITABILITY LAYER:

Criteria Selection:

Rational:

Each habitat layer was classified as either present or absent. These layers were then combined to create one data layer which included all valuable habitats. Classes were determined by geographic extent of each habitat, considering each species specific habitat needs along with their ability to adapt to changes.

Suitability Criteria:

Class 1 (Least Suitable)

Class 1 consists of valuable salmon and steelhead streams. A one hundred foot buffer was created during the creation of the wildlife suitability layer in order to protect important stream conditions and riparian areas.

Class 2 (Less Suitable)

Class 2 includes valuable elk range throughout the county. The extent of this habitat is relatively small compared to the entire area of the county. Some development may not substantially harm the habitat, but specific herds may be affected.

Class 3 (Moderately Suitable)

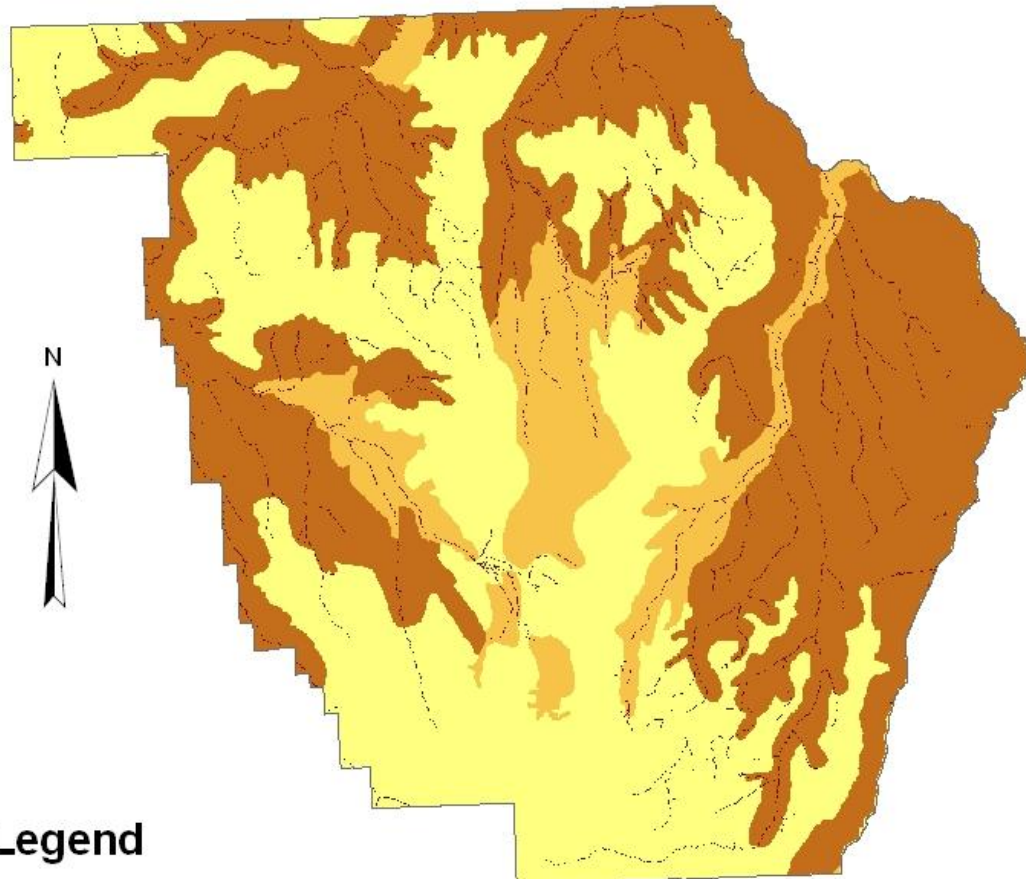
The third class consists of deer habitat which has not been included in classes 1 or 2. Deer range is relatively extensive throughout the county. These are zones which represent valuable deer habitat only.

Class 4 (Most Suitable)





A class 4 designation identifies areas that do not fall under any of the first three classifications.

MAP:

Wildlife Submodel



Legend

-  Class 1 - Low Suitability
-  Class 2 - Less Suitability
-  Class 3 - Moderate Suitability
-  Class 4 - High Suitability

0 5 10 20 30
Miles

Compiled by: Jason Colver
Oregon State University
Geography 553

Projection: Lambert Conic Conformal, NAD 83

SOIL SUBMODEL

DESCRIPTION:

The Soil Submodel uses the National Resources Conservation Service's classification for soil to classify agricultural suitability based on the Non-Irrigated Soil Capacity Class. Irrigation or additional soil data could be added to this submodel and a "Working Landscapes Submodel" created, similar to the Ravalli Case Study. The soils layer is clipped to only include non-public lands.

SOILS DATA LAYER:

Criteria Selection:

Rationale:

Soils were classified based on their non-irrigated soils capability class (determined by the National Resources Conservation Service). The soil data available contained greater detail about soil type by polygon, so a weighted averages method was used to determine the average non-irrigated (NIRR) soils capability class (SCC) for each polygon. The non-irrigated SCC was used because limited information was available about the irrigated soil capability class. NRCS defines the soil classes as follows:

Class I (1) soils have slight limitations that restrict their use.

Class II (2) soils have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Class III (3) soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Class IV (4) soils have very severe limitations that restrict the choice of plants or require very careful management, or both.

Class V (5) soils have little or no hazard of erosion but have other limitations, impractical to remove, that limit their use mainly to pasture, range, forestland, or wildlife food and cover.

Class VI (6) soils have severe limitations that make them generally unsuited to cultivation and that limit their use mainly to pasture, range, forestland, or wildlife food and cover.

Class VII (7) soils have very severe limitations that make them unsuited to cultivation and that restrict their use mainly to grazing, forestland, or wildlife.

Class VIII (8) soils and miscellaneous areas have limitations that preclude their use for commercial plant production and limit their use to recreation, wildlife, or water supply or for aesthetic purpose. (U.S. Department of Agriculture, Natural Resources Conservation Service 2007)

Suitability Criteria

Class 1 (Least Suitable)

Class 1 identifies location where the soil class was below Class IV because these classes represent soil suitable for farming and some ranching operations.

Class 2 (Less Suitable)

The second class (Class 2) identifies locations where the weighted soil class was between Class IV and Class V.

Class 3 (Moderately Suitable)

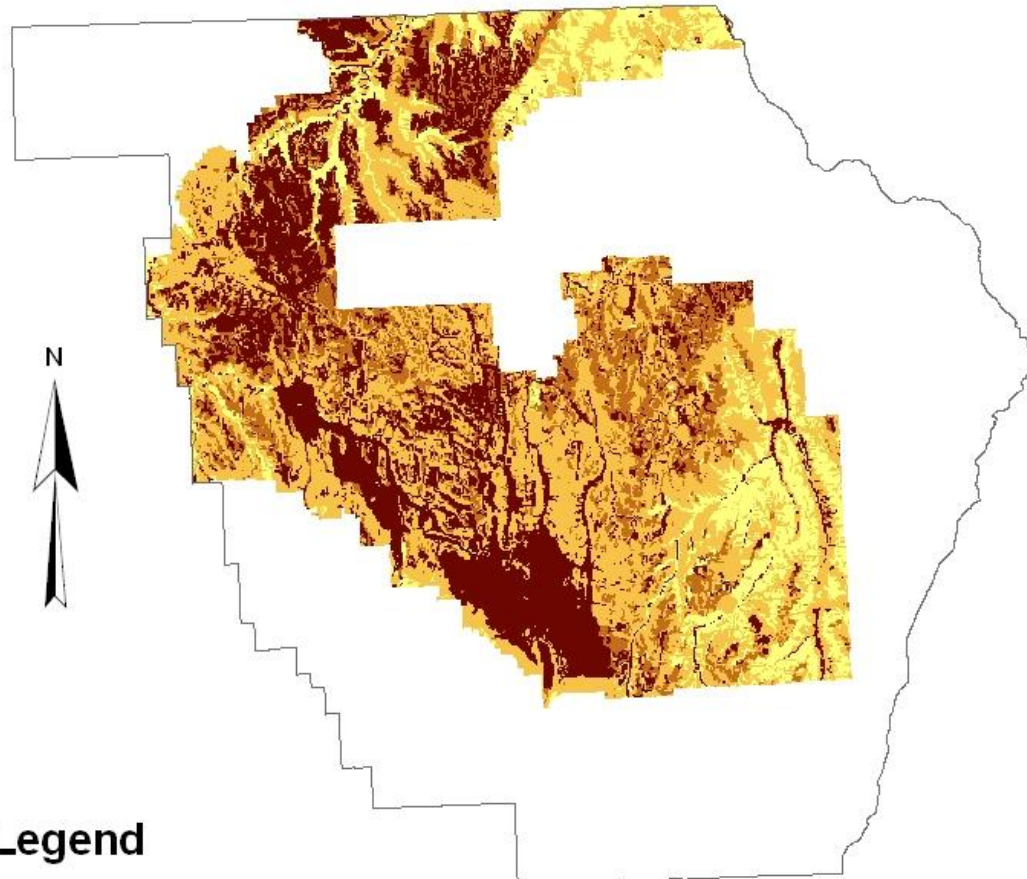
Class 3 identifies the locations with soil class between Class V and Class VI.

Class 4 (Most Suitable)





Class 4 was reserved for lands with a weighted average soil classification above Class VI. This includes all soils ranging from Classes VI-VIII which is soil generally considered unsuitable for agriculture.

MAP:

Soil Submodel



Legend

-  Class 1 - Low Suitability
-  Class 2 - Less Suitability
-  Class 3 - Moderate Suitability
-  Class 4 - High Suitability

0 4.5 9 18 27
Miles

Compiled by: Robyn Paulekas
Oregon State University
Geography 553

Projection: Lambert Conic Conformal, NAD 83

COMMUNITY VALUES SUBMODEL

DESCRIPTION:

This submodel incorporates data gathered by Max Nielsen-Pincus and Jo Ellen Force from the University of Idaho during a community values mapping survey (Nielsen-Pincus and Force, Wallowa County Beliefs, Attitudes, and Values: A Survey of Wallowa County Property Owners 2005). It is an attempt to incorporate “fuzzy” data into the spatial analysis. By incorporating community values into the land suitability analysis, Wallowa County has a unique opportunity to account for the presence of special or unique locations. The study incorporates the following values: aesthetic, biological, diversity, cultural, development, economic, future, historic, intrinsic, learning, life sustaining, recreation, spiritual, subsistence, and therapeutic. For this analysis, all values were mapped and given equal weight.

DATA LAYER: COMMUNITY VALUES MAP

This submodel used data collected by Max Nielsen-Pincus and Jo Ellen Force to incorporate community values into the Land Suitability Analysis. The data was derived from the “Wallowa County – An Atlas of Values”. During this study 989 randomly selected land owners in Wallowa County were asked to place stickers “on the map on those locations in the County that you feel best represents those values to you” (Nielsen-Pincus and Force, Wallowa County- An Atlas of Values 2005). There was no limit to the number of stickers participants could place in each category. The results were digitized and incorporated into a GIS file, with points representing each sticker.

For this submodel, the stickers were mapped for their density. Densities were calculated on a 1 acre (209 feet) grid using the point density tool in Map Algebra. For each grid cell we calculated the density of values stickers within a 1 acre search radius. Those data were then reclassified into the four classifications based on the density of stickers present on a grid cell.

Criteria Selection:

Rational:

All stickers were given equal value. (see Appendix B for a discussion of limitations of the value data used and recommendations for improvement). Criteria selection was based on natural breaks in the data.

Suitability Criteria:

Class 1 (Least Suitable):

Locations where greater than .075 stickers per acre (48 stickers per mile)

Class 2 (Less Suitable):

Locations with 0.038 – 0.075 stickers per acre (24-48 stickers per mile)

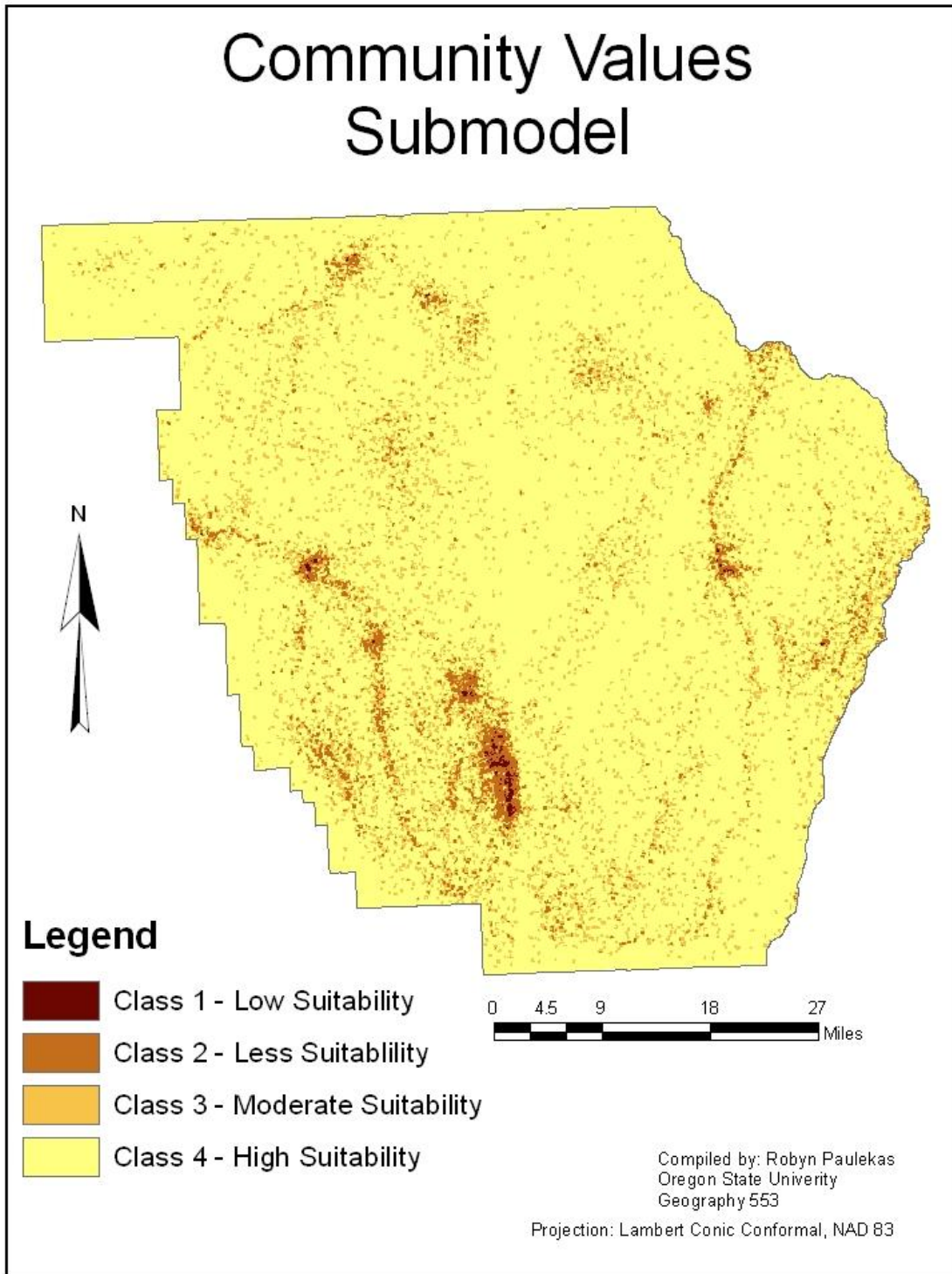
Class 3 (Moderately Suitable):

Locations with 0 - 0.038 stickers per acre (0-24 stickers per mile)

Class 4 (Most Suitable)

Locations where no stickers were placed was deemed most suitable for development.

MAP:



THE LAND SUITABILITY ANALYSIS: COMBINING SUBMODELS

The submodels were combined together using the Raster Calculator feature in the ArcTool box. No weighting was assigned to the submodels, so each contributed equally. The final suitability value for any given pixel is simply the additive sum of all the submodel results of that pixel.

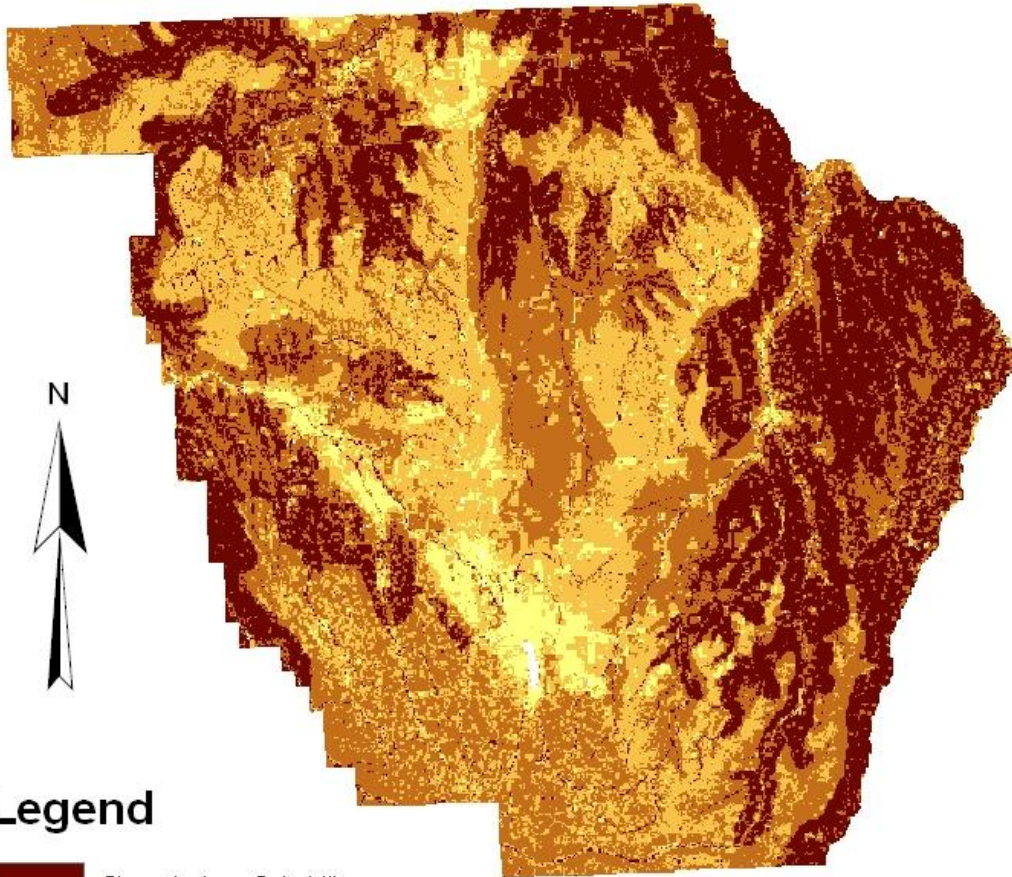
Because the soil submodel was created from data that was clipped to only include private land (not public land), combining the submodels into a final Land Suitability Analysis proved problematic. Because all pixels on public land were assigned a value of 0 they skewed the values of those pixels towards the lower end of the range (less suitable). To resolve this, we decided to perform two analysis:

(1) A Land Suitability Analysis without the Soil Submodel. The calculated values ranged from 6-20 The data were reclassified using “natural breaks” into 4 categories. The values in these categories are: class 1 (Least Suitable) 6-10, Class 2 (Less Suitable) 10-12, Class 3 (More Suitable) 12-14 and , Class 4 (Most Suitable) 14-20 .

(2) The Final LSA analysis with the Soil Submodel. We had to shift the “natural breaks” reclassification to account for the reclassification skewing on the public land. The calculated values ranged from 6-22 with 6 being the least suitable score and 22 being the most suitable for development. The data were reclassified using “natural breaks” into 4 categories. The values in these categories are: class 1 (Least Suitable) 6-13, Class 2 (Less Suitable) 13-15, Class 3 (More Suitable) 15-17 and , Class 4 (Most Suitable) 17-22 .

MAPS:

Wallowa County Land Suitability Analysis (Without Soil Data)



Legend

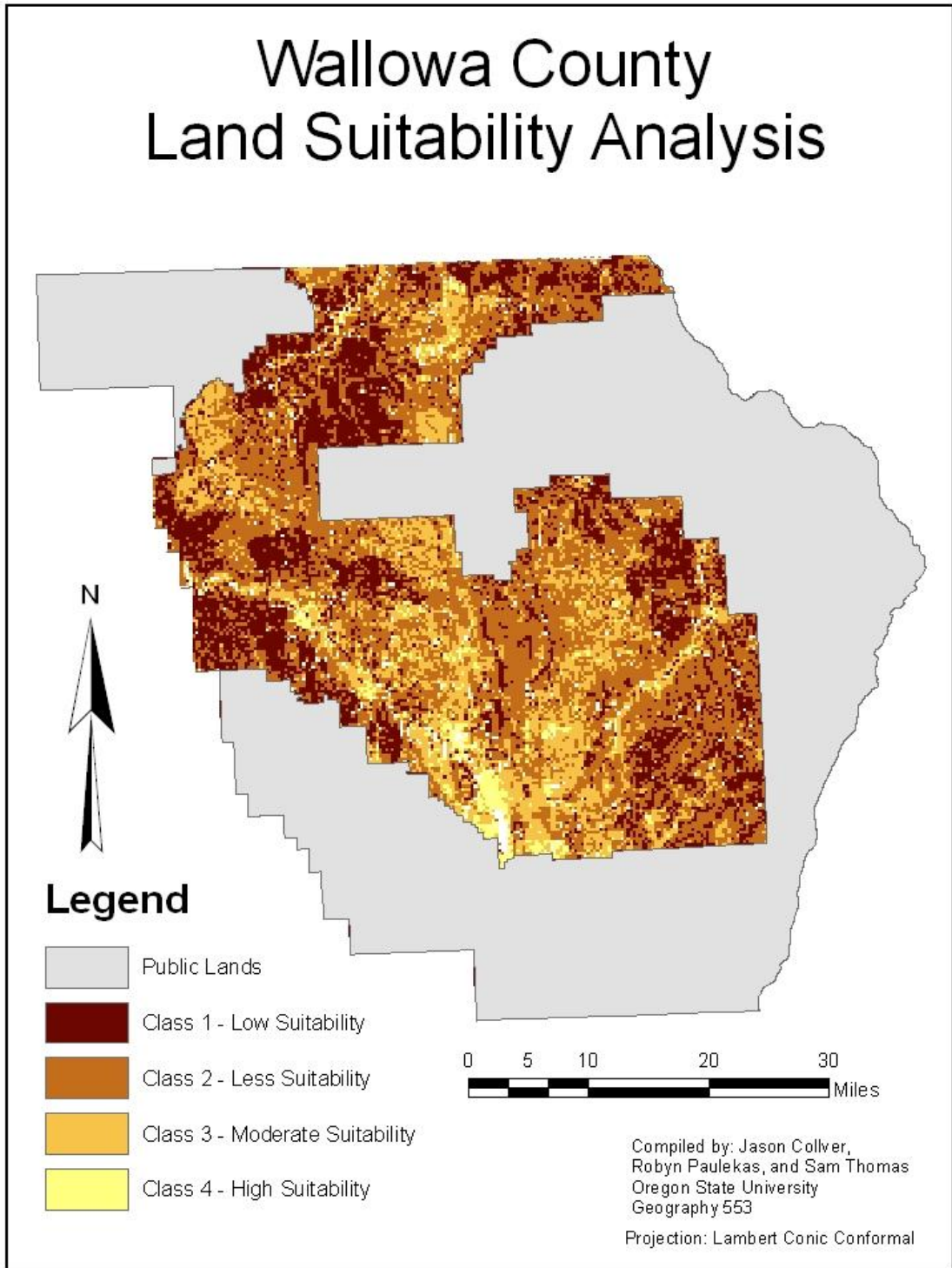
-  Class 1 - Low Suitability
-  Class 2 - Less Suitability
-  Class 3 - Moderate Suitability
-  Class 4 - High Suitability

0 5 10 20 30
Miles

Compiled by: Jason Colver,
Robyn Paulekas, and Sam Thomas
Oregon State University
Geography 553

Projection: Lambert Conic Conformal

Wallowa County Land Suitability Analysis



USE AND RECOMMENDATIONS:

The results from this Land Suitability Analysis are valuable information that will prove to be an asset to Wallowa County. However, this initial LSA should be considered preliminary. Any use of the results needs to take into consideration its limitations and the lack of community involvement in submodel and criteria selection. The following are some suggestions for potential future use and next steps:

POTENTIAL USES AS IS:

Without modification, the Wallowa LSA could serve as a starting point for community discussions about land use planning, development and zoning.

SUGGESTED NEXT STEPS:

- **Submodel selection:** Because the submodels are the most significant units of the analysis, the first step modifying the LSA would be to determine if the submodels best represent the community's considerations for land suitability for development. Those selected were intended to encompass physical constraints, environmental considerations, and the working landscapes/open spaces characteristic of Wallowa rural nature. It might be beneficial to consider submodels that were not used in this analysis. For example The Polk and Big Horn County case studies use existing regulatory and legal constraints in their analysis. Considering the major determinants of "suitability" for Wallowa could strengthen the applicability of the analysis.
- **Criteria Selection:** The selection of criteria for classifying data into the land suitability classes is a value-laden process. The community and experts should be engaged in a more extensive process for selecting LSA criteria.
- **Data Improvements:** There were several situations where the data was insufficient for the analysis. The soils data was only available for the non-public lands, the irrigation data was not in a usable format, and the parcel data wasn't easy to convert to raster. These problems (and others) could be addressed if more GIS resources (time and expertise) were available.
- **Public Participation:** Having citizens and stakeholders engaged in the Land Suitability Analysis could provide a critical method for not just improving the accuracy of the analysis, but ultimately improving its utility as well. Local experts and non-experts should be engaged in guiding the Land Suitability Analysis process.
- **Re-run the analysis with Wallowa Revisions:** Once the model has been refined based on the above criteria, re-run the analysis. This could be done with different weighting, or different classifications of the final map could produce paired maps, one with an emphasis on development and the other emphasizing conservation goals (see Big Horn county for an example).

POTENTIAL USES AFTER IMPROVEMENTS HAVE BEEN MADE:

The LSA has the potential to be a useful tool in countywide planning efforts. It could potentially be used to make zoning and other land use planning decisions. Understanding the relative suitability of a site can be a powerful resource in land use decision-making, allowing the continued maintenance of a high quality of life in Wallowa County for generations to come.

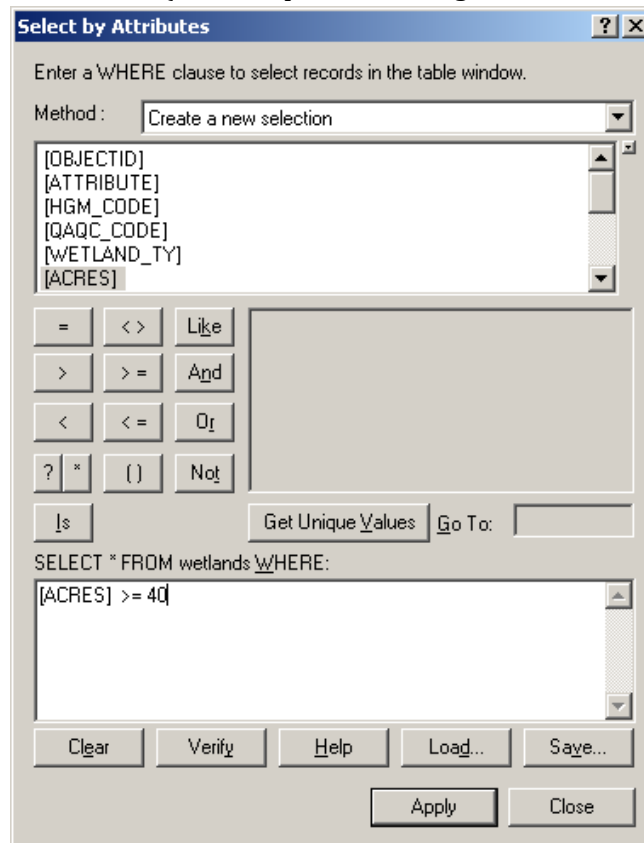
PART 3: LAND SUITABILITY ANALYSIS TECHNICAL MANUAL

This technical manual will walk through the steps that were utilized in the development of this LSA. It assumes that the user has a basic knowledge of ArcGIS functions. This, combined with the information in the appendix should allow for the recreation and modification of all maps and analysis.

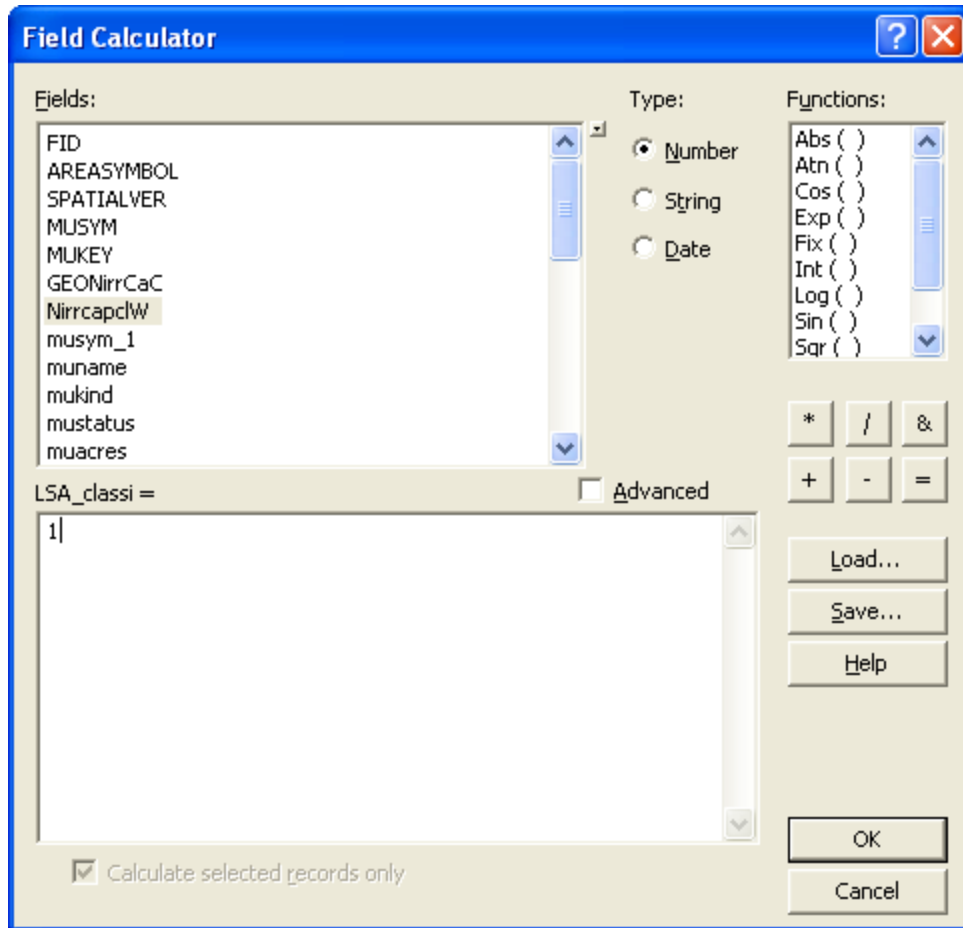
CLASSIFYING THE DATA:

ADD A FIELD TO THE ATTRIBUTE TABLE:

1. This will allow for the division of feature attributes into 4 classifications (or however many are needed).
2. Open the attribute table for the layer of interest.
3. Click the Options button - select "Add Field..." Name the new column "LSA_CLASS". Leave type as Short Integer.
4. Use the "Select by Attributes..." option from the Option button within the attribute table.
5. Use the calculator to write a SQL statement to classify the data based on a particular attribute or set of attributes (for example Wetlands greater than or equal to 40 acres).



6. From the attribute table look right click on the LSA_CLASS column and select "Field Calculator".
7. Select desired Field and assign a class (1-4). Make sure the "Calculate selected records only" box is checked.



Repeat steps 3-7 to classify the remaining data for that layer*.

*Once the data have been classified you may need to change the Symbology (in the Properties Tab) to suit your needs.

COMBINING MULTIPLE DATA SOURCES INTO ONE SUBMODEL:

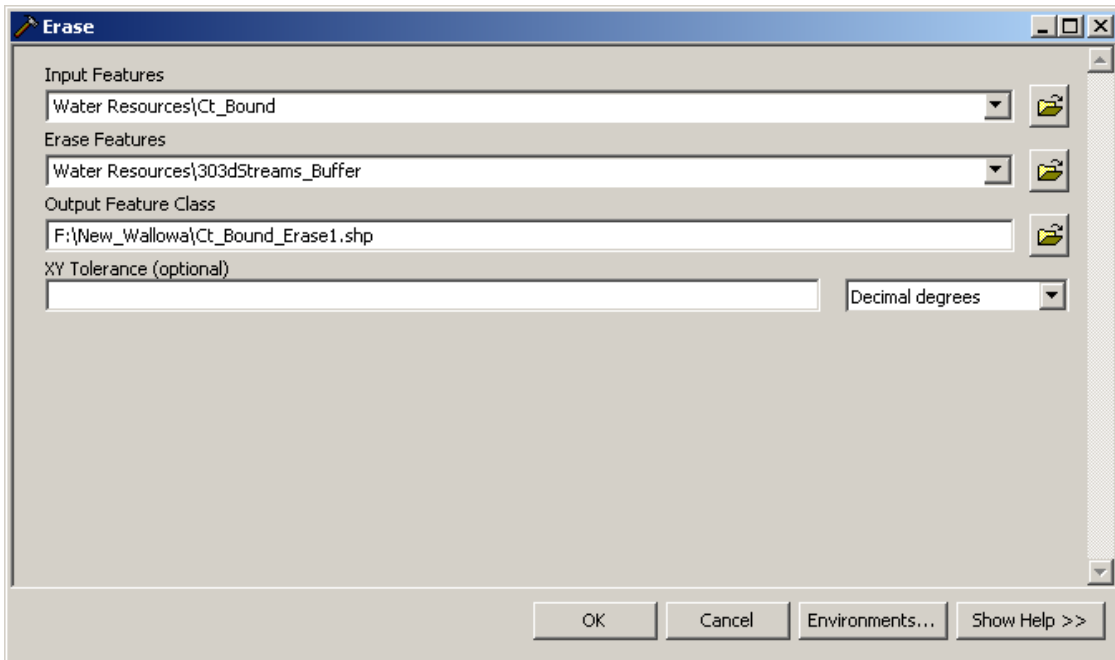
The majority of the submodels used in this LSA pull on data from more than one source. These data sets must be combined before being converted to a raster file. This was done with each submodel.

ERASE AND MERGE:

In order for the vector datasets to display properly and combine properly in raster format, some features may need to be erased and then merged.

ERASE:

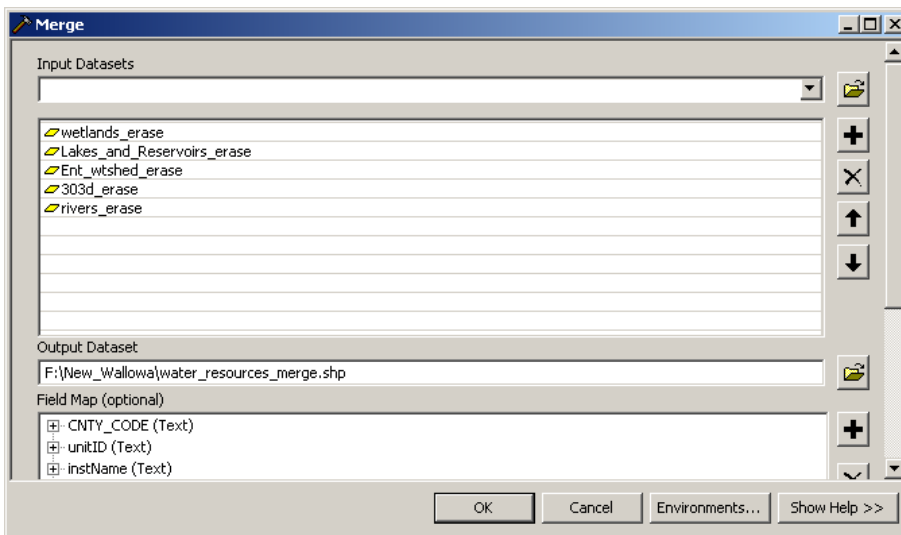
1. Open ArcToolbox from the main toolbar
2. Select **Analysis** → **Overlay** → **Erase**. A dialog box will appear.
3. Populate the fields based on an input feature (for example an underlying feature such as the county boundary) and the feature to be erased. Specify a name for the output file in your working directory. The output file should be added to your map document.



4. Repeat Steps 1-3 for each feature dataset.

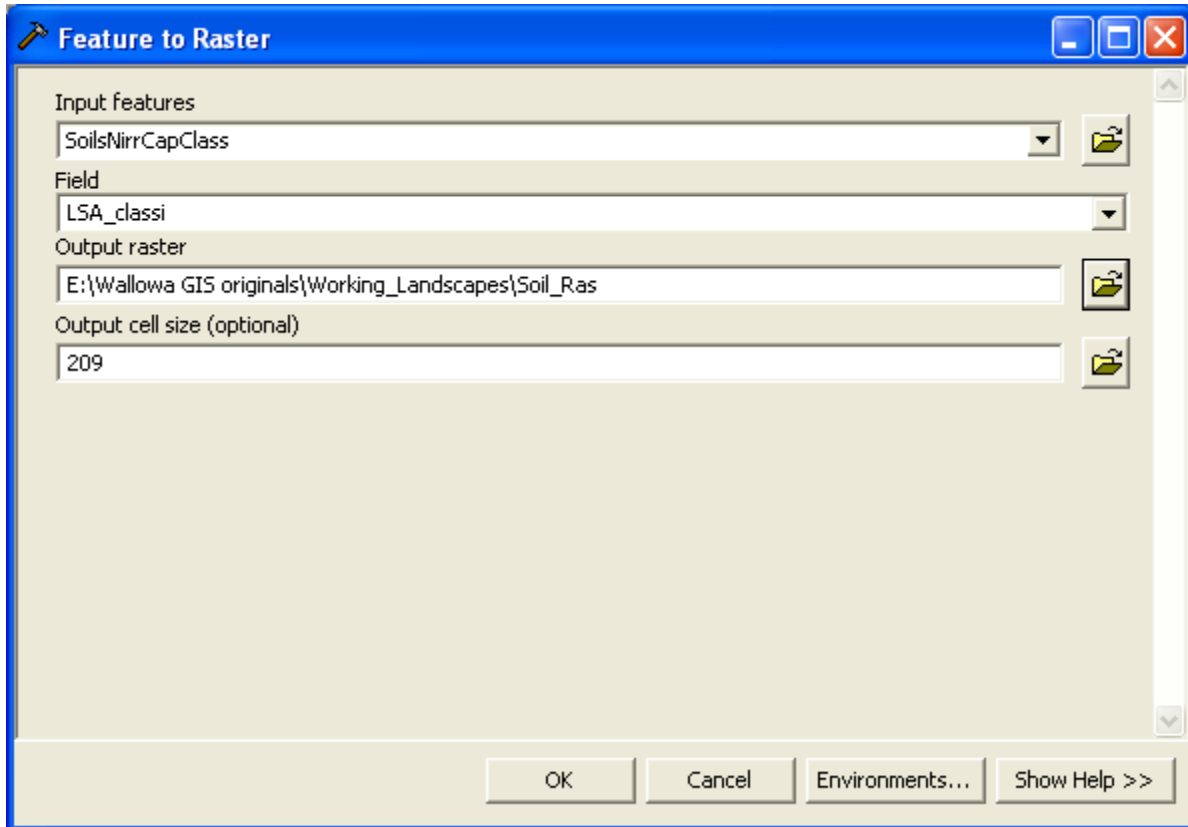
MERGE:

1. With the newly created erase feature data select **Data Management Tools** → **General** → **Merge** from the ArcToolbox menu. A dialog box will appear.
2. Add the newly created erase feature data as the input datasets.
3. Choose an output file name and click **OK**.

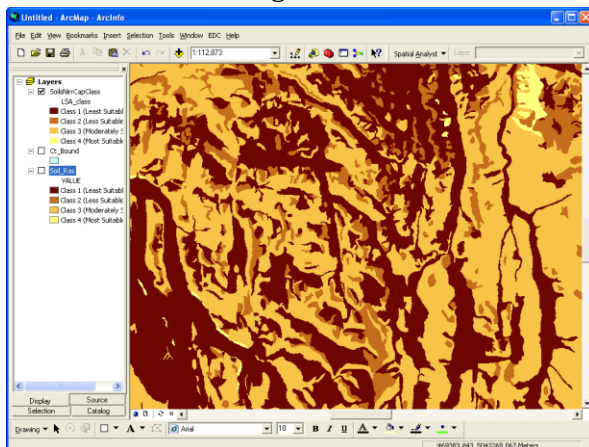


CONVERT FEATURE DATA TO RASTER:

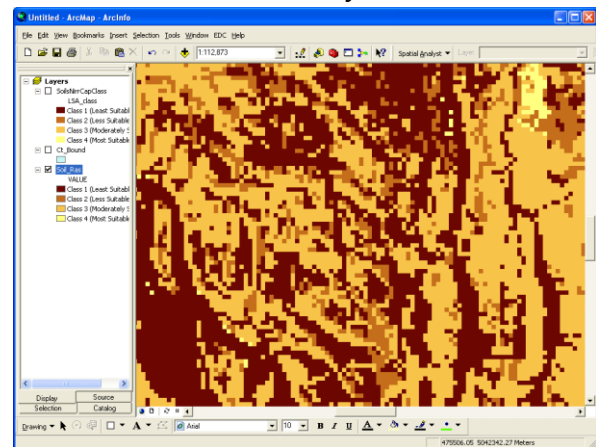
1. Open ArcToolbox from the main ArcMap toolbar.
2. Select Conversion Tools → to Raster → Feature to Raster
3. Fill in the field data as shown in the graphic below.
4. Select an input feature, an appropriate field, and an Output cell size of 209 which is approximately 1 acre pixels.



You now have the original vector file:



And a raster of the same layer:



TOOLS AND DETAILED STEPS USED FOR EACH SUBMODEL:

OPEN SPACES

Original data – parcels

Select by attributes for “ACRES” using parcel layer

SQL statements:

1. “ACRES” <= 25 → Export selected attributes as shapefile → **parcels_less_than_25.shp**
2. “ACRES” > 25 AND “ACRES” <= 160 → Export selected attributes as shapefile → **parcels_25_to_160.shp**
3. “ACRES” > 160 AND “ACRES” <= 400 → Export selected attributes as shapefile → **parcels_160_to_400.shp**
4. “ACRES” > 400 → Export selected attributes as shapefile → **parcels_greater_than_400.shp**

Create new field in attribute table “LSA_Class”.

Assign parcel layers value (1-4) based on acreage (i.e. 4 for parcels_less_than_25.shp).

Repeat for remaining 3 parcel layers.

Convert to Raster:

Conversion Tools → Feature to Raster → **parcels_less_than_25.shp** becomes **ras_25**.

Same process as above for remaining 3 parcels layers.

Raster Mosaic:

Data Management Tools → **Raster** → **Mosaic To New Raster** → input the newly created rasters which becomes **ras_mosaic**.

PUBLIC HEALTH AND SAFETY

Original data – Highways, City Limits, UGB, Wallowa DEM, FEMA Flood, County Boundary

Flood Risk Map – FEMA Flood layer

Select by Attributes

Select all features labeled either “A” or “X500” in the Zones column

Create a new layer with the selected features → **Floodplains**

*Create LSA_Class column in attribute table – **A = 1, X500 = 2**

Erase

Ct_Bound – Floodplains → **Ct_Bound_Erase1**

* Create LSA_Class column in attribute table – Assign all entries a value of 4

Merge

Ct_Bound_Erase1 + Floodplains → **Flood_Suit**

Convert to raster based on LSA_Class → Flood_Raster

Existing Infrastructure - Highways, City Limits, and UGB layers

Buffer

Half mile Highway buffer → **Highways_Halfmile**

One mile Highways buffer → **Highways_Onemile**

Erase

Highways_Onemile - Highways_Halfmile, City_Limits, and UGB → **Roads_Onemile**

* Create LSA_Class column in attribute table - Assign all entries a value of 2

Highways_Halfmile - City_Limits and UGB → **Roads_Halfmile**

* Create LSA_Class column in attribute table - Assign all entries a value of 3

City_Limits and UGB → No erase required

* Create LSA_Class column in attribute tables - Assign all entries a value of 4

Merge

Roads_Onemile + Roads_Halfmile + City_Limits + UGB → **Pub_Safety**

Clip

Clip Pub_Safety to Ct_Bound → **Pub_Safety_Clip**

Erase

Ct_Bound - Pub_Safety_Clip → **Ct_Bound_Erase2**

* Create LSA_Class column in attribute table - Assign all entries a value of 1

Merge

Ct_Bound_Erase2 + Pub_Safety_Clip → **PHS_Suit**

Convert to raster based on LSA_Class → PHS_Raster

Slope - DEM layer

Slope

Create slope layer using DEM (percentage rise) → **Slope**

Reclassify to create 4 breaks → Slope_Raster

1 = >30% slope

2 = 20-30% slope

3 = 10-20% slope

4 = <10% slope

Combining PHS Rasters - Slope_Raster, PHS_Raster, and Flood_Raster

Raster Calculator

Add all three rasters using equal weights

Slope_Raster + PHS_Raster + Flood_Raster → **Wallowa_PHS**

Reclassify to create 4 breaks → Public_Safety

1 = Values of 3 and 4

2 = Values of 5, 6, and 7

3 = Values of 8, 9, and 10

4 = Values of 11 and 12

WILDLIFE

Original Data – Deer Range, Elk Range, Steelhead Rivers, and County Boundary
Buffer

100ft buffer – Steelhead_Sum → **Fish_Buffer**

*Represents both Salmon and Steelhead streams throughout the county

Erase

Deer – Elk and Fish_Buffer → **Deer_Only**

* Create LSA_Class column in attribute table – Assign all entries a value of **3**

Elk – Fish_Buffer → **Elk_Only**

* Create LSA_Class column in attribute table – Assign all entries a value of **2**

Fish_Buffer → No erase required

* Create LSA_Class column in attribute table – Assign all entries a value of **1**

Merge

Deer_Only + Elk_Only + Fish_Buffer → **All_Wildlife**

Erase

Ct_Bound – Wildlife_All → **No_Wildlife**

* Create LSA_Class column in attribute table – Assign all entries a value of **4**

Merge

Wildlife_All + No_Wildlife → **Wildlife_Suit**

Convert to raster based on LSA_Class → **Wildlife_Rast**

WATER RESOURCES:

Original layers – Wetlands, Rivers, 303d Streams, Enterprise Watershed, County *Boundary*

Erase

Wetlands – Rivers, 303dstreams, and Ent_Wtshed → **Wetlands_Only**

Rivers – 303dstreams and Ent_Wtshed → **Rivers_Only**

303dstreams – Ent_Wtshed → **303d_Only**

Ent_Wtshed → No erase require

Merge

Wetlands_Only + Rivers_Only + 303_Only + Ent_Wtshed → **Water_All**

*Create LSA_Class column in attribute table – Assign all entries a value of **1**

Erase

Ct_Bound – Water_All → **Ct_Only**

*Create LSA_Class column in attribute table – Assign all entries a value of **4**

Merge

Ct_Only + Water_All → **Water_Final**

Convert to raster based on LSA_Class → **Water_Raster**

SOIL

Original layers – soilsNirrCapClass.shp This is the original file from Jeff with the NirrCapCIW being the weighted average of the non-irrigated soil capacity class for that polygon.

Erase

Ct_Bound – SoilsNirrCapClass.shp → CtBound_Soils_Erase

Merge

CtBound_Soils_Erase + SoilsNirrCapClass.shp → CtBound_Soils_Merge.shp

Convert to raster based on LSA_Class → Soils_RAS

COMMUNITY VALUES

Original layers – Wallowa_Value_Points.shp

Point Density

Wallowa_Value_Points.shp → PtDe_values

cell output size 209 (1 acre); Circle- Radius 209; area units acres

Reclassify

Ptde_values → values_recl

Class 1 0

Class 2 0 - 0.038

Class 3 0.038 - 0.075

Class 4 0.075 – 0.826

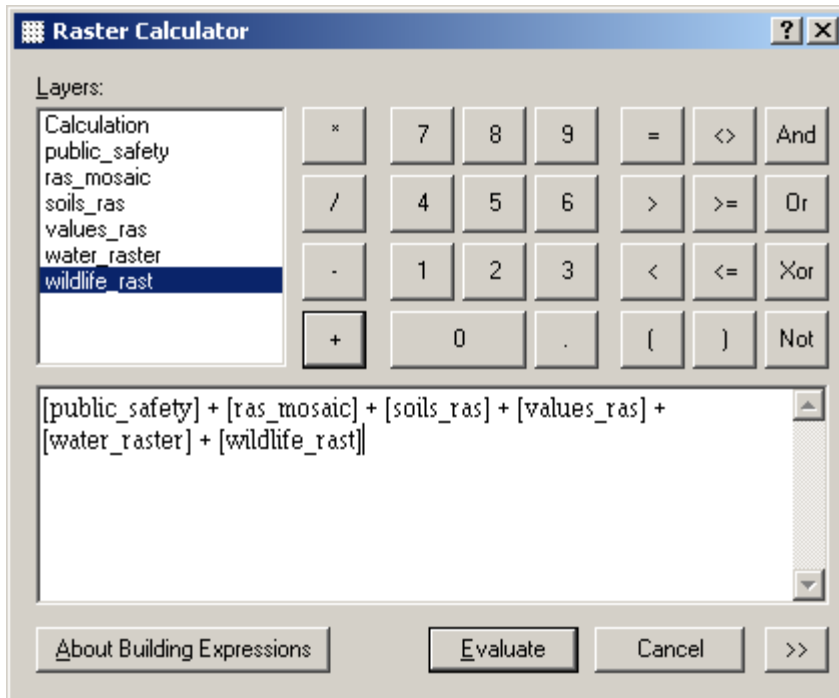
Extract by Mask

Ct_Bound -- values_recl → recl_values

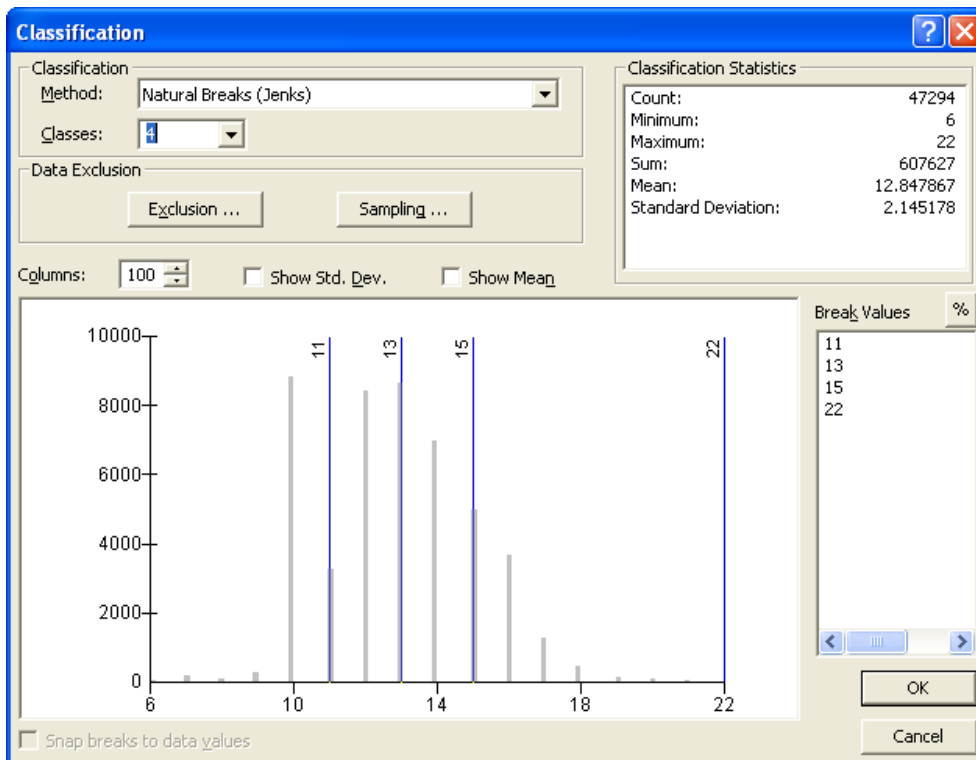
COMBINING SUBMODELS:

The submodels were combined using Raster Calculator function from the Spatial Analyst toolbar.

1. The raster grids for each submodel were combined using simple addition and no weighting as shown in the Raster Calculator screenshot below:



2. The output raster named Calculation was reclassified using the **Natural Breaks (Jenks)** method with 4 classes as shown in the screenshot below:



As mentioned in Part 1, this was done with the soil layer, and then once without the soil layer.

WORKS CITED:

Nielson-Pincus, Max, and Jo Ellen Force. "Wallowa County- An Atlas of Values." 2005.

Nielson-Pincus, Max, and Jo Ellen Force. "Wallowa County Beliefs, Attitudes, and Values: A Survey of Wallowa County Property Owners." 2005.

U.S. Department of Agriculture, Natural Resources Conservation Service, 2007. National Soil Survey Handbook, part 662. [Online] Available: <http://soils.usda.gov/technical/handbook/>.

APPENDIX A: DATA DESCRIPTIONS:

DATA USED:

This is a table of all the data layers and ArcGis tools that were used This includes the original data files provided by Jeff Baker and Myrica McCune along with key files created for the LSA.

OPEN SPACES SUBMODEL:

File Name	Description	Data Source	ArcGIS tools
parcels	Information about parcel size, ownership, and zoning	Dawn Smith	Select by attributes
parcels_less_than_25	Parcels less than 25 acres	parcels	Feature to raster
parcels_25_to_160	Parcels between 25 and 160 acres	parcels	Feature to raster
parcels_16_to_400	Parcels between 160 and 400 acres	parcels	Feature to raster
parcels_greater_than_400	Parcels greater than 400 acres	parcels	Feature to raster
ras_25	Raster of parcels less than 25 acres	parcels_less_than_25	Mosaic to new raster
ras_25_160	Raster of parcels between 25 and 160 acres	parcels_25_to_160	Mosaic to new raster
ras_160_400	Raster of parcels between 160 and 400 acres	parcels_160_to_400	Mosaic to new raster
ras_400	Raster of parcels greater than 400 acres	parcels_greater_than_400	Mosaic to new raster
ras_mosaic	Mosaic of 4 rasters	ras_25, ras_25_160, ras_160_400, and ras_400	Raster calculator

PUBLIC HEALTH AND SAFETY SUBMODEL:

File Name	Description	Data Source	ArcGIS tools
DEM	Digital Elevation Model of Wallowa County	USGS EROS Data Center	
Slope_Raster	Percentage rise in slope	DEM Layer	Slope, Reclassify
UGB2007	Urban Growth Boundaries	Dawn Smith – Wallowa County	
Citylim_2007	2007 City Limits	ODOT	
highways	Highways within Wallowa County	ODOT	
Roads_Halfmile	Half-mile highway buffer	highways Layer	Buffer – ½ mile
Roads_Onemile	One mile highway buffer	Highways layer	Buffer – One mile
Pub_Safety_Clip	*All existing infrastructure layers combined	Roads_Onemile, Roads_Halfmile, City_Limits, and UGB	Merge, Clip to Ct_Bound
PHS_Suit	Final existing infrastructure shapefile with all data included	Pub_Safety_Clip, Ct_Bound_Erase2	Merge
PHS_Raster	Raster of PHS_Suit	PHS_Suit	Feature to Raster
FEMAflood	FEMA flood designation	Dawn Smith – Wallowa County	
Floodplains	100 and 500 year flood data only	FEMA_Flood	Select by Attributes, Export Data
Flood_Suit	Flood data combined with county outline	Floodplains, Ct_Bound_Erase1	Merge

*Layers which were used during intermediate steps are not included. Refer to Tools and Steps for each Submodel section for additional information

WATER RESOURCES SUBMODEL:

File Name	Description	Data Source	ArcGIS tools
303dStreams	List of impaired streams as required by the Clean Water Act Section 303(d)	Oregon Department of Environmental Quality	
Rivers	1:250,000 scale rivers and streams	Oregon Department of Energy	
Ent_wtshed	Enterprise Watershed Protection Area	Dawn Smith	
Lakes_and_Reservoirs	Location of lakes and reservoirs in the county		
Wetlands	Wetlands throughout Wallowa County	U.S. Department of Fish and Wildlife	
Ct_Bound	County boundary shapefile	OR/WA BLM	
Water_All	*All water layers combined after erasing overlapping features	303dstreams, Rivers, Ent_Wtshed, Lakes_and Reservoirs, and Wetlands	Erase, Merge
Ct_Only	County boundary layer with Water_All layer removed	Ct_Bound and Water_All	Erase
Water_Final	Final vector map of water resources	Ct_Only and Water_All	Merge
Water_Raster	Raster image of Water_Final	Water_Final	Feature to Raster

*Layers which were used during intermediate steps are not included. Refer to Tools and Steps for each Submodel section for additional information

WILDLIFE SUBMODEL:

File Name	Description	Data Source	ArcGIS tools
Deer	Deer Winter Range	ODFW	
Elk	Elk Winter Range	ODFW	
steelhead_sum	Summer Steelhead Streams	ODFW	
Ct_Bound	County Boundary	OR/WA BLM	
Fish_Buffer	100ft buffer along all waterways considered to be valuable Salmon or Steelhead habitat	Steelhead_sum	Buffer – 100ft
All_Wildlife	*All habitat layers combined after erasing overlapping features	Fish_Buffer, Deer_Only, Elk_Only	Erase, Merge
No_Wildlife	County boundary layer with All_Wildlife layer removed	Ct_Bound and All_Wildlife	Erase
Wildlife_Suit	Final vector map of wildlife habitat	All_Wildlife and No_Wildlife	Merge
Wildlife_Rast	Raster image of Wildlife_Suit	Wildlife_Suit	Feature to Raster

*Layers which were used during intermediate steps are not included. Refer to Tools and Steps for each Submodel section for additional information

SOIL SUBMODEL:

File Name	Description	Data Source	ArcGIS tools
SoilNIRRCapClass.shp	Soil Data including NRCS soil capacity classification.	Jeff Baker **	
CtBound_Soils_erase.shp	Soil vector with public land added as LSA class 0	SoilNIRRCapClass.shp	Erase
CtBound_Soils_Merge	This vector layer contains the combined polygons for the soil capacity class and County boundary erase layer	Soil_ct_erase.shp AND SoilNIRRCapClass.shp	Merge
Soil_ras	This is the final classified raster for the soils submodel	SoilNIRRCapClass_Merge	Feature to Raster

** Jeff Baker created this data layer from the NRCS soils data. To determine a capability class rating for non-irrigated soil classes in Wallowa County using NRCS soil survey data he did the following steps:

1. Downloaded tabular and spatial data and an MS Access template for SSURGO files from <http://soildatamart.nrcs.usda.gov/>.
2. Brought the tabular files into the MS Access template and used MS Access to complete steps 3 and 4.
3. Linked the Map Unit (359 records) and Component (737 records) tables together with the mukey field and ran a query to create a single table of combined attributes (737 records).
4. Calculated a weighted capability for each component by multiplying the component capability class (nirrcapcl field) by the percent the component is represented (comppct_r field) and dividing by 100 to remove the percent (737 records) (example: 7 capability class X 35% represented value / 100 = 2.45)
5. Summed the weighted capability classes (calculated in step 4) for each map unit (359 records) and added into a field called NirrcapclWtMn to a Map Unit table titled GEOMapunitNirrCapClWtMn (359 records) (example: 2.45 + 3.5 = 5.95).

6. To view in GIS joined the table GEOMapunitNirrCapLcWtMn to the table of the soils shapefile using the map unit symbol or map unit key.

Example for Getaway-Snell complex, 30 to 70 percent north slopes (mu symbol 93, mukey 84457):

Snell component- 35% representative value X capability class 7 / 100 = 2.45

Getaway component- 50% representative value X capability class 7 / 100 = 3.5

Sum to the two: 2.45 + 3.5 = 5.95

Giving a weighted mean capability class for non-irrigated soil of 5.95 for Getaway-Snell complex, 30 to 70 percent north slopes.

COMMUNITY VALUES SUBMODEL:

File Name	Description	Data Source	ArcGIS tools
Wallowa_Value_Points.shp	This is the shape file from Max Pincus. Each point represents the center of the location where a participant placed a sticker.	Max Pincus	
Ptde_values	This is the density of value stickers per acre.	Wallowa_Value_Points.shp	Point density tool
Values_recl	This layer was reclassified based on the criteria selected for the community values submodel.	PointDE_Wall1	Reclassify
Values_ras	The data was clipped to the county boundary	Values_recl6	Extract by mask

COMBINING THE SUBMODELS:

File Name	Description	Data Source	ArcGIS tools
Final_lsa	This is the reclassified raster calculation with all submodels	Values_ras; Soil_ras; Wildlife_Rast; Water_Raster; PHS_Raster; ras_mosaic;	Raster calculator
No_soil	This is the reclassified raster calculation without the soil submodel	Values_ras; Soil_ras; Wildlife_Rast; Water_Raster; PHS_Raster; ras_mosaic;	Raster calculator

DATA NOT USED:

These data were not included in the LSA analysis for several reasons (exceeded the scope of this analysis, insufficient detail, etc.). However, the data may be useful as this Land Suitability Analysis is further refined to meet Wallowa County's needs or may provide key information as stand along maps. This data has been modified (clipped, joined, etc.) by Jeff and Myrica.

Name	Layer name	Source
Areas of Critical Environmental Concern	ACC	OR/WA BLM
Conservation Opportunity Areas	COA	Oregon Department of Fish and Wildlife
Hazard: Fire Fuel Model	FireFuelModel	Oregon Department of Forestry
Hazard: Slope	slope	Oregon Department of Forestry
Hillshade	hshade	DEM
House Bill 3326 claims	HB3326	Dawn Smith- Wallowa County
Measure 37	M37	Dawn Smith- Wallowa County
National Wild and Scenic Rivers	wld_scn_river	National Wild and Scenic River System
Oregon Current Wildlife Habitat Types	Wlife_cur	NHI and NWPCC
Oregon Historic Wildlife Habitat Types	Wlife_hst	NHI and NWPCC
Public Land Ownership	publicLand	Oregon Department of Forestry
Railroads	railroads	ODOT
Rivers (1:24,0000)	river_detail	Northwest Hydrography Framework
Soils (STATSGO)	soils	Oregon State University
State parks	stateparks	Oregon Parks and Recreation
State Scenic Waterways	stat_scn_river	Digitized from list of state scenic waterways
Tax Lots	parcels	Dawn Smith- Wallowa County
Zoning	zoning	Dawn Smith- Wallowa County

APPENDIX B: ASSUMPTIONS, LIMITATIONS AND RECOMMENDATIONS

Recognizing the limited scope of this Land Suitability Analysis, we would like to include some of the significant limitations of this analysis and propose alternatives that could strengthen the analysis as time and resources allow.

COMMUNITY VALUES SUBMODEL:

Recommendation: Limit selection to a few specific values in the LSA.

The community values submodel assumes that the more values located on a piece of property the less suitable it is for development. While this might be an appropriate assumption for some values (such as aesthetic, spiritual, biodiversity, therapeutic) it does not hold true for all values. Some, such as learning, life sustaining, and cultural values, might be irrelevant in considering suitability for development. Others, such as development and economic values, would have an inverse relationship with suitability for development. For example, a sticker that was placed on the Wallowa County map for the statement “Residential development could occur in these places if there was a good plan” would indicate a location highly suitable for development. It would be appropriate to assess each value individually, determining the appropriate classifications (class 1-4). All values could then be combined into the community values submodel.

SOILS SUBMODEL:

Recommendation: Include other data related to “Working Landscapes”.

We originally envisioned the soils submodel to be a “working landscapes” and tried to incorporate place of use data to describe irrigated, domestic, and other water uses. Since the Place of Use data describes the location where water is removed from the source (often a point), it was difficult to attribute a specific water use to a parcel of land. Many parcels had multiple use-codes associated with them. As a result, the Working Landscapes Submodel was reduced to a Soils Submodel and information about water use was dropped from the LSA. A more comprehensive LSA could incorporate irrigation information.

OPEN LANDS SUBMODEL:

Recommendation: define more criteria based upon community input

The acreage sizes selected for the Open Spaces submodel were primarily based partly on the current minimum acreage size for parcels zoned as EFU as a middle ground. The classification of acreages can easily be changed to meet the needs of the county. For example instead of classifications of less than 25 acres for most suitable, between 25 acres and 160 acres for moderate suitability, between 160 and 400 acres for less suitable, and greater than 400 acres for least suitable one could create a new classification of less than 10 acres for most suitable, between 10 and 40 acres for moderate suitability, between 40 and 1000 acres for less suitable and greater than 1000 acres for least suitable.

WILDLIFE SUBMODEL:

Recommendation: Identify other valuable wildlife habitat that should be represented.

Although the data that is present in the wildlife submodel is very helpful, it would be good to identify additional habitats of other species that may need to be protected. An additional idea to consider would be changes in the classification process. In this particular case classes were selected based on species type. An alternative may include the use of data that raises the issue of location and ability to adapt to changes.

PUBLIC HEALTH AND SAFETY SUBMODEL:

Recommendation: Develop additional classification criteria that may fit the individual community.

Much of the criteria included in this submodel was implied or formulated using the creators best guess. This process of classification should be discussed by the community in order to determine specific values that may be present. In this particular case these decisions might include highway buffers that illustrate access corridors for emergency medical vehicles, riparian buffers or safe slope for development.

APPENDIX C: LAND SUITABILITY ANALYSIS CASE STUDIES

BIG HORN COUNTY, WYOMING

BACKGROUND AND PURPOSE:

Big Horn County completed a Land Suitability Analysis as part of county-wide planning efforts. The analysis used a combination of four subcomponent maps: (1) Agriculture (2) Infrastructure (3) Land Use Limitations (4) Land Use Status

GIS METHODS:

These maps were combined to create a map entitled "Land Use Suitability- All Factors.". From this map, two alternatives were created: one with an emphasis on conservation and the other with an emphasis on development. An additional set of maps were created that focus solely on the deeded lands, excluding public lands.

TYPES OF DATA USED

The following data sources were used, listed by subcomponent maps:

1. Agriculture:
 - Deeded land used for agriculture
 - Irrigated Land
 - Parcel Size
 - Soil Capacity – Irrigated agriculture
 - Soil Capacity -- Non- Irrigated Agriculture
2. Infrastructure:
 - Road Networks
 - Water Systems (major public water supply systems)
 - Service Efficiency (efficiency in providing essential public services). This map illustrates that it is more cost effective to provide governmental services at locations close to service centers. These services included: public schools, fire protection, hospitals, and law enforcement.
3. Land Use Limitations:
 - Big Game Habitat
 - Floodplains (100-year floodplains)
 - Groundwater Sensitivity (location of areas sensitive to groundwater contamination)
 - Geohydrologic setting (availability of groundwater)
 - Bedrock Geology (useful in understanding the reports on groundwater availability)
 - Land Slope
 - Wetlands
 - Land Use Status
 - Current land use

- Land Parcel sizes (shows where deeded land remains in large tracts and where it has been broken into small tracts)
 - Subdivisions (location and size of major subdivisions and old townsites)
 - Land Surface Management (surface management status- federal, state, deeded)
4. Other:
- Land tenure (location of lands owned by local and non-local owners)
 - Population Density

WEBSITES OR ADDITIONAL INFORMATION:

This website contains the maps and overlays used to create the Land Suitability Analysis:

http://mmiplanning.com/bhc09/planning_process/plan%20map%20series.htm

POLK COUNTY, NORTH CAROLINA

BACKGROUND AND PURPOSE:

Polk County, North Carolina developed a land suitability analysis as a way of classifying areas with potential for development. Two maps were created which identified areas with either least, low, moderate, or high suitability. GIS layers were selected and used to identify three types of land suitability constraints: (1) Regulatory (2) Legal (3) Environmental

GIS METHODS:

The first map consisted of data layers, which had been identified by the county as either a regulatory, legal, or environmental constraint. The second only took into account the constraints that were in the environmental category. Highest suitability was identified in both maps as areas that were not covered by existing layers

TYPES OF DATA USED:

Map 1: LSA – Regulatory, Legal, and Environmental Constraints

1. Least Suitable

- High Quality Water Management Zones (HQW)
- Land Trust Conservation Properties
- Lands managed for Conservation and Open Space
- Significant Natural Heritage Areas
- National Wetlands Inventory (NWI)
- Wildlife Resource Commission Public Trout Waters
- Wildlife Resource Commission Public Game Lands
- Surface Waters
- State-Owned Lands
- Water Supply II Waters (WS – II)
- Slope at 30+%
- Low Suitability
- Farmland Preservation Areas

- Flood Zone (Zone AE)
 - Prime Farmland Soils
 - Hydric Soils
 - Water Supply III Waters (WS – III)
 - Slope at 20.01 – 30%
2. Moderate Suitability
 - Water Supply IV Waters (WS – IV)
 - Slope at 10 – 20%
 3. High Suitability
 - Land mass not covered by an existing layer
 - Land within a half mile proximity to existing municipal areas
 - Public Sewer Systems
 - Slope less than 10%

Map 2: LSA – Environmental Constraints

1. Least Suitability
 - High Quality Water Management Zones (HQW)
 - Water Supply II Waters (WS – II)
 - Significant Natural Heritage Areas
 - National Wetlands Inventory
 - Wildlife Resource Commission Public Trout Waters
 - Surface Waters
 - Slope at 30+%
2. Low Suitability
 - Flood Hazard Zone (Zone AE)
 - Prime Farmland Soils
 - Hydric Soils
 - Slope at 20.01 – 30%
 - Moderate Suitability
 - Slope at 10 – 20%
3. High Suitability
 - Slope less than 10%

LINK TO WEBSITE:

This PDF outlines the process of data selection and classification along with tabular results.

http://www.polknc.org/departments/development/documents/1.LSAReport_Revised.pdf

This is a link to Polk County's Planning and Zoning Department

<http://www.polknc.org/departments/development/zoning.php>

FLORENCE TOWNSHIP, MINNESOTA

BACKGROUND AND PURPOSE:

Florence Township (Goodhue County) is located 90 miles southeast of the Minneapolis-St. Paul metropolitan area and is bordered on the right by the Mississippi River. The location and scenery

have attracted new housing developments, more traffic, and changing demographics. County planners and citizens became increasingly concerned with protecting areas with natural features and agricultural lands. The township formed a Land Use Committee (LUC) to establish suitability criteria and use GIS to identify natural resources, scenic and cultural resources, and agricultural working lands. Goodhue County's comprehensive plan is based upon a natural resource planning approach which puts natural resources at the forefront.

CRITERIA SELECTION:

Realizing that public input and acceptance of map analysis was required, criteria were developed during facilitated small group discussions. The group identified three major categories: Agricultural Use Protection, Natural Resource Connectivity, and Water Resource Protection. A recently published Goodhue County Geologic Atlas (2003) had raised public awareness of groundwater areas sensitive to pollution. This data, however, was left out of the suitability criteria because it would have raised all scores by an equal amount (essentially rendering all development as unsuitable).

DATA:

The following data were selected by Comprehensive Plan Goal as identified by the community.

- Agricultural Preservation (Comprehensive Plan Goal)
- Crop Land Unit - tilled lands
- Parcels data - registered feedlots
- Zone map - agricultural lands
- Parcels data - owner operated farm (rather than rented)
- Soil type - Crop Equivalency Rating (CER)
- Natural Resource Connectivity (Comprehensive Plan Goal)
- MCBS Biodiversity Ranking - areas having biodiversity significance in the county
- County Natural Resource Inventory – private land with natural resource value
- Parcels data - public lands or conservation easements
- Steep slopes (greater than 30%)
- 250 foot buffer of steep slopes
- 200 foot riparian buffer
- Water Resource Protection (Comprehensive Plan Goal)
- National Wetlands Inventory (NWI)
- 200 foot riparian buffer
- FEMA Floodplain
- 500 foot buffer of steep slopes
- Known springs and sinkholes
- St. Lawrence Edge geology

DATA PROCESSING:

All GIS data used was selected during public participation sessions and given a value score. The applicable data for the township was clipped and saved as a shapefile and vector data was converted to a raster format. All data was then converted to a raster size of 30 meter cells. Each

cell was given a value of “1” if the feature of interest was present or “0” otherwise. The Analytical Hierarchy Protocol (AHP) was used for analysis which combines each parameter with a scale factor to determine relative importance or degree of influence to the overall measure of site suitability. This method is more transparent and more likely to be accepted by the public. Finally a composite grid was created using map algebra.

LINK TO PAPER:

Summary provided by Beth J. Knudsen, Department of Resource Analysis, Saint Mary’s University of Minnesota <http://www.gis.smumn.edu/GradProjects/KnudsenB.pdf>

RAVALLI COUNTY, MONTANA

BACKGROUND AND PURPOSE:

The Land Suitability Analysis was used to evaluate the relative suitability of land for development in Ravalli County, Montana. The LSA map will be used to develop baseline zoning and generally guide development at a coarse scale. The process relied heavily on the knowledge and experience of local experts to organize and rank the existing spatial information. Six submodels were used to incorporate key spatial data: existing infrastructure; water resources; wildlife resources; working lands; open lands; and public health and safety.

GIS METHODS:

Spatial data was acquired for each of the submodels (see Data below). Maps were then shown to local experts to facilitate discussions about which data was most appropriate to include in each submodel. Within each submodel, criterion were assigned rankings or ‘classes’ from least to most suitable for development based on expert opinion. The data was then edited for use in the submodels. Each of the submodels was converted to a raster with one-acre “pixels”. Since each submodel has a different number of classes, they were reclassified on a scale of 1-13. Lastly, the six submodel values were totaled (without weighting) to determine the final LSA value.

DATA:

1. Existing Infrastructure Submodel

- City of Hamilton 20- Year Planning Area (City of Hamilton)
- Stevensville Planned Growth Area (Town of Stevensville)
- Incorporated Areas (Ravalli County GIS Department)
- Sewer Districts (Ravalli County GIS Department)
- Water Resources Submodel
- National Hydrography Dataset – Flow Line (USGS and USEPA)
- National Hydrography Dataset – Area (USGS and USEPA)
- National Hydrography Dataset – Waterbody (USGS and USEPA)
- 2007 Wetlands (USFWS National Wetland Inventory)
- 2005 Pilot Wetlands Mapping Project (Bitterroot Water Forum)
- U.S. Forest Service Wetlands (USFS)
- Riparian (Montana National Heritage Program)
- Floodplain (FEMA)

- Bitterroot Valley Area, Montana Soil Survey (USDA NRCS)
 - Irrigation Ditches (State Engineer's Office)
 - Subwatershed (6th -code) Hydrologic Units (NRCS)
 - TMDL Streams and Lakes (MTDEQ)
2. Wildlife Resources Submodel
- National Hydrography Dataset – Flow Line (USGS and USEPA)
 - National Hydrography Dataset – Area (USGS and USEPA)
 - National Hydrography Dataset – Waterbody (USGS and USEPA)
 - 2007 Wetlands (USFWS National Wetland Inventory)
 - 2005 Pilot Wetlands Mapping Project (Bitterroot Water Forum)
 - U.S. Forest Service Wetlands (USFS)
 - Riparian (Montana National Heritage Program)
 - Bitterroot Important Bird Area (Montana Audubon Society)
 - Blodgett Important Bird Area (Montana Audubon Society)
 - National Wildlife Refuges (Montana Natural Heritage Program)
 - Bighorn Sheep Overall Distribution and Winter Range (Montana Fish Wildlife and Parks)
 - Mule Deer Distribution (Montana Fish Wildlife and Parks)
 - Moose Distribution (Montana Fish Wildlife and Parks)
 - Mountain Goat Distribution (Montana Fish Wildlife and Parks)
 - Elk Distribution (Montana Fish Wildlife and Parks)
 - Bull Trout – Critical Habitat (streams) (USFWS)
 - Subwatershed (6th – code) hydrologic Units (NRCS)
 - Floodplain (FEMA)
3. Working Lands Submodel
- Ravalli County Parcel Data (Montana Cadastral Mapping Project)
 - Bitterroot Valley Area, Montana Soil Survey (USDA NRCS)
 - Irrigated Lands (State Engineer's Office)
4. Open Lands Submodel
- Bitterroot Important Bird Area (Montana Audubon Society)
 - Blodgett Important Bird Area (Montana Audubon Society)
 - National Wildlife Refuges (Montana Natural Heritage Program)
 - Parks (Ravalli County GIS Department)
 - Stewardship Easements (Montana Natural Heritage Program)
 - Stewardship Leases (Montana Natural Heritage Program)
 - Stewardship Owners (Montana Natural Heritage Program)
 - Ravalli County Parcel Data (Montana Cadastral Mapping Project)
 - Public Health and Safety Submodel
 - Wildfire Hazard (US Forest Service)
 - Slope (USGS)
 - Floodplain (FEMA)
 - Dam Breach Floodplain (DNRC)

- Septic Suitability (NRCS)
- Miscellaneous
- Ravalli County Boundary (State)

LINK TO WEBSITE:

<http://www.co.ravalli.mt.us/planning/LandSuitabilityAnalysis.htm>