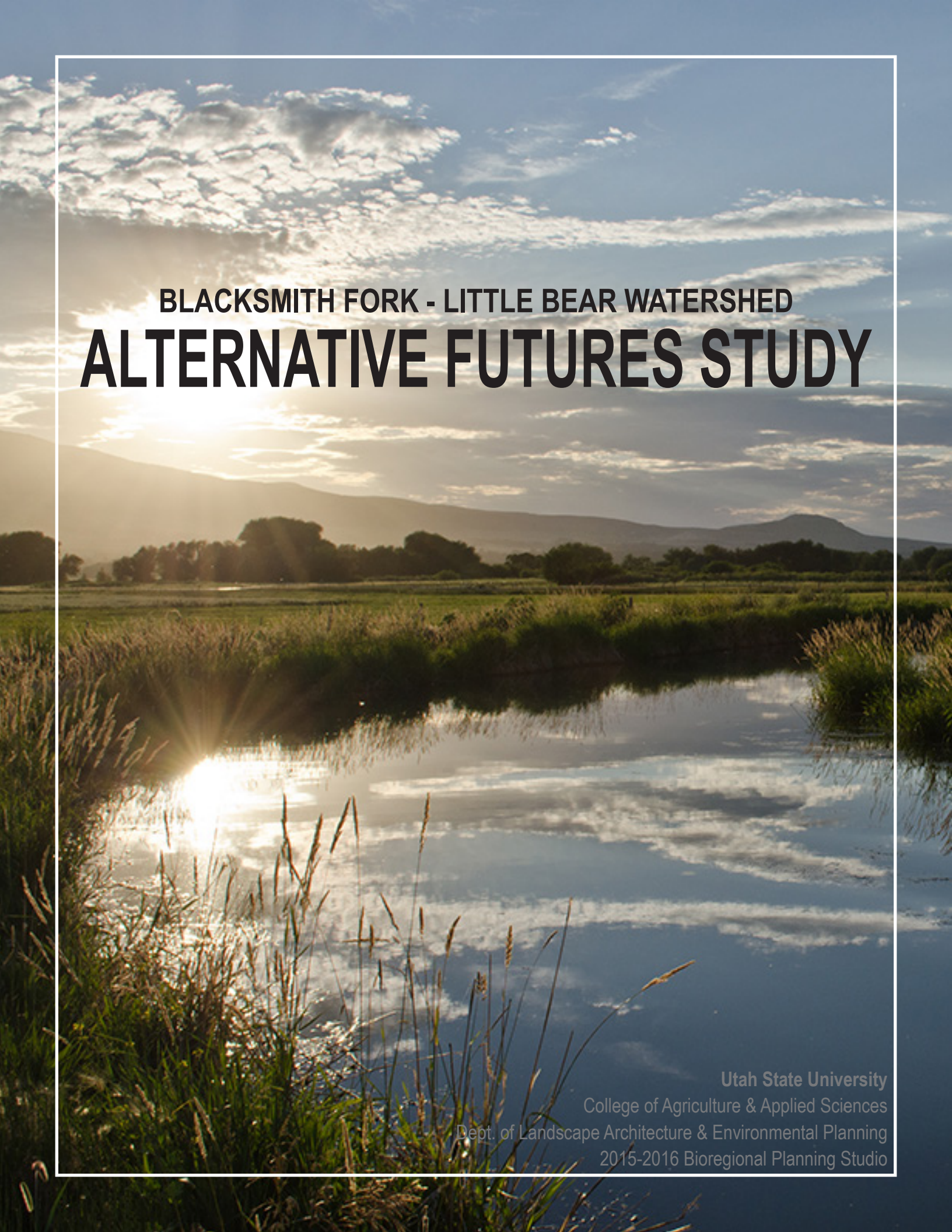


## BLACKSMITH FORK - LITTLE BEAR WATERSHED

# ALTERNATIVE FUTURES STUDY

**Utah State University**
College of Agriculture & Applied Sciences
Dept. of Landscape Architecture & Environmental Planning
2015-2016 Bioregional Planning Studio

# Blacksmith Fork & Little Bear Watershed Alternative Futures Study

2015-2016 Bioregional Studio

# Foreword

The following project was carried out in conjunction with the Logan River Task Force, under the chairmanship of Dr. Frank Howe. The Logan River Task Force was formed to develop an overall approach for managing the Logan River that balances ecology with people's social values for the river including public safety and property protection. Although the work of the Task Force has focused primarily on the Logan river, the Bioregional Planning graduate students have provided the Task Force with contextual information about the watershed, by exploring alternative futures for the Blacksmith Fork and Little Bear watersheds. This work expands on a previous bioregional planning study of the Logan, Blacksmith Fork and Little Bear watersheds that was carried out by bioregional planning students, Aubrey Christensen and Lyndi Perry in 2014-15.

More specifically, the objectives of this study are to develop a landscape-level approach for the analysis of physical, ecological, and cultural landscape components in the Blacksmith Fork and Little Bear watersheds. Broadly, the objectives are to:

- Create a Geographic Information Systems[GIS] database describing various biophysical and socio-demographic systems of the study area, including the basic land use infrastructure of the region. This database will consist of existing sources of data available from Utah Automated Geographic Reference Center [AGRC] and other geo-information sources as well as pertinent research findings;
- Develop objective definitions and criteria by which regionally significant landscape elements can be identified and evaluated within the study area, and its regional context;
- Assess likely future growth and land use patterns in relation to landscape and natural resources, and prioritize areas to be considered for management and/or protection;
- Develop strategies to protect regionally significant “critical lands” considering attributes like public health, welfare and safety; connectivity between local and regional patterns and biodiversity;

This report represents work that graduate students accomplished during two semesters (Fall 2015- Spring 2016) of the Master of Bioregional Planning (MsBRP) program at Utah State University. During the Fall semester, the MsBRP students collaborated with graduate students in the Landscape Architecture program to develop scenarios that addressed future growth in a portion of the study area, southern Cache Valley. Together they prepare and participate in a Geodesign workshop with community members, experts, faculty at USU. (For an overview of the workshop see the report: South Cache Valley Project- Planning with Geodesign, 2015.) The results of the workshop informed the landscape analysis, and ultimately the alternative futures that were developed for the Blacksmith Fork and Little Bear watersheds.

The merit of the study is to provide stakeholders and policy makers in the watershed with background for future environmental and development policies within the region. The study has the potential for a broader contribution to future planning in the region by providing relevant data, methodologies and models for conducting additional evaluations on the impacts and benefits of growth in the study area over the next ten to twenty years.

Dr. Bartlett Warren-Kretzschmar
Bioregional Planning
Landscape Architecture and Environmental Planning
Utah State University
Logan, Utah 2016

# Acknowledgments

The Little Bear - Blacksmith Fork Study would not have been possible without our many community and Utah State University advisors.

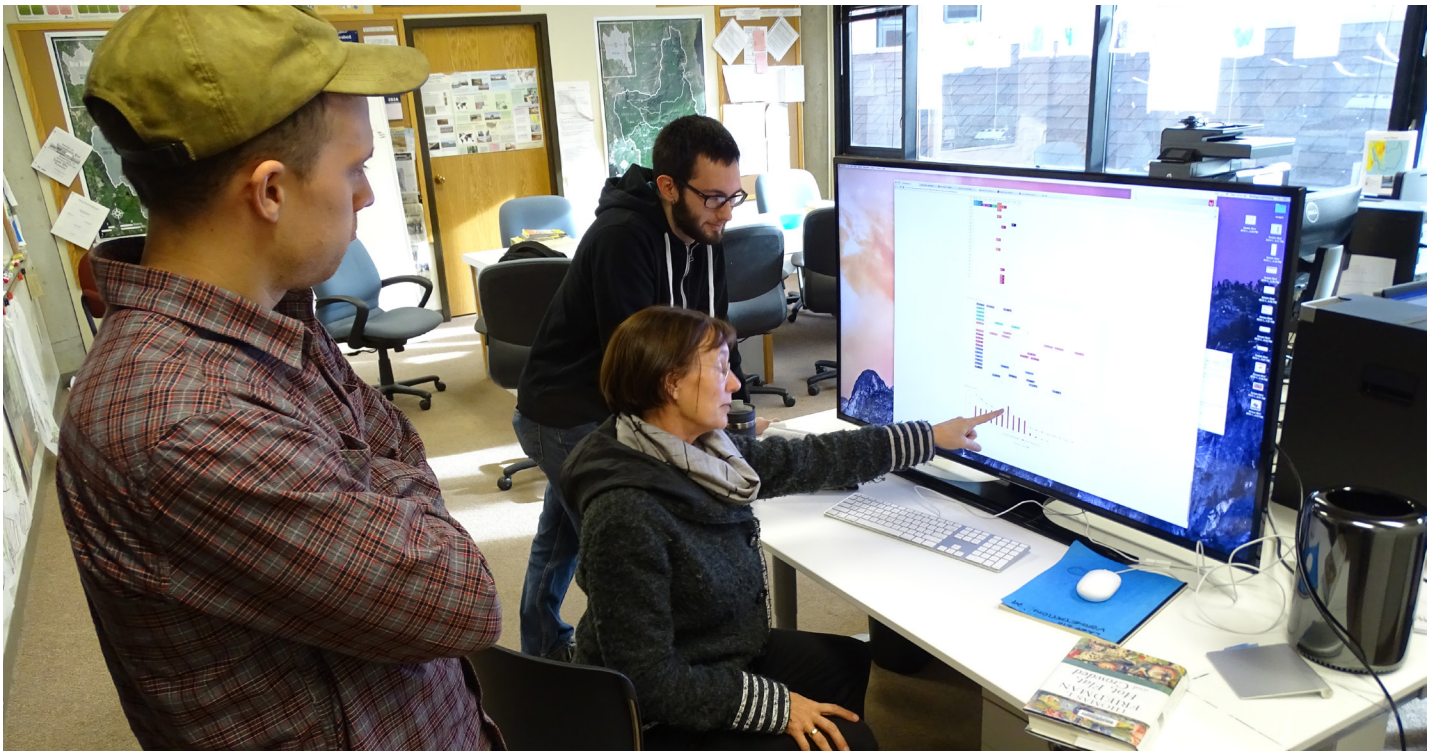
Prof. Barty Warren-Kretzschmar, USU Landscape Architecture and Environmental Planning Department [LAEP], led the bioregional planning studio in efforts and activities for the study. Professor emeritus Richard Toth also contributed significantly to the studio's daily activities. Prof. Carlos Licon and Prof Todd Johnson, also of LAEP, provided guidance and critiques throughout the early phases of the study.

Other USU faculty that served in advisory roles during the study included: Prof. Nancy Mesner, Department of Watershed Sciences; Prof. Robert Giles, Utah Climate Center; Prof. Jacopo Baggio and Prof. Chirstopher Monz, Environment and Society Department; Prof. Frank Howe, Department of Wildland Resources; and GIS experts Ellie Leydsman McGinty, Chris McGinty, Shannon Belmont, and Prof. R. Douglas Ramsey.

Community partners and advisors included: Shari Phippen, Nibley City Planner; David Zook, Nibley City Manager; Zac Covington, Rodger Jones, and Brian Carver from the Bear River Association of Governments; Joshua Runharr, Zoning Administrator for Cache County Development Services; John Hardman, District Conservationist for the United States Department of Agriculture Natural Resource Conservation Service; and Brad Hunt, Ranch  Manager of the Utah Division of Wildlife Resource's Hardware Ranch.

Finally, USU graduate students Tairon Kimura, Keni Althouse, Tanya Rice, Lynda Smith, and Jennifer Weisman also contributed to the early efforts of the study.

This report was prepared by M.S. Bioregional Planning students Scott McComb, Emmet Pruss, Thomas Terry and Conner White.



*Dr. Barty Warren-Kretzschmar leading the 2015-2016 Bioregional Planning Studio*

# Table of Contents

# Figures

# CHAPTER 1: INTRODUCTION

*"Drawing on holistic assumptions, the bioregional movement emphasizes living within the resources of the local watershed and developing them to sustain the human and nonhuman community as an ecological whole" (Merchant, 1992, pg. 78).*

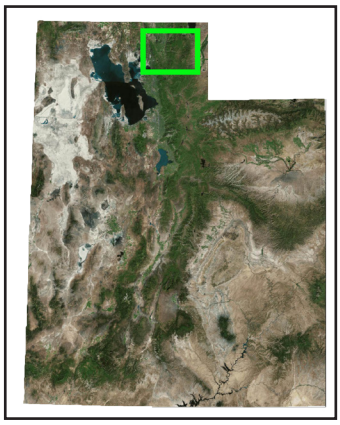


*Figure 1.1.* The study area (outlined in green) is located in northern Utah.

## The Study Area

The study area is located in northern Utah, about 70 miles north of Salt Lake City and 20 miles south of the Idaho state border (see Figure 1.1). It is composed of the Blacksmith Fork River watershed, Little Bear River watershed and a portion of the Logan River watershed. These watersheds form a portion of the larger Bear River watershed. The Bear River has its headwaters in the nearby Uinta Mountains, and then winds nearly 500 miles through portions of Wyoming, Idaho, and the areas north and west the study area, before emptying into the Great Salt Lake.

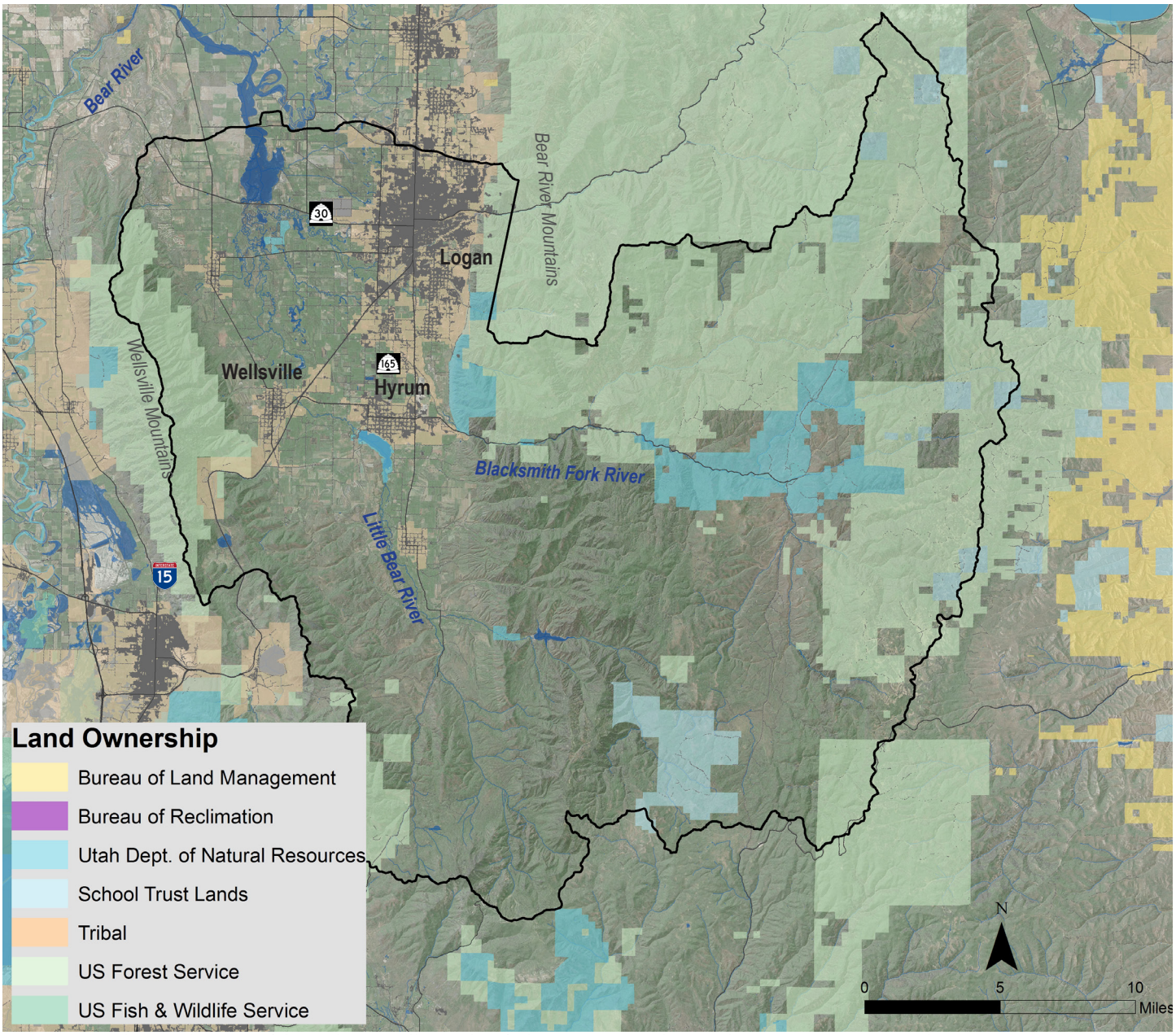



*Figure 1.2.* Land ownership map of the study area. All non-classified areas are privately owned. Data sources: ESRI, Utah AGRC

The Blacksmith Fork, Little Bear and Logan Rivers all have their headwaters in the Bear River Mountains Range. This range is partially located in the eastern half of the study area and includes both federal and private lands (see Figure 1.2). These lands provide a number of benefits to the stakeholders of the study area: including recreation, grazing, habitat for iconic species and water storage in the form of snowpack, which usually forms during the fall and winter seasons.

The western extent of the study area is located along the ridgeline of the adjacent Wellsville Mountains Range. Together, the Wellsville and Bear River Mountain Ranges form a bowl, within which is located Cache Valley.

Cache Valley contains the confluence of the Little Bear, Blacksmith Fork and Logan Rivers. It also contains the majority of the population of the study area, which is mainly located within several municipalities. The largest of the municipalities include Logan, Wellsville and Hyrum. All together, the study area has a current population of about 100,000 residents (United States Census Bureau, 2015).

The dominant land uses in Cache Valley include agriculture, residential and commercial development. The mountain areas on either side of the valley are mostly undeveloped in terms of permanent structures or high impact land uses.

While the study area is currently prosperous with a 3.1 percent unemployment rate, compared to the 4.4 percent national standard (United States Bureau of Labor Statistics, 2015), its residents and stakeholders do face a number of important challenges. These challenges may determine the continued prosperity of the region, and include: a declining agricultural sector, suburban sprawl, hazardous winter air quality, high water consumption rates and the implications of a warming climate. Without significant strategies to address these challenges, they will likely be exacerbated by the growing population of the study area, which is expected to double to about 200,000 individuals by the year 2040 (Envision Utah, 2009).

## Study Objective

The main objective of this study was to identify strategies to address the study area's current challenges, while also accommodating population growth.

The study researchers pursued this objective by following a methodology adapted from Toth (1974). In this way, the study culminated in the development of *alternative futures*, i.e., snapshots of how the area may change by 2040 based on the response of the stakeholders to the challenges.

Each alternative future has its own strengths and weaknesses. By comparing the futures to one another, stakeholders may identify strategies to pursue their most desired 2040 outcomes.

# CHAPTER 2: ISSUES

There are a number of issues that are currently of critical importance to the study area. In addition to these contemporary concerns, the population of the study area is projected to double by the year 2040 (Envision Utah, 2009). This population growth has the potential to increase the negative impacts of each of the current issues affecting the study area.

All of these issues are related to each other, and affected by the capacity in which the residents and stakeholders interact with the biological and physical systems of the study area. However, within these issues, there are two essential categories: biophysical and cultural.

Biophysical issues are those that involve impacts to the biological and physical environment and that can be characterized chiefly by a quantitative measure. For example, air quality can be characterized as poor or adequate by the density of particulate pollutants in the study area's airshed at any given time.

Cultural issues, by contrast, are those that involve more qualitative assessments of relationships between the residents and stakeholders of the study area and how they interact with biophysical systems. For example, the number of trailheads in the study area can be used as a quantitative measure of the recreation access of the area. However, if there are significant barriers preventing the residents of the study area from accessing these trailheads, the actual recreation access may be less than is indicated by the quantitative trailhead count alone.

As the population of the study area continues to grow, communities will need to address these issues, including: maintaining agricultural lands, improving air quality, providing enough clean water, maintaining rural character, encouraging biodiversity, providing access to recreation, growing the economy and providing sufficient transportation (Envision Utah, 2009).

## Biophysical Issues

### Air Quality

Due to its unique topography, particulate pollutants from cars, businesses and livestock can remain in Cache Valley under inversion conditions (EPA, 2014). This occurs mainly during the winter, when pockets of warm air above the mountains "trap" cold air in the valley, reducing the rate at which air circulates away from the area. Winter inversions that trap high levels of particulate pollutants can have serious health implications, including heart and respiratory disease (Pope, Dockery & Schwartz, 1995).

Between 2002 and 2012, about 26% of winter days in Cache Valley experienced "red" air quality conditions (Moscardini & Caplan, 2015). Red air quality conditions are those in which "everyone may begin to experience health effects [and] members of sensitive groups may experience more serious health effects" (EPA, *AirNow*).

*Winter inversions trap particulate pollutants in Cache Valley.*

### Biodiversity

The expansion of agriculture, residential development and roads all fragment habitat areas. Each species requires a unique amount of habitat range to maintain genetic viability (Fahrig, 2003). As such, even if there are habitat conditions that are suitable for certain species in portions of the study area, if the range of these habitat conditions is interrupted by development and/or roadways, the habitat may not, overall, support a genetically viable population of that species (Fahrig, 2003).

Similarly, water diversions can cause waterways in the study area, such as the Blacksmith Fork River, to run dry for part of the year. Lack of water quantity, even if some water is left in the waterway, can negatively affect habitat by increasing the concentrations of runoff pollutants and natural turbidity, as well as causing increases in water temperatures. Increasing water temperatures especially affect the viability of the waterways to support cold-water species such as the Bonneville cutthroat trout (Teuscher & Capurso, 2007).

### Water Quality

The water quality of the aquifers and first order streams

in the high basin areas of the study area is considered good according to national standards (Utah Division of Water Resources [DWR], 2004). However, runoff from impervious surfaces and nonpoint source pollution from agricultural crops, concentrated animal feedlot operations and other activities negatively affect the quality of surface water quality in the valley (DWR, 2004).

Diminished water quality reduces the viability of the waterways in the valley to support biodiversity and also lessens their recreational potential.

*Development, agriculture and other industrial activities occur in the valley in close proximity to water ways. These activities have negative effects on water quality.*

## Water Quantity

Groundwater and surface water reservoirs, such as the Cutler, Hyrum and Porcupine Reservoirs, supply industrial and municipal uses for the study area residents. Allotments from reservoirs have a first priority for agricultural or hydropower use (Stewart, 2015). However, residents in the study area also use an average of 1 acre foot of water per household annually (Stewart, 2015). Of the Cache County municipal supply, 66% of the total water used for residential purposes, of which 67% is applied for outdoor purposes (e.g., lawn irrigation) (J. Runharr, personal communication, March, 2016).

In recent years, concerns involving current consumption rates vis-a-vis population growth have led the Utah Division of Water Resources (DWR) to assess the prospects of developing two to three new dams in the region. These projects would entail a statewide cost of about $2 billion (Stewart, 2015). In addition to financial costs, building dams would alter the habitat of the locations where the dams would be located, and at least three of the potential new dams are located within or near the study area (Henline, 2015).

In addition to new demand from population growth, available water supply in the study area could be affected by climate change. In this scenario, warming annual temperatures could result in precipitation in the study area increasingly occurring in the mountain regions as rain, rather than sustained snowpack (R. Davies, personal communication, 2016). Currently, snowpack functions as a natural reservoir, slowly releasing water throughout the spring and early summer months. As such, reductions in snowpack could reduce the total water quantity available in the study area during the spring and summer crop growing seasons.

*As population grows and the climate warms, residents may be increasingly dependent on water storage areas, such as the Hyrum Reservoir (pictured here) for municipal and industrial water supplies.*

# Cultural Issues

## Agriculture

New residential developments consume nearly 600 acres of agricultural land in the study area each year (UACD, 2011). One of the drivers of this land use shift involves a larger trend within the national agricultural industries. That is, the children of current farmers are less likely to remain and continue the family business once their parents retire, in comparison to previous generations. In Cache Valley, this results in the sale of existing agricultural lands to developers as an attractive option for current farmers who are approaching or have reached retirement age (J. Ruhnarr, personal communication, March, 2016.

*Agricultural lands are increasingly being transitioned into new residential developments.*

In addition to crop agriculture, grazing and ranching also occur in the study area, largely in the mountainous areas. Continued grazing on federal lands depends on the consistent management in future years.

## Economy

The current unemployment rate in the study area is below the national average (*Cache County, Utah*, 2017). However, current trends may result in shifts within the existing dominant production modes.

Agricultural production currently accounts for about 26% of the economic output of the study area (UACD, 2011). This largely occurs in the forms of crop production, dairy operations and meat processing. However, as agricultural lands transition to new development, and the population continues to grow, the study area will require new economic opportunities.

Currently, Utah State University is one of the largest single employers in the study area. There are also commercial businesses throughout the watershed, and some technological firms, especially in nearby North Logan. These sectors have the potential to grow in coming years. The area also has considerable recreational assets in the mountains, canyons and rivers of the study area. As such, the recreational sector of the economy also has potential for growth.

*As the agricultural sector declines, other sectors, such as recreation, may have to increase to maintain current economic conditions.*

## Recreation Access

Eighty two percent of land in the study area is privately owned, and more than 90% of the rivers run through private land (Utah AGRC, 2016; United States Geological Service, 2016). This situation makes it difficult for residents and tourists to fish, hike, bird watch or canoe in the valley.


*Lack of public right-of-ways in Cache Valley create barriers between residents and local recreation opportunities.*

The mountain regions of the study area are a recreation destination for valley residents. Recreation occurs in these areas in non motorized and motorized forms, including: hiking, backpacking, rock climbing, skiing, hunting, fishing, snowmobiling and off-highway vehicle use. As the population increases, access to recreational opportunities may become crowded.

## Recreation Impacts

Current recreation predominantly occurs in a dispersed capacity on the public land of the mountains with minimal oversight by regulatory agencies. As the population grows, recreational impacts may produce additional pollution and habitat fragmentation, which could create new issues with the biophysical systems of the study area.

Additionally, the effects of recreation impacts may be exacerbated by currently limited U.S. National Forest Service funding. The implications of limited funding to manage recreation impacts are already visible in areas such as Providence Canyon, where trash and off-trail driving have degraded the quality of the natural environment.

*Litter and pollution that occurs in the mountains and canyons of the study area can concentrate in the waterways of the valley, further reducing recreational potential in these ares.*

## Rural Character

Rural character, as identified by Cache Valley residents, includes farmland, undisturbed mountains and rivers, and distinct, unique town identities (Envision Utah, 2014). The advancement of subdivisions and strip development threatens the agricultural and natural lands that contribute to the economic vitality and visual nature of the region.

*Residents identify agricultural open space, small towns and mountain backdrops as defining characteristics of the rural character of the study area (Envision Utah, 2014).*

## Transportation

Dispersed residential development in the valley leads to longer commute times, high service costs and logistical barriers to alternative transportation (J. Runharr, personal communication, March, 2016). Cache Valley currently has a bus transit system that includes stops in several urban districts throughout the study area. However, it is difficult to incorporate dispersed homes in the rural portions of the valley into these service routes. As such, the dominant transportation form in the valley is transit via personal vehicle. Similarly, there are no present public transportation services to the recreation areas in the mountains and canyons.


*The study area already experiences traffic congestion in downtown areas during high-transit hours.*

Currently, traffic already becomes congested on major roadways in the study area during high transit hours. Without alternative options, this problem will worsen with growing population. Also, current major transportation corridors, such as U.S. Route 89 and 91, often pass through the downtown areas of the major municipalities. This traffic impacts pedestrian access to these commercial centers.

# CHAPTER 3: METHODOLOGY

The methodology employed in this study involved an iterative process with four basic sections: Research & Analysis, Model Development, Alternative Futures and Evaluations (see Figure 3.3 shown later on the next page). Most of the sections included multiple phases. An overview of the sections is displayed on the next page. Throughout this report, the color bars behind each chapter heading indicate the primary section in which the content for that chapter was produced (see figure 3.1).

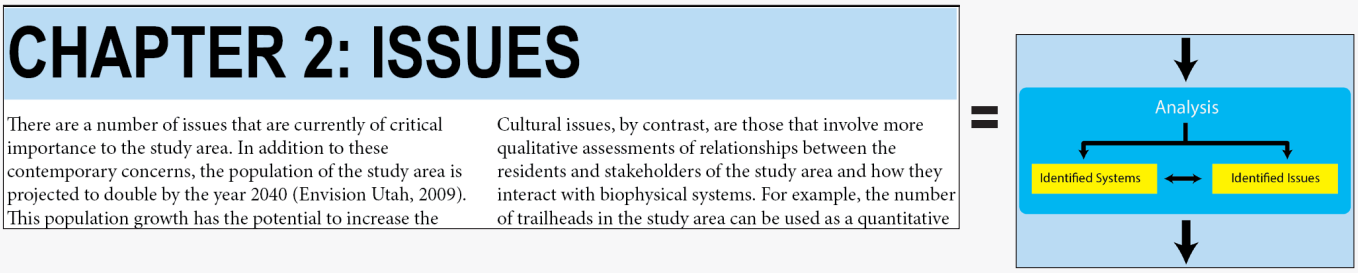



*Figure 3.1.* Each chapter heading of this report is color coded to correspond with a section of the methodology

## Research & Analysis

### Identify Study Area

Cache Valley is located within the Logan, Little Bear and Blacksmith Fork watersheds. In 2014-2015, the bioregional planning studio developed a study examining the Logan River watershed. Continuing with the analysis for Cache Valley, the 2015-2016 bioregional planning studio examined the Little Bear-Blacksmith Fork watershed. However, a significant portion of Logan City is contained within the abutting Logan River watershed. Since the cultural systems and infrastructure of Logan City significantly affect the human and natural systems in the Little Bear-Blacksmith Fork watershed, the study area was expanded to include the portion of the Logan River watershed (see Figure 3.2).

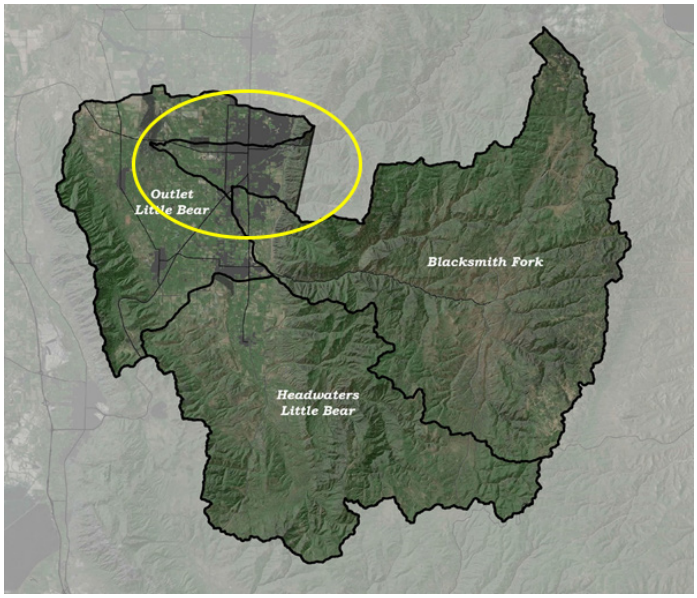



*Figure 3.2.* The study area is composed of the Blacksmith Fork and Little Bear River sub-watersheds, in addition to a portion of the Logan River sub-watershed (circled in yellow).

### Pre-Analysis

The pre-analysis involved observational surveys of the study area and meetings with stakeholders. In this way, it functioned as a means of gathering data and experiences to inform the later analysis.

#### *Site visits*

Observational surveys were preformed by motor vehicle transit and an aerial tour of the study area. Often, site visits were incorporated into stakeholder meetings, to examine the subjects discussed firsthand, e.g., the researchers met with Nibley City Manager David Zook at diesel-contamination well site, while discussing possible sources of groundwater contamination.

*The site visits included a fly-over of the study area.*

# 2015-2016 Bioregional Planning Process

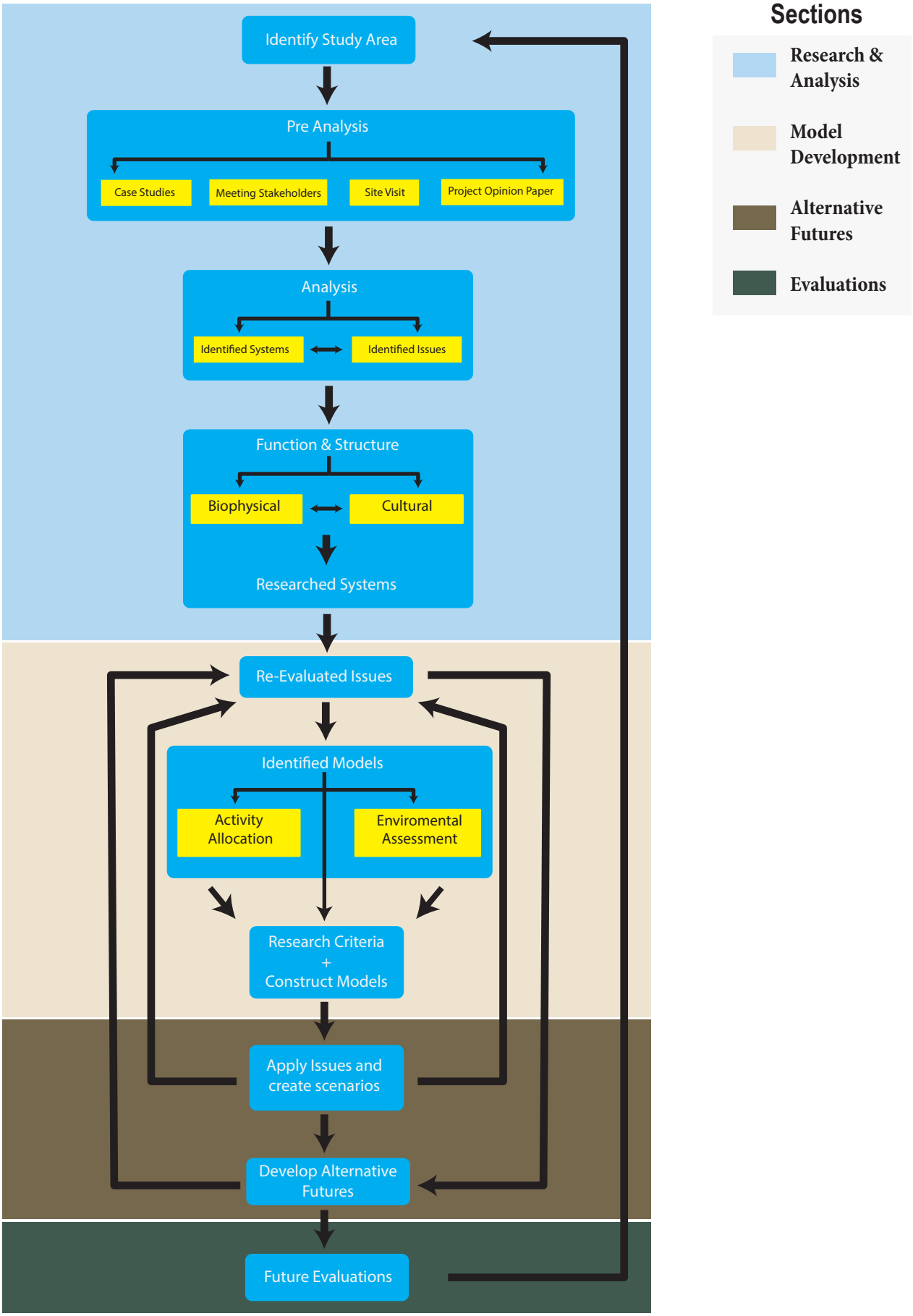



*Figure 3.3.* The 2015-2016 bioregional planning process follows (Toth, 1974) adapted for the Little Bear-Blacksmith Fork Watershed.

### *Stakeholder Meetings*

During the stakeholder meetings, stakeholders shared informed opinions about the top issues and the natural and human systems present in the study area. The stakeholders present at the meetings included: Shari Phippen, Nibley City Planner; David Zook, Nibley City Manager; Zac Covington, Rodger Jones, and Brian Carver from the Bear River Association of Governments; Joshua Runharr, Zoning Administrator for Cache County Development Services; John Hardman, District Conservationist for the United States Department of Agriculture Natural Resource Conservation Service; and Brad Hunt, Ranch Manager of the Utah Division of Wildlife Resource's Hardware Ranch.

The stakeholder meetings covered a range of subjects, from municipal policy conflicts to the biophysical constraints and opportunities of the watershed, such as drinking water contamination and river restoration.

*The issues discussed at the stakeholder meetings covered a wide range of issues, including county zoning issues with Cache County Zoning Administrator Joshua Runharr (top) to the natural resource assets of the watershed with Hardware Ranch Manager Brad Hunt (bottom).*

### *Case studies*

In addition to gathering information about the study area, the pre-analysis phase of this study involved researching regional planning precedents in the form of published case studies. Some of these case studies included seminal regional planning texts such as Ian McHarg's (1970) *Design With Nature* and *The Brandywine Plan* (Keene & Strong, 1970). Other case studies included reports on projects that were similar in scope and location to the one being conducted, including *Alternative Futures Study: Little Bear Watershed* (Toth et al., 2007) and *Envision Utah* (2014). Reviewing the case studies provided context for developing the methodology used for this study.

### *Project Opinion Papers*

The last step of the pre-analysis phase involved composing project opinion papers, which identified prominent systems and articulated concerns about the study area. These papers were informed by the earlier stages of the pre-analysis phase, and were intended to help summarize the concerns and subjects that would be explored in more depth in the analysis phase of the project.

## Analysis

The analysis phase of the Research & Analysis section was informed by the information collected in the pre-analysis phase. This information was used to define the critical biological, physical and cultural systems and issues affecting the study area. *Critical* systems and issues are those that have a defining influence on the character, operations and potentialities of the study area. Thus, changes to these critical systems and issues could significantly alter the way-of-life for the study area's residents and stakeholders. For example, the elimination of agriculture would have critical effects on both the economic output and rural character of the study area.

Throughout the analysis phase of the Research & Analysis section, faculty and experts from Utah State University (USU) helped guide and inform the research. These experts included: Prof. Nancy Mesner, Department of Watershed Sciences; Prof. Robert Davies, Utah Climate Center; Prof. Jacopo Baggio and Prof. Christopher Monz, Environment and Society Department, and Prof. Frank Howe, Department of Wildland Resources.

### *Identified Systems*

Based on the pre-analysis and additional review of online journals, databases and the USU library, biophysical and cultural systems were identified that were central to the understanding of the study area. These systems included: the biophysical categories, i.e., Geology & Soils, Climate, Water and Wildlife & Vegetation, and the cultural categories, i.e., Economy, Settlement History and Population.

### *Identified Issues*

As with the critical systems, critical issues affecting the study area were informed by the pre-analysis phase and the review of academic articles from online databases, journals and the USU library. The significant issues that emerged included: biophysical categories, i.e., improving air quality, enhancing water quality and quantity and preserving biodiversity, and cultural categories, i.e., increasing recreation access, decreasing recreation impacts, preserving the agricultural sector of the economy and preserving the study area's current rural character.

### *Function & Structure*

The final stage of the analysis phase involved researching the function and structure of the critical systems identified in the earlier phase of the analysis.

'Function' and 'structure' are landscape ecology terms used to describe the spatial patterns and process of the landscape. Structure is the spatial relationship among landscape elements, and influences the conditions and resources that determine the diversity, distribution and abundance of living organisms (Coulson & Tchakerian, 2010). Function is the interaction between these structural elements and deals with the flux of energy, materials and information within and among the elements forming the landscape (Coulson & Tchakerian, 2010).

As with the processes used to identify the critical systems and issues, the function and structure of the identified critical systems were based on the literature review, discussions with USU faculty and experts, as well as feedback from the study area stakeholders.

# Model Development

## Description

Models are spatial representations of the critical biophysical and cultural systems present in the study area. Two types of models are used to represent these systems: assessment and allocation.

## Assessment Models

Assessment models are spatial representations, i.e., maps, of existing or potential biological, physical or cultural systems contained in the study area. In this way, they function as means of understanding where and how the systems operate, as well as the implications for human land uses in these areas. For example, the 100-year floodplains of the study area represent flooding and erosion risks for any developments located within them. As such, they were mapped and included in the Public Health & Safety assessment model (see p. 45).

Similarly, assessment models are used to identify important areas to protect for the systems based on the current conditions of the landscape. For example, riparian areas that are least affected by human land uses often provide the greatest habitat for aquatic species. Thus, these areas were mapped and included in the River Ecosystem assessment model (see p. 47).

Finally, assessment models allow for the evaluation of suggested future land use patterns according to the impacts that those land uses may have on the represented systems. For example, impervious surfaces in groundwater recharge areas reduce recharge potential. As such, by overlaying the Groundwater assessment model with maps of future land use allocations, it may be determined how future recharge potential may be affected (see Figure 3.6 seen later in this chapter).

The assessment models created in this study include: Agricultural Crop, Agricultural Grazing, Geothermal Energy, Groundwater, Public Health & Safety, River Ecosystems, Species Richness, Solar Energy and Surface Water.

## Allocation Models

Allocation models represent existing or potential land uses that may exert a critical influence on the biological, physical and cultural systems of the study area. In this way, they function as blueprints for allocating future land uses based on the suitabilities of the landscape. For example, areas with prime soils for cultivation are the most suitable for agricultural crops, and thus were mapped and included in the Agricultural Crops allocation model (see p. 19).

In this way, each allocation model may be used as a "building block" to construct comprehensive scenarios of potential future critical land uses. These projections are referred to as *alternative futures.*

The allocation models created in this study include: Agricultural Crops, Commercial, Conservation, Groundwater, Group Activity, Manufacturing, Multi-Recreation, Residential and Trails.

## Model Development Process

Both the assessment and allocation models were created by combining Geographic Information System (GIS) data layers in ESRI ArcMap 10.3.1.

Both the assessment and allocation models include *tiers*. For the assessment models, tiers represent levels of decreasing significance for the continued operation of the system being modeled. For the allocation models, tiers represent levels of decreasing suitability for the land use being modeled. Thus, tier 1 of each model represents the most essential areas for that system or land use, and tiers 2 and 3 represent less essential areas for continuing these purposes.

Figure 3.4 provides an illustration of the model construction process, and Figure 3.5 provides an illustration of how the model tiers are used in the Alternative Futures development.

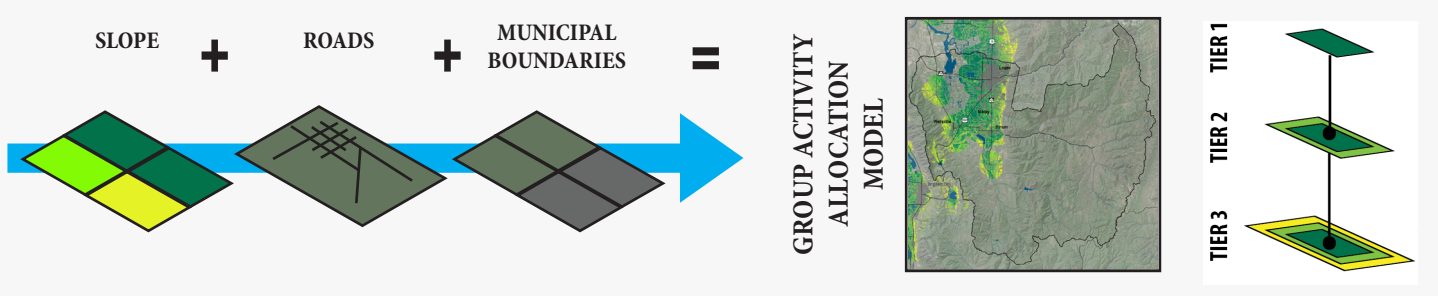



*Figure 3.4*. The model development process

# Alternative Futures

## Description

As previously described, alternative futures are projections of future lands uses based on different scenarios of change. Four alternative futures were developed in this study.

The alternative futures were developed based on four possible scenarios of change. These scenarios included: no change (i.e., maintaining the status quo), agricultural conservation, natural systems conservation, and recreational development. These scenarios correspond to the Business as Usual; City-City, Country-Country; Self Sufficient Cache and Trailhead to the Outdoors alternative futures, respectively.

Each alternative future has unique strengths and weaknesses. Generally, the Business as Usual future is used as a baseline to compare the possible effects of each scenario of change, which are represented in the other alternative futures.

The alternative futures were modeled using the land use allocation models: Agricultural Crops, Commercial, Conservation, Group Activity, Manufacturing, Multi-Recreation, Residential and Trails.

## Alternative Future Development Process

The alternative futures were created by first selecting the three most significant land uses of each future. Then, for each future, the allocation models were overlayed in ArcMap in the priority of importance to that future, so that the top priority land uses, by default, clipped out any lower priority land uses that overlayed them. For example, preserving some agriculture was determined to be the only land use more critical than conservation for achieving the Self Sufficient Cache future. As such, the Agricultural Crops allocation model was assigned the top priority in creating this model. So, all other land uses that overlayed tier 1 (i.e., most essential) Agricultural Crop areas were removed from the spatial representation of this future.

The Trails allocation model provides an exception to the clipping rule. Since trail areas are linear, rather than polygonal, the Trails allocation model was overlayed over the rest of the allocation models in each future, so that the linear trail areas would not be removed from the final spatial representations.

Figure 3.5 provides an illustration of the overlay process for the Self Sufficient Cache alternative future.

## Self Sufficient Cache Alternative Future

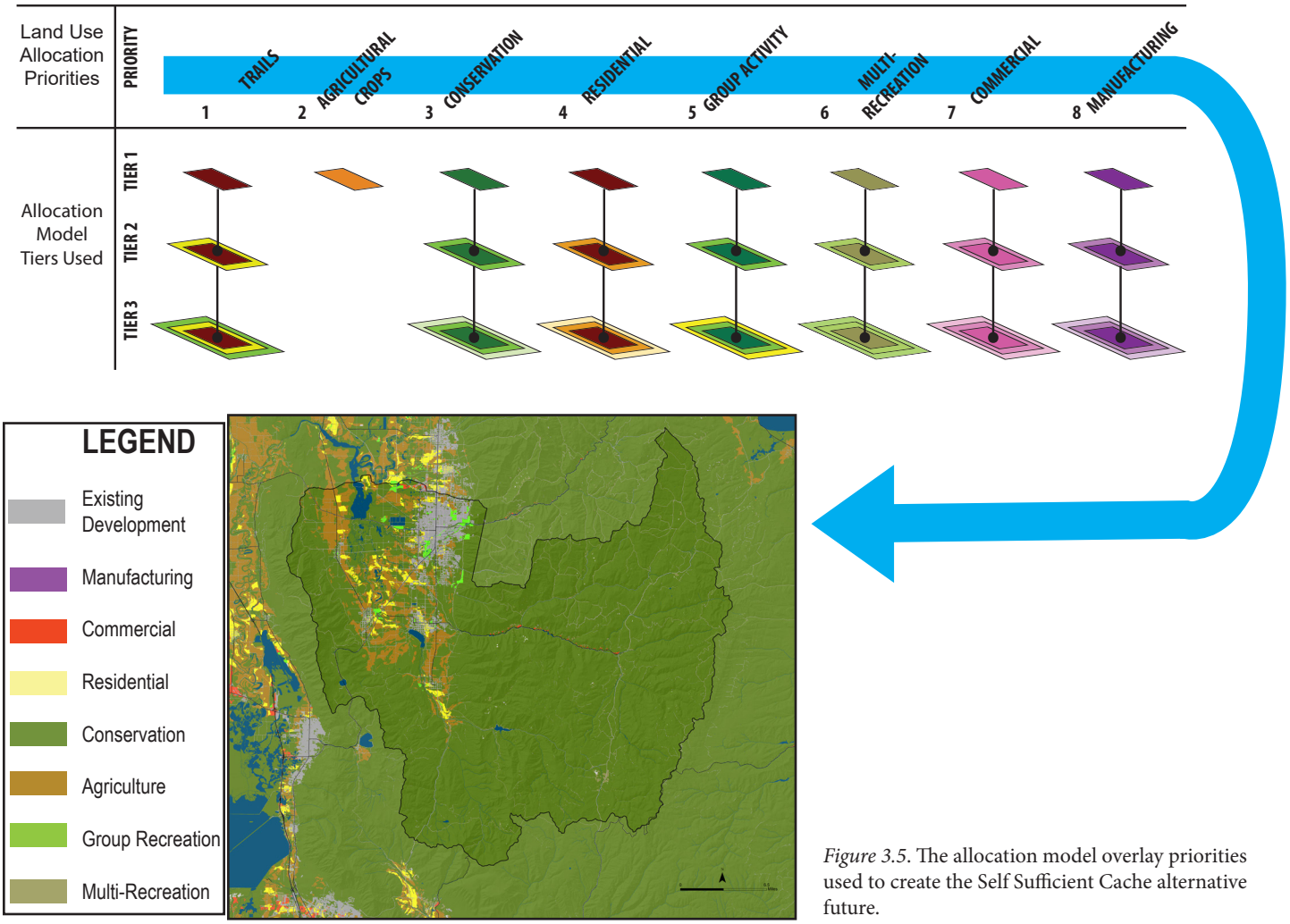



*Figure 3.5*. The allocation model overlay priorities used to create the Self Sufficient Cache alternative future.

# Evaluations

## Description

In the final section of the study, the researchers evaluated the four alternative futures according to three criteria: land use change, systems impacts and issues impacts.

Land use changes were determined by pixel counts in ArcMap. Land use change categories include: Development, Conservation, Agriculture and Trails.

System impacts were determined by overlaying each future with each assessment model. The researchers then performed a qualitative analysis of how each future would affect each system component (i.e., assessment model) (see Figure 3.6).

Finally, issues impacts were also determined by qualitative assessments of how each alternative future would impact each of the study area's critical issues. These assessments were informed by the information collected in the Research & Analysis section. For example, futures that exhibited sprawl development where determined to negatively affect the transportation and rural character issues.

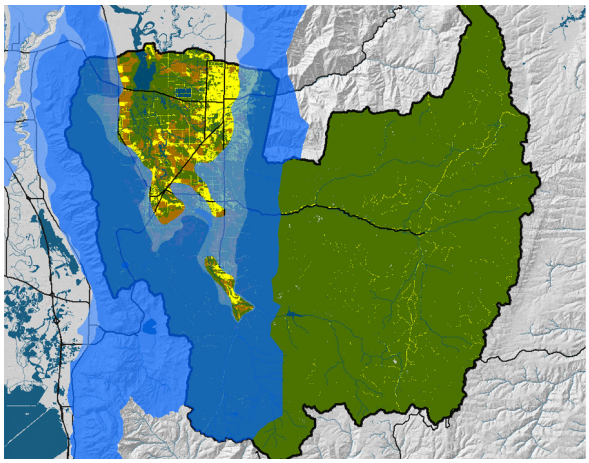


*Figure 3.6*. The Groundwater assessment model is overlayed on top of the Business as Usual future to assess impacts to the groundwater system.

# CHAPTER 4: FUNCTION & STRUCTURE

Functions and structures include the important forms and relations that constitute each critical biophysical and cultural system. On a landscape level, these include spatial patterns and processes. For example, water quantity and quantity is largely determined by the water cycle on a regional scale. The water cycle is affected by geological structures (e.g., mountains) as well as by biological functions (e.g., transpiration). The relations between the water cycle and geological structures also affects biological structures, e.g., riparian habitat (see Figure 4.1) The functions and structures described in this chapter correspond to the each of the critical systems identified in this study.

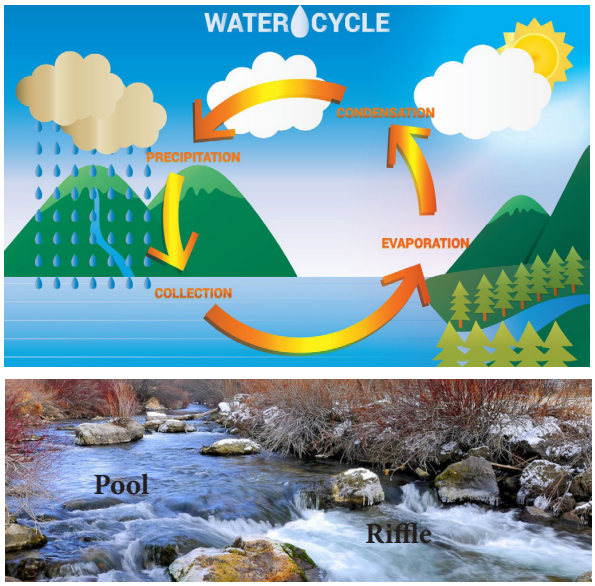



*Figure 4.1.* Regional functions and structures, such as the water cycle and geological forms, determine site-specific functions and structures, such as riparian habitat.

## Biophysical Systems

### Water

Water is a precious resource in the Intermountain West. Utah is the second most arid state in the nation, with an average precipitation of 15 inches per year and 18 inches locally (*Annual Rainfall for US States,* 2016). This scarcity creates competition for water resources amongst a variety of desired uses (Osborn, 2016).

In the study area, three main rivers flow out of the Bear River Mountains: the Little Bear, the Blacksmith Fork and the Logan. These waterways converge at the Cutler Reservoir, a man made containment area, before reaching the Bear River.

Spring precipitation and winter snowpack fuel these rivers, as well as the wetlands, reservoirs and aquifers of the watershed. However, municipal and agricultural water use demands put stress on the system to the point that some rivers and streams, such as the Blacksmith Fork, run dry during the late summer and fall months.

Water shortages not only affect farms and towns, but also the environment and recreation. Low flows in the river can impact kayaking, canoing, fishing and other water sports, as well as habitat for iconic sport fish like the Bonneville cutthroat trout. Fishing contributes $293 million per year to the State economy (Prettyman, 2013). Thus, low or no flowing rivers can affect wildlife and the local economy.

*Like other water bodies in the study area, the volume of Hyrum Reservoir is dependent on the snow melt of the spring and early summer seasons.*

Conversely, too much water can also be a problem. When large snow melt occurs quickly, the rivers and streams in the area swell and inundate the floodplain. Many of the floodplains have been built on over the years and may experience property damage in 50- and 100-year flood-events. For example, in 2011, $12.7 million in infrastructure damages occurred in Logan and Providence due to flooding events (*FEMA Inspects...,* 2011).

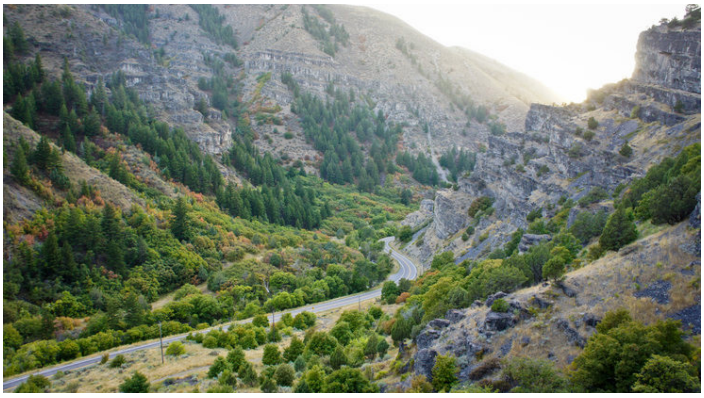
Development also impairs aquifer recharge along the foothills of the Bear River and Wellsville Mountains. That is, increased impervious surfaces and gray stormwater infrastructure reduces the potential for surface water to percolate into the study area's aquifers.

## Geography & Soils

South Cache Valley is part of a transitional zone between the Basin and Range province, an area characterized by flat deserts and elongated mountain ranges, and the Middle Rocky Mountain province, an area defined by folded mountains (Spangler & Constance, 1999). Over thousands of years, tectonic activity along the East and West Cache Fault Zones formed the Wellsville Mountains in the east of the study area and the Bear River Mountains in the west.

Today, tectonic activity continues to occur along these fault zones, posing earthquake and landslide risks. Additionally, the high water table in the valley, combined with the seismic activity, poses a liquefaction risk. Liquefaction is a phenomenon that occurs when shallow water-saturated sandy soils are subjected to ground shaking, causing the soil to lose strength and behave like a liquid, similar to quicksand.

During the last ice age, between 30,000 and 15,000 years ago, the Bear River and Wellsville Mountains experienced significant glaciation (Eldredge & Biek, 2010). When this period ended, the glaciers began to recede, and the historic Lake Bonneville was formed. Lake Bonneville was a massive freshwater lake occupying parts of Idaho, Nevada, and Utah, including Cache Valley.



*Limestone walls along Blacksmith Fork Canyon, a popular route to camping, hunting and hiking activities in the Bear River Mountains.*

Approximately 18,000 years ago, the lake reached its peak level and breached its elevated boundaries at the nearby Red Rock Pass in Southern Idaho (Hintze, 2005). Lake Bonneville then receded, depositing nutrient rich alluvial soils into the region, and helped form terraces along the foothills of the mountains.

The rich valley soils are finely textured and poorly drained, creating ideal conditions for agriculture, including the water intensive practice of flood irrigation (BioWest, 1990). The foothill and canyon soils, however, tend to be well drained.

## Climate

The study area experiences a humid continental climate, with warm dry summers and cold winters. The mountain ranges receive approximately 50 inches of snow a year, feeding the rivers and reservoirs throughout the valley. However, over the next century, climate change is predicted to diminish the snowpack and decrease the amount of usable water in Cache Valley (Davies, R., personal communication, September 22, 2015).

The Wellsville and Bear Mountains form a unique bowl shape around Cache Valley, causing winter inversions in the area. Winter inversions are formed when cold air is trapped below warm air. Inversions seal in toxic chemicals from furnaces, cows and automobiles. Due to the inversions, poor air quality conditions occur frequently enough for the area to be designated by the U.S. Environmental Protection Agency as a non-attainment zone for particulate matter 2.5 (Idaho Department of Environmental Quality, 2010). Long exposure to PM 2.5 is known to cause significant health risks, including asthma and heart disease (World Health Organization, 2013).


*The topography of the study area creates unique climatic conditions.*

## Vegetation & Wildlife

South Cache Valley contains eleven distinct lifezones (Donaldson & Raming, 1979) with considerable biodiversity. Although some species, such as the bison and grizzly bear, were extirpated in the 19th and 20th centuries, other iconic species, like the elk, mule deer, and mountain lion, remain in the area and are popular species for hunting. (Utah Department of Natural Resources [DNR], 2017).

*Elk are indigenous to the study area. In addition to supporting the local ecosystems, they are also a valuable asset for the hunting and tourism industries.*

The Cutler Reservoir, a shallow wetland reservoir which is fed by the Little Bear, Blacksmith Fork and Logan Rivers, provides critical habitat for migratory and local birds of Cache Valley. Also, in the upper reaches of the watershed, these rivers provide habitat for iconic sport fish, such the Bonneville cutthroat trout. The prime condition of this habitat is reflected in the current Blue Ribbon status of the upper reaches of the Logan River (Utah DNR, 2016).

Historically, the study area would have been dominated by grasses and riparian vegetation in lower elevations, and juniper, shrubs and coniferous trees at higher elevations. Bison herds helped maintain this cover with their migratory grazing until they were hunted to extirpation in the 1930s (Cache Valley Visitors Bureau, 2010). Additionally, by 1910 the area contained over 300,000 sheep and 16,000 dairy cows (Utah Division of State History, n.d.). This new, fixed grazing depleted the natural vegetation and invited nonnative species such as sagebrush and cheatgrass to the area (Hull & Hull, 1974). Cheatgrass, an invasive plant, dies off during summer and contributes to the area's wildfire hazards.

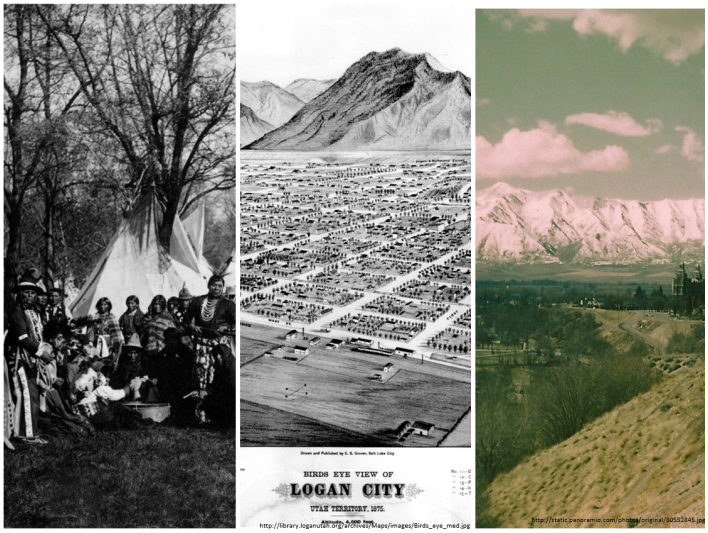
# Cultural Systems

## Settlement History

Before the introduction of horses in the 18th century, Fremont Indians used the study area for seasonal hunting grounds, but had not established permanent populations (Cache Valley Visitors Bureau, 2010). During this period, Cache Valley was referred to as "Willow Valley," after the vegetation that grew naturally along the river banks. After the introduction of horses, however, native tribes, including the Shoshone, began to burn land cover in the region in order to increase grazing area for their herds (Cache Valley Visitors Bureau, 2010). These activities allowed them to extend their presence in the area.

The first non-native presence in South Cache Valley were the "mountain-men" of the mid-19th century. These fur traders found ample resources in the rivers and mountains of the study area. Jim Bridger's outfit, for example, was said to have cached nearly 50,000 beaver pelts within the borders of what is today Hyrum Township (Cache Valley Visitors Bureau, 2010). By the start of the 20th century, most of the native inhabitants of the area had been driven out, and the valley was most commonly referred to as Cache Valley, after the industry of the mountain men.

The second wave of non-natives to establish a presence in




*Prior to settlement by Mormon emigrants, the study area utilized as seasonal hunting and grazing territory for native peoples.*

the area where the Mormon pioneers of Brigham Young. The Mormons built the first settlements according to their Plat of Zion, a system of gridded streets with half-acre lots that encouraged sustenance farming. They also constructed elaborate irrigation canals to move mountain water across the valley to feed the growing agriculture practices (Stegner, 1964/1992).

## Population

The population of the study area remained relatively small, as well as agriculturally based, until WWII. Post WWII, the agricultural industries in the area began to slowly decline, while the population more than doubled. The growing population and the rising popularity of the automobile pushed large, single family housing into the farmlands.

Today, South Cache Valley continues to see rapid growth, with a population of about 100,000 that is expected to double again by 2040 (see Figure 4.2) (Envision Utah, 2009). The population is spread over 10 communities ranging in size from Logan, with approximately 50,000 residents, to Avon, with nearly 400.

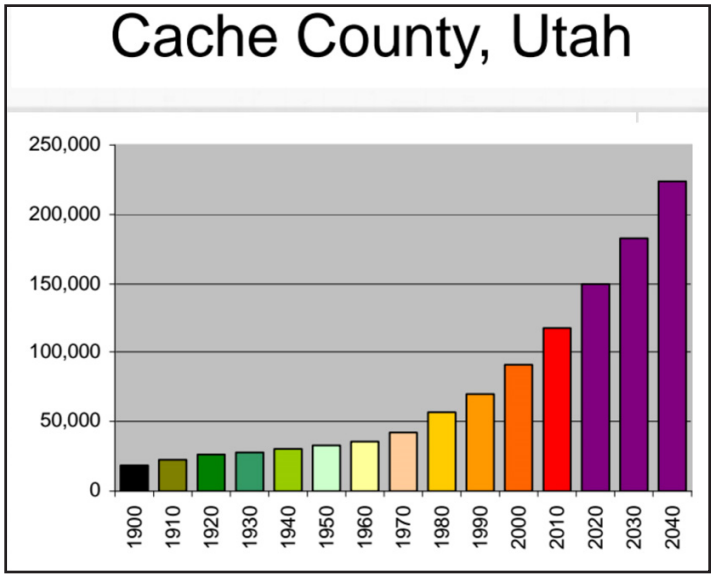



*Figure 4.2.* Population in the study area has doubled since 1960 and is expected to double again by 2020. Source: Josh Runharr, Cache County Development Services, reproduced with his permission.

## Economy

The economic structures of the first settlements were dominated by agriculture, including ranching, woolen mills, dairies, irrigated crops, dry crops and timber harvesting. Throughout the early to mid-20th century, Cache Valley was also a prominent citrus-crop producer.

Currently, agriculture directly contributes 26% of the gross economic output of Cache County (Utah Association of Conservation Districts, 2011, p. 5). Agricultural industries include: ranching, dairies and irrigated and dry crops, especially alfalfa and corn (USU Extension, 2006). Agriculture and grazing employ a large number of residents, including dairy manufacturing at Gossner Food, Schreibner Food and West Point Dairy, and meat packing at JBS. However, sprawling residential patterns threaten the availability of agricultural land for future generations. This,

*Agriculture and Utah State University are two major economic drivers of the study area.*

combined with a workforce transitioning to technology, consulting and other industries, leaves current agricultural land at risk for development for other uses.

Many of the employment opportunities for people living in the study area are located in Logan. Utah State University contributes many of these opportunities. Many of the other communities, e.g. Nibley, are bedroom communities, i.e., a suburban town where many commuters live but do not work. The lack of strong commercial and manufacturing centers within bedroom communities places strain on local governments to maintain the necessary infrastructure for residential and commuter use (Josh Runharr, Cache County Development Services, personal communication, March, 2016).

Recreation and tourism are also prominent components of the current economy. The nearby Naomi and Wellsville Mountain Wilderness Areas attract people from around the west for hiking, fishing, rock climbing, backpacking, and backcountry skiing. Cache National Forest, which surrounds the wilderness areas, serves for additional forms of recreation, including ATV use and hunting. These activities bring tourism and retail opportunities to South Cache Valley.

*Hiking and skiing attract visitor to the watershed year round. Late season snow allows backcountry skiers to extend their season.*

# CHAPTER 5: MODELS

## What are models?

Bioregional planning models are spatial representations of biological, cultural, and physical systems. Models that identify sensitive areas of natural systems are called *assessment models.* Models that identify areas for human activities based on the landscape suitability are called *allocation models*.

## How are they used?

In context of the overall bioregional planning process, allocation models are used to identify suitable areas for different land uses. In this way, they function as building blocks to construct alternative futures for the study area. As such, each alternative future is a comprehensive, spatial representation of all the land uses that were considered critical to the future of the study area.

Assessment models, on the other hand, are used to evaluate the effects of the proposed land uses of each alternative future according to the critical biological, cultural, and physical systems of the study area. For example, the Surface Water assessment model is used to assess how proposed future land uses will affect the surface water systems of the study area.

## How are they built?

Layers of spatial data are combined to create the models, which are broken into two to three tiers, as represented in Figure 5.1. In this way, the most important areas of each data layer, for the system or land use being represented, are combined into the tier 1 category of each model. Similarly, the non-essential, but contributing, areas of each data layer are incorporated into tiers 2 and 3.

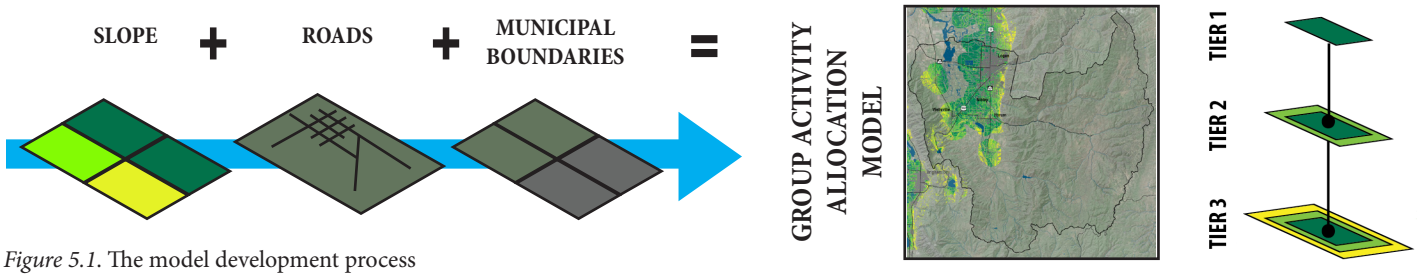



*Figure 5.1.* The model development process

# ALLOCATION MODELS

Allocation models identify areas for human land uses based on the suitability of the landscape. Landscape suitability is determined by natural and/or human factors, as seen in the Multi-Recreation model, where both human factors, e.g., roads, and natural factors (e.g., proximity to water) were used as criteria for development.

Each allocation model includes up to three tiers: (1) essential, (2) moderate, and (3) extensive. The tier 1 *essential* category of each model includes those areas that are necessary to maintain the critical influence of the land use represented by each model for the study area. The tier 2 *moderate* category adds areas that are not vital to maintaining the critical influence of the land use, but which demonstrate moderate suitability for that land use. Finally, the tier 3 *extensive* category includes all other areas that demonstrate some suitability for that land use.

# Allocation model index

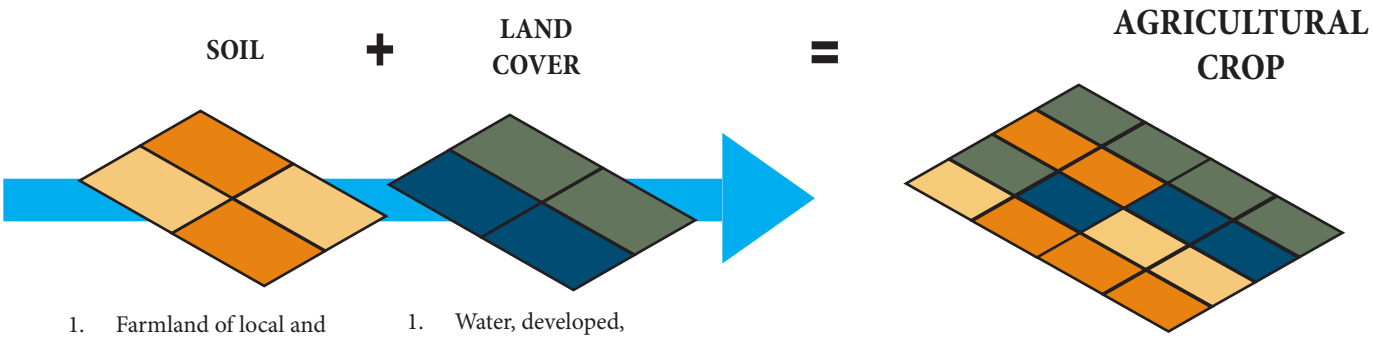
# AGRICULTURAL CROPS ALLOCATION MODEL

## Description

Agricultural crop production currently accounts for about 26% of the market value of agricultural production in Cache County (United States Department of Agriculture, 2012). The primary crops produced in the area include fodder crops such as corn, alfalfa and other hay, as well as cereal grains such as oats, barley and wheat (USU Extension, 2006). These crops also largely account for the miles of farm fields that contribute to the rural character of Cache Valley. As population has expanded outwards, agricultural land has been sold off and converted to density residential and commercial development. This model identifies current areas that produce agricultural crops and/or have soil conditions that are suitable for this purpose.

## Data, Layers, Criteria & Sources

The model was created by combing soil types and land cover data.




1. Farmland of local and statewide importance
2. Farmland of unique importance
3. Prime farmland if drained and/or irrigated

*National Resource Conservation Service, Soil Survey Geographic Database*

1. Water, developed, barren, forest, wetlands, shrubland, herbaceous
2. Planted/cultivated

*U.S. Geologic Survey, National Land Cover Database*

## Discussion

Several large areas of prime agricultural cropland are located throughout the southern, western and eastern portions of Cache Valley (see Figure 5.2). These areas contain cropland of statewide and local importance. Agricultural crop production has a strong presence in the valley, and if protected it will continue to contribute a significant portion to the regional economy and rural character that residents value. However, as population continues to grow outward, pressure to develop the cropland will increase especially in areas around Wellsville, Logan and Hyrum.

This model is also used to evaluate the alternative futures in chapter 5 of this report. As such, it is replicated as an assessment model on pp. 37-38.

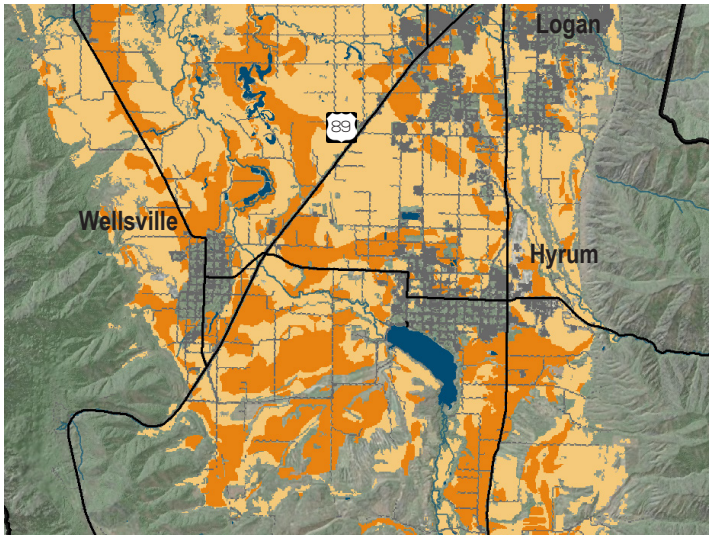
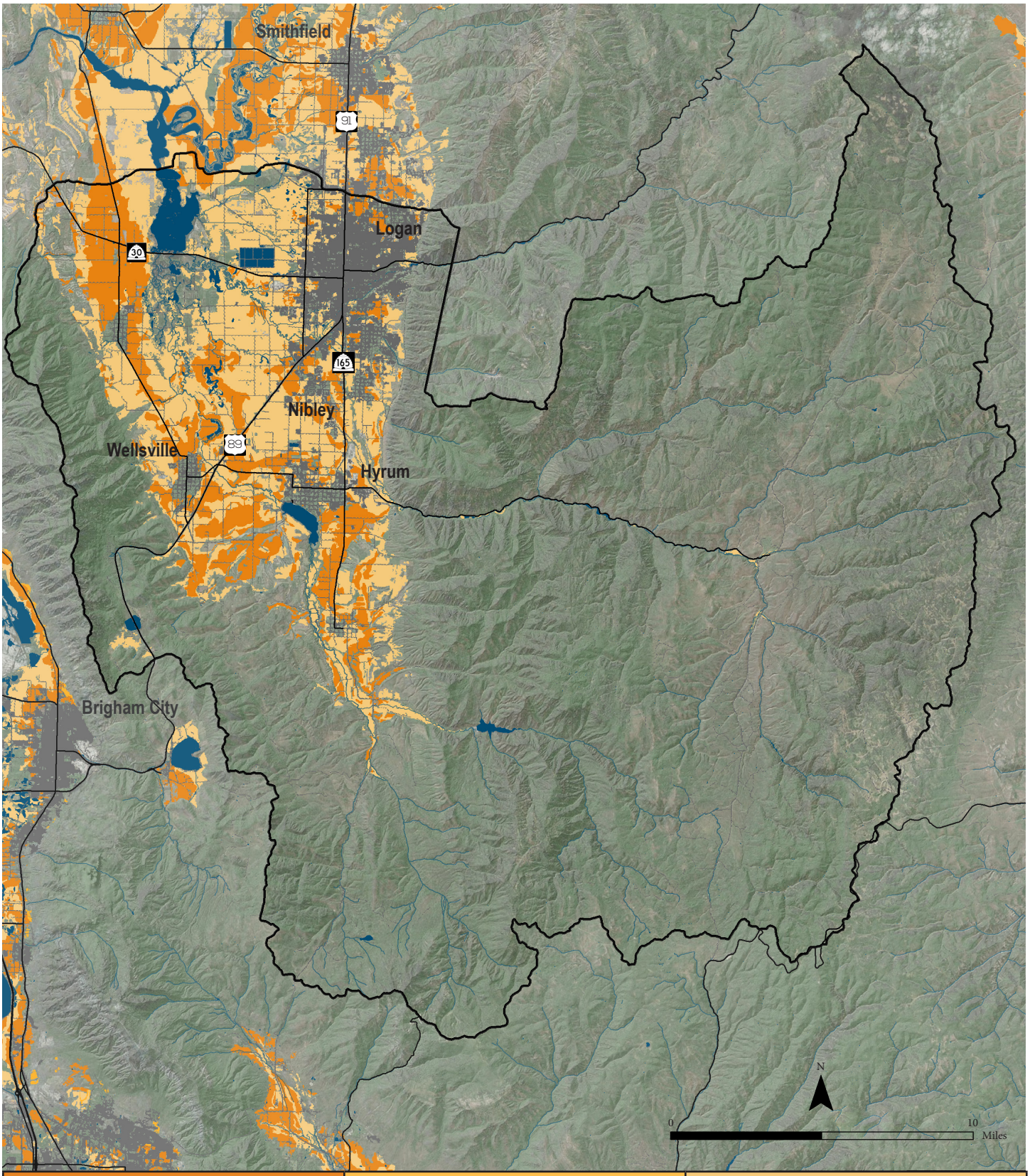



*Figure 5.2.* Agriculture crop production has a strong presence in the south and eastern portions of Cache Valley.




| TIER 1: ESSENTIAL | TIER 2: MODERATE | TIER 3: EXTENSIVE |
|---|---|---|
| Areas of prime farmland. | Areas unique importance farmland. | Areas of statewide and local important farmland. |

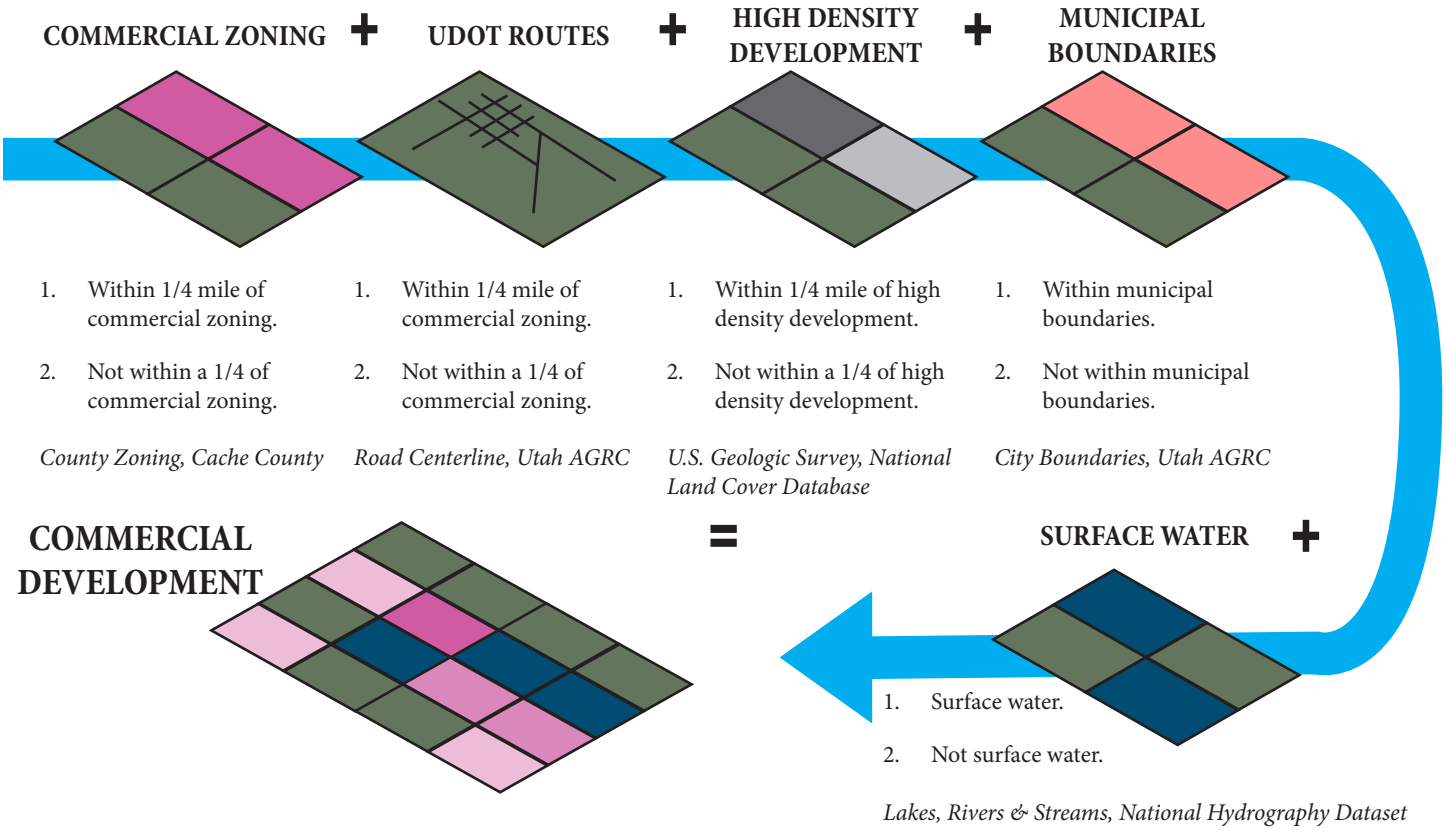
# COMMERCIAL ALLOCATION MODEL

## Description

Commercial businesses, such as recreation retailers, boutiques, restaurants, and grocery stores make up 20% of the regional economy (Utah Department of Workforce Services [DWS], 2016). Commercial businesses provide the basic services residents and visitors use daily and are important to expand as the population continues to increase. This model shows the most suitable locations for accessible land that is centrally located with respect to existing commercial centers and high density housing.

## Data, Layers, Criteria & Sources

The model was created by combing current commercially zoned areas, locations within a quarter-mile of Utah Department of Transportation (UDOT) highway routes, locations within high density development areas, areas within current municipal boundaries, and areas outside of surface water locations, such as streams and reservoirs.




## Discussion

Several essential pockets for additional retailers and other commercial businesses are located around Logan city where there are road networks, higher density development and commercial zoning (see Figure 5.3). As the watershed continues to grow in population, commercial businesses will compete with residential and manufacturing development for locations within municipal boundaries and along the major highways.

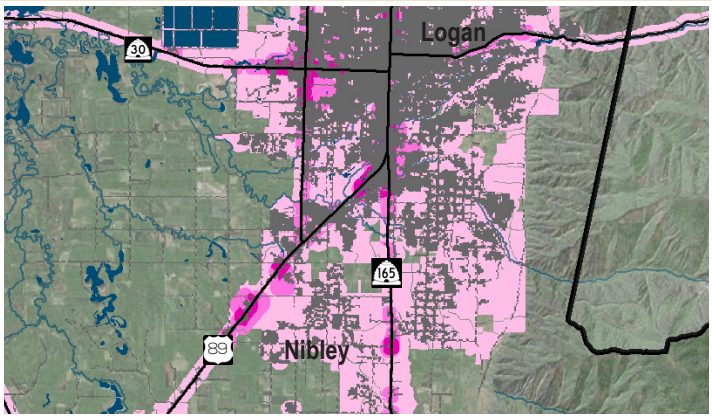
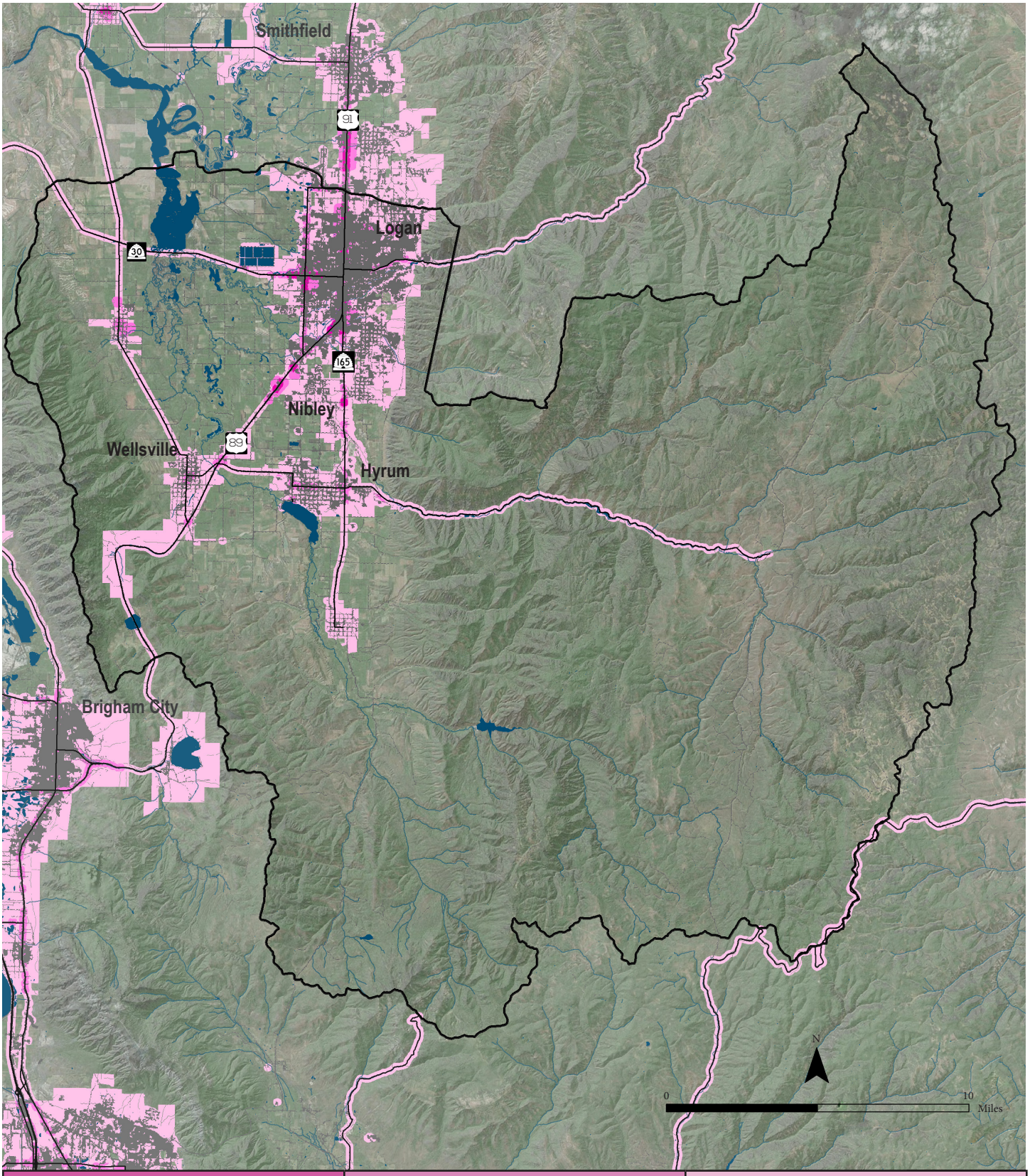



*Figure 5.3.* Nibley has several suitable areas for commercial development.




| TIER 1: ESSENTIAL | TIER 2: MODERATE | TIER 3: EXTENSIVE |
|---|---|---|
| Areas within municipal boundaries, within high density development, within commercial zoning and near a UDOT routes. | Areas within high density development, within the municipal boundaries, and near a UDOT routes. As well as locations that are zoned commercial and are in high density areas and near UDOT routes. | Areas within municipal boundaries, or near a UDOT route, or within high density development. |

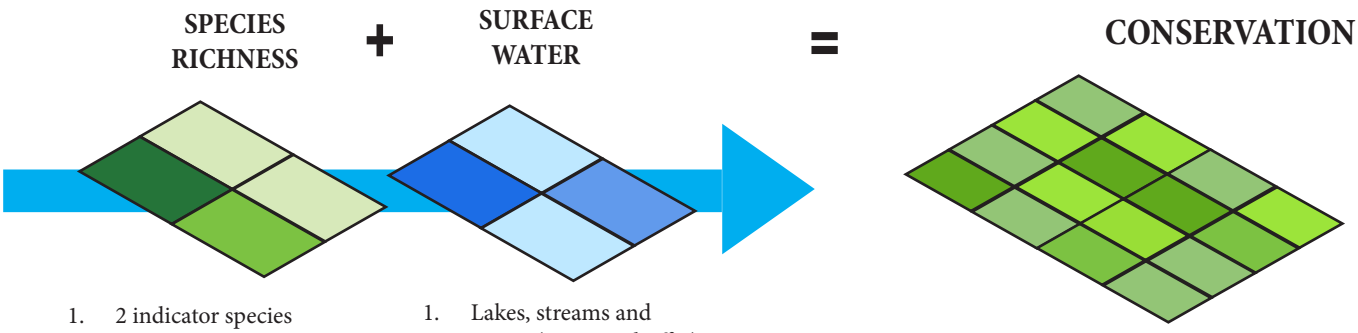
# CONSERVATION ALLOCATION MODEL

## Description

This model identifies areas to implement conservation regulations, in order to enhance existing or potential biological and hydrological values. Conservation regulations are those that restrict permanent development and certain high impact activities, such as dispersed off-highway vehicle use. Conserving areas for habitat and surface water quality would provide a number of goods and services for the residents of the study area, including recreational opportunities and food and fiber. This model was used in the alternative futures development process to allocate regulated areas, in order to promote these benefits.

## Data, Layers, Criteria & Sources

The model was created by combing the Species Richness and Surface Water assessment models.




1. 2 indicator species
2. 3-4 indicator species
3. 5 indicator species

*Utah AGRC*

1. Lakes, streams and rivers (30 meter buffer), wetlands
2. 100 year floodplain
3. First order watersheds

*ESRI, Utah AGRC*

## Discussion

The conservation model is based on biophysical conditions, rather than cultural ones such as land ownership.

The mountains in the Bear River Range contain more intact wildlife habitat than is present in the valley or the Wellsville Mountains Range, as well as many first order streams. As such, these areas are high value, low restoration cost targets. In contrast, the developed areas of Cache Valley have lower quality habitat (see figure 5.4). As such, they involve a higher restoration cost to provide habitat and hydrological function. Conserving these areas would also reduce area for other critical land uses, such as agriculture and development.

Much of the wetland area around the Cutler Reservoir requires some restoration in order to provide prime habitat and high surface water quality. However, the high potential for rich habitat and fewer competing land uses in this area contribute to its moderate to essential conservation value.

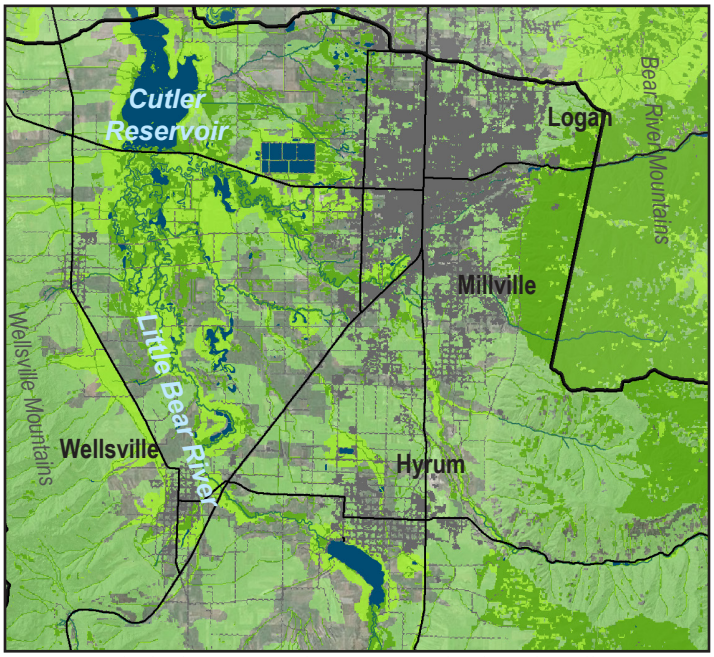
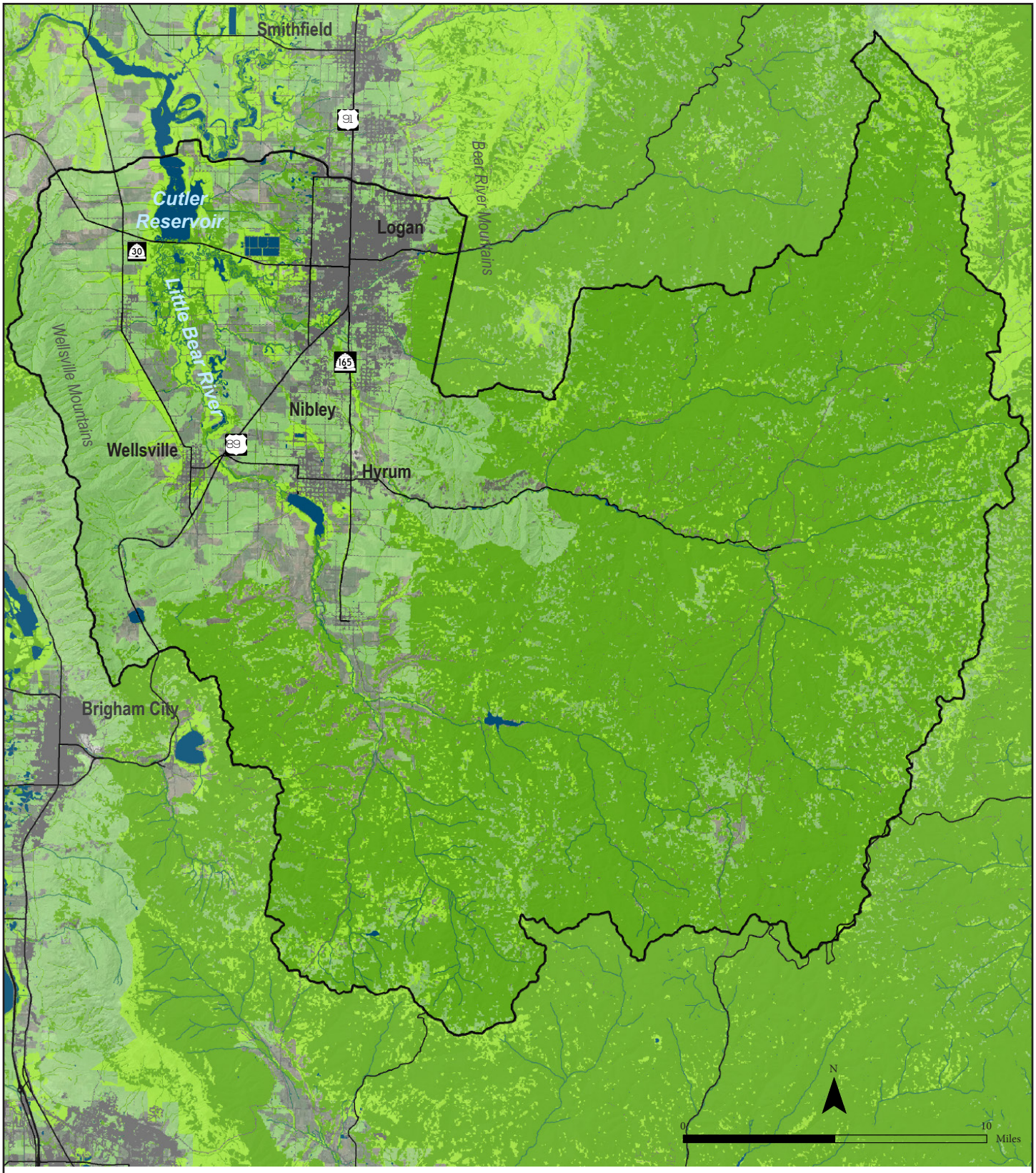



*Figure 5.4.* The highest potential conservation lands in the valley are located around the Cutler Reservoir.




| TIER 1: ESSENTIAL | TIER 2: MODERATE | TIER 3: EXTENSIVE |
|---|---|---|
| Areas with 5 indicator species and/or within first-order watersheds. | Areas with 3-4 indicator species and/or within the 100 year floodplain | Areas with 2 indicator species, and/or lakes, wetlands, rivers and streams (30 meter buffer) |

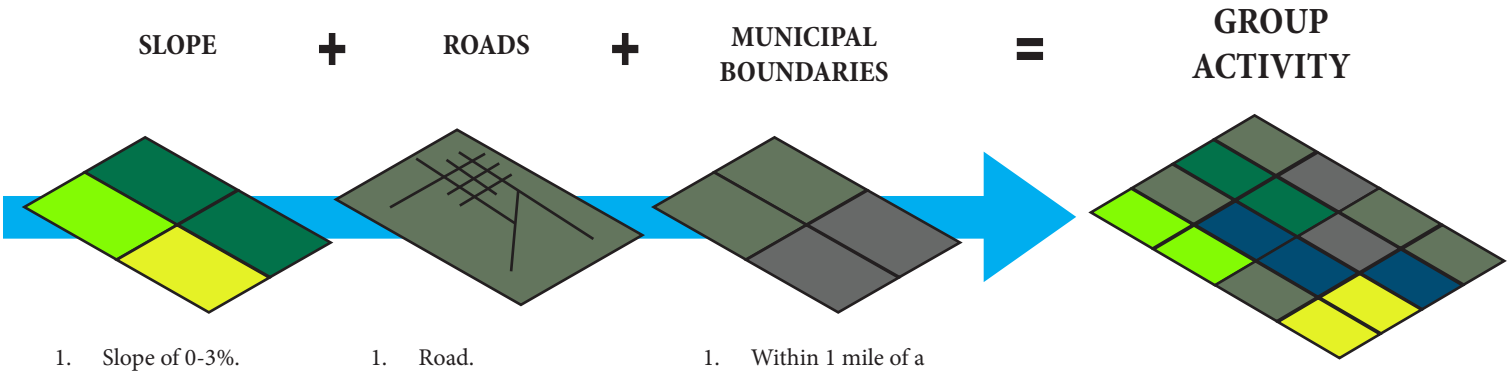
# GROUP ACTIVITY ALLOCATION MODEL

## Description

Group recreational activity areas, such as sports fields and city parks, provide economic value, improve physical and mental health, and provide places for communities to interact (Crompton, 2001; Peters et al., 2010; and Pretty et al., 2005). Areas for group activities should be easily accessible for residents and visitors of all ages and abilities. This model identifies the most suitable locations where groups can engage in recreation, leisure, and education as communities continue to grow.

## Data, Layers, Criteria & Sources

The model was created by combing municipal areas, slopes, and roads.




1. Slope of 0-3%.
2. Slope of 3-6%
3. Slope of 6-10%.
4. Slope of 10-20%.
5. Slope of 20% or greater.

*10 meter U.S. Geological Society Digital Elevation Model (DEM), Utah AGRC*

1. Road.
2. Not road.

*Road Centerline, Utah AGRC*

1. Within 1 mile of a municipal boundary.
2. Not within 1 mile of a municipal boundary.

*City Boundaries, Utah AGRC*

## Discussion

As communities in the watershed continue to expand, suitable locations for group activities exist in each municipality, such as the level areas between Logan and Nibley (see Figure 5.5). However, many of the suitable locations will come at the expense of losing agricultural fields. It is important that communities balance the health and welfare benefits of providing group recreational activity sites with the loss of farmlands.

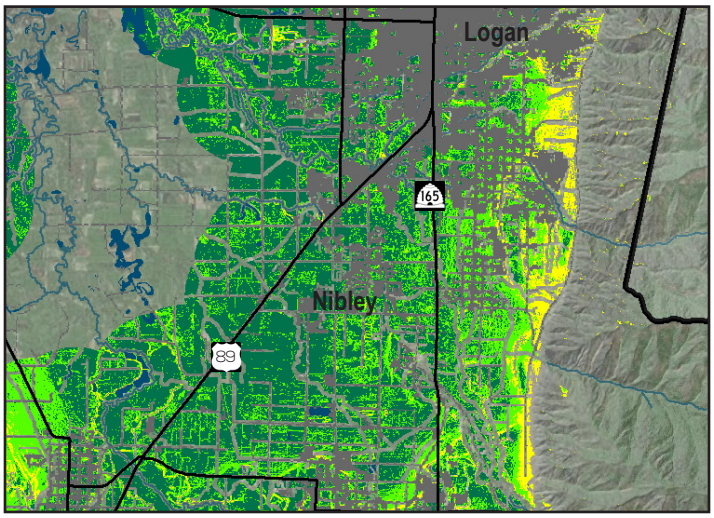
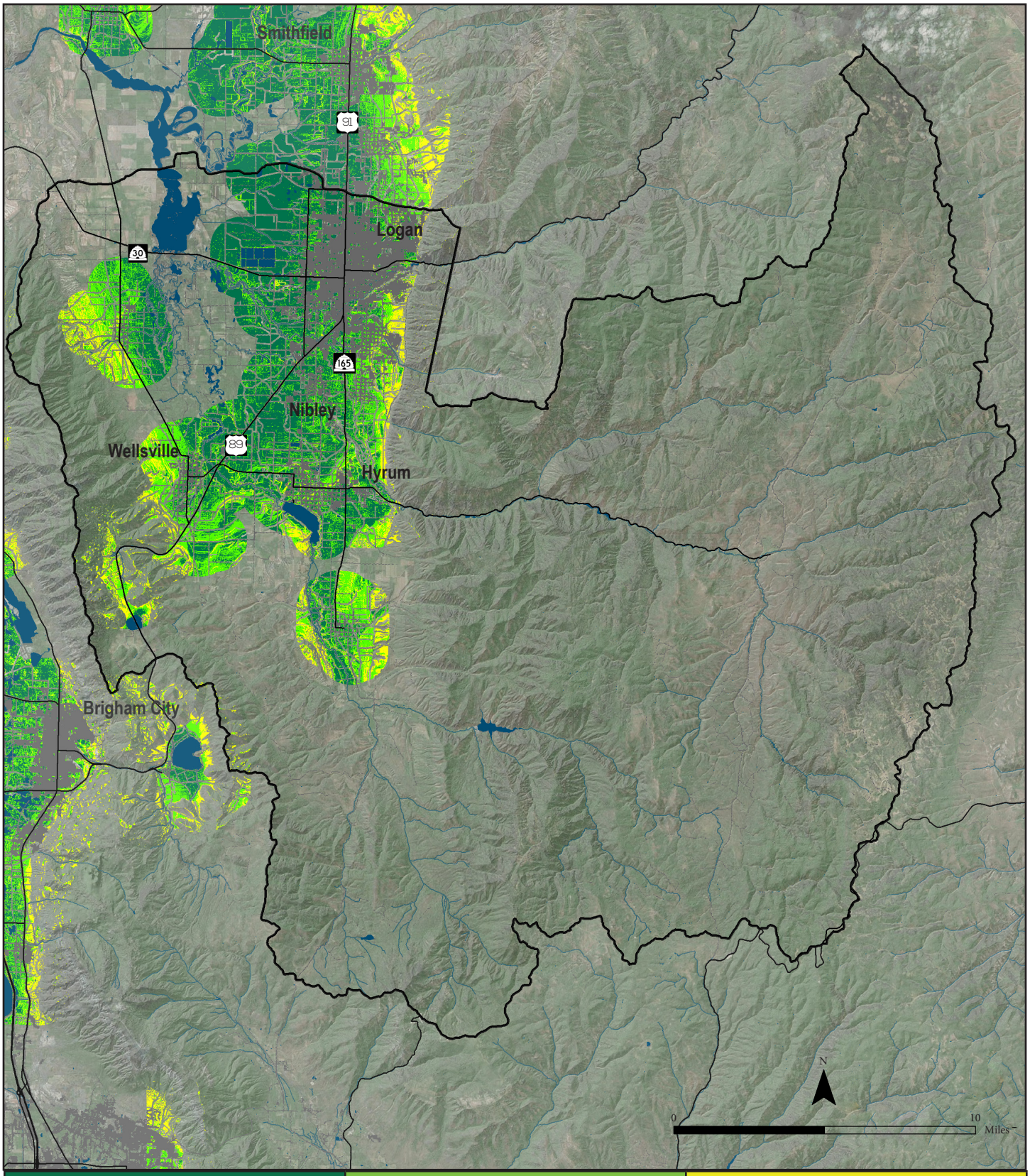



*Figure 5.5.* Several essential suitable sites for the watershed exist in the low sloping areas between cities, such as the area between Nibley and Logan.




| TIER 1: ESSENTIAL | TIER 2: MODERATE | TIER 3: EXTENSIVE |
|---|---|---|
| Areas with slope between 0 and 3 percent, and within a mile of municipal boundaries | Areas with slope between 3 and 10 percent, and within a mile of municipal boundaries | Areas with slope between 10 and 20 percent, and within a mile of municipal boundaries |

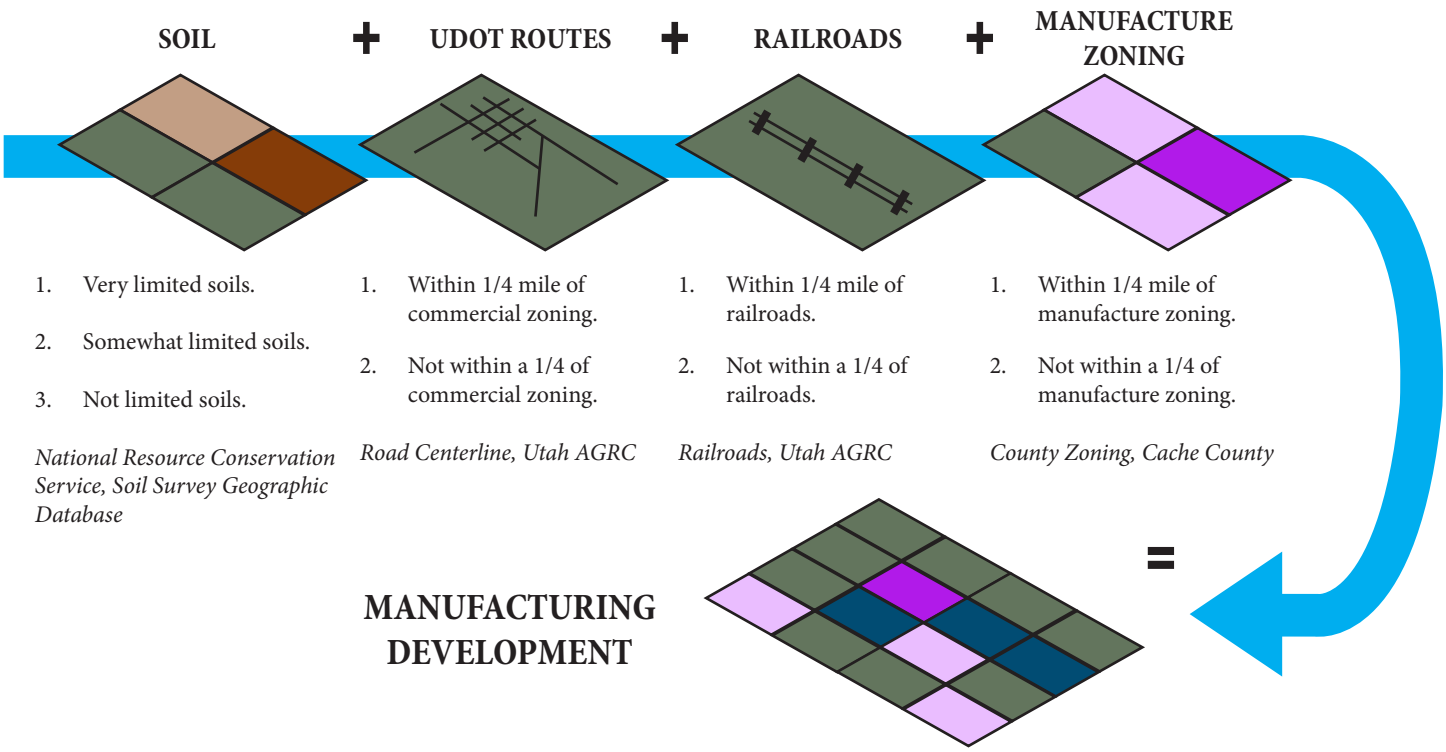
# MANUFACTURING ALLOCATION MODEL

## Description

Manufacturing businesses, such as ICON Health & Fitness, Schreiber Foods, Gossner Foods, and E.A. Miller make up almost 20% of the regional economy (DWS, 2016). Manufacturing businesses produce agricultural products such as cheese, milk and meat, as well as fitness equipment and scientific instruments for national, regional and local consumption. As the population increase, more manufacturing jobs will be need to support the local workforce. This model identifies suitable, accessible land to develop for manufacturing businesses.

## Data, Layers, Criteria & Sources

The model was created by combing current areas zoned for manufacturing, locations within a quarter-mile of UDOT highway routes, locations within a quarter mile of railroads, and areas with high soil weight capacity for larger buildings.




## Discussion

Attracting and developing manufacturing businesses is important for the current and future workforce. As communities develop, there are several suitable locations to expand manufacturing businesses around current municipalities. An important corridor to develop is between Wellsville and Hyrum (see Figure 5.6). However, the development of this land will be in competition with other residential and commercial developments due to the access to major roads and proximity to city centers.

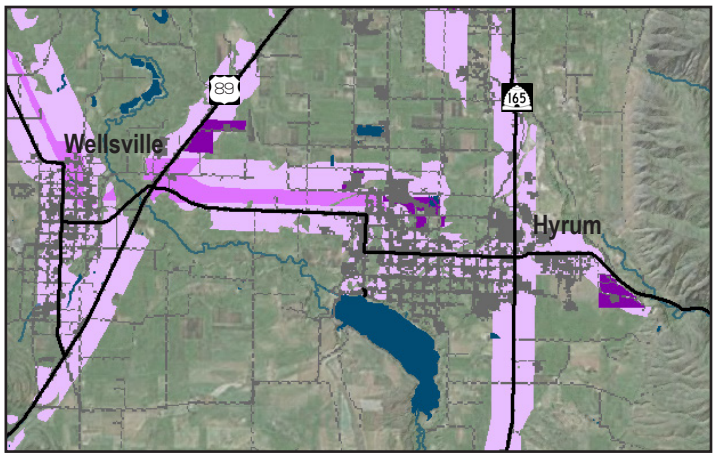
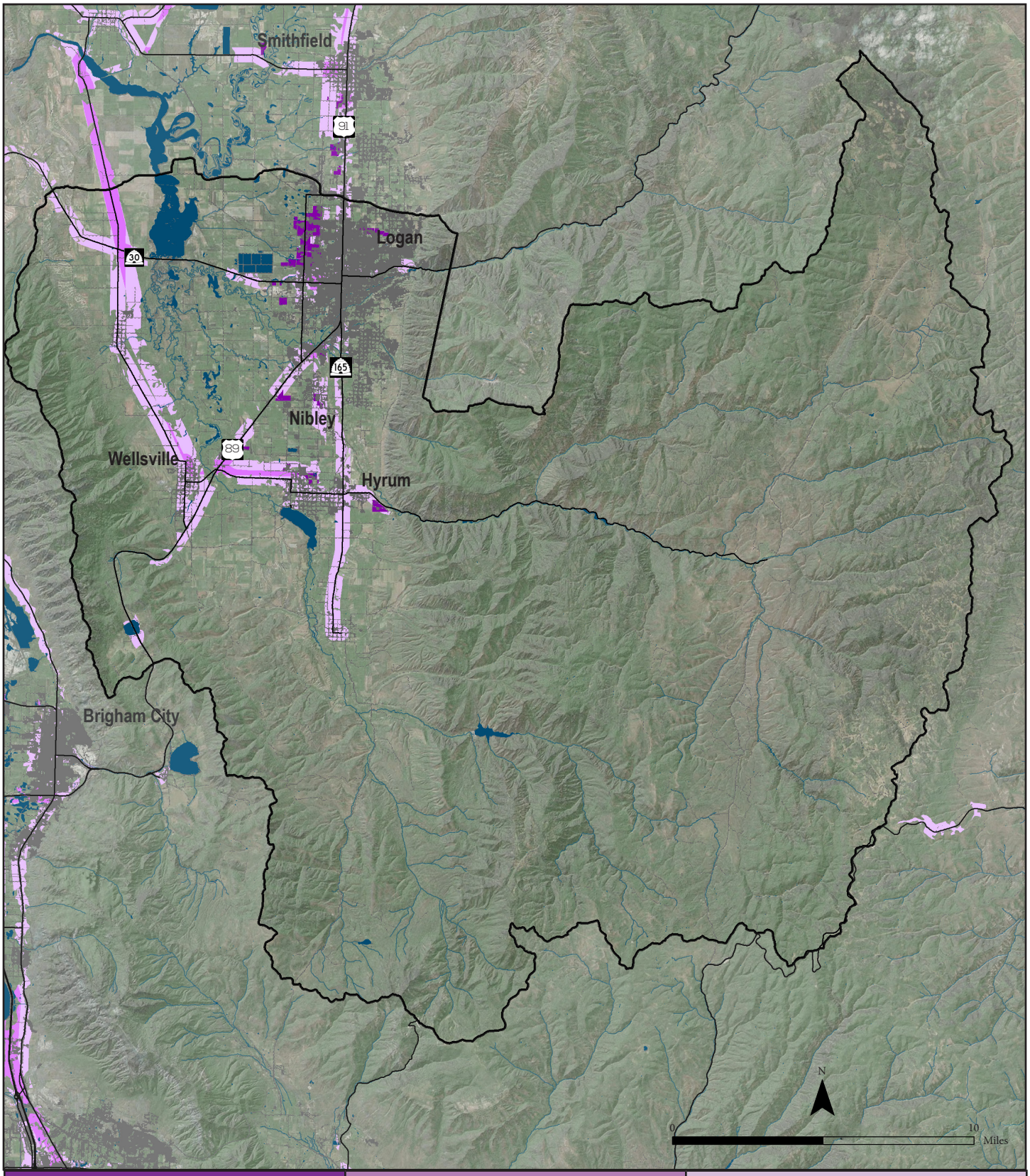



*Figure 5.6.* The Hyrum-Wellsville corridor has several suitable locations for manufacturing businesses to develop.




| TIER 1: ESSENTIAL | TIER 2: MODERATE | TIER 3: EXTENSIVE |
|---|---|---|
| Within areas zoned for manufacturing | Areas within a 1/4 mile of roads and/or railroads, and not limited or somewhat limited soils | Areas within a 1/4 mile of roads and/or railroads, not limited to somewhat limited soils, and outside areas zoned for manufacturing |

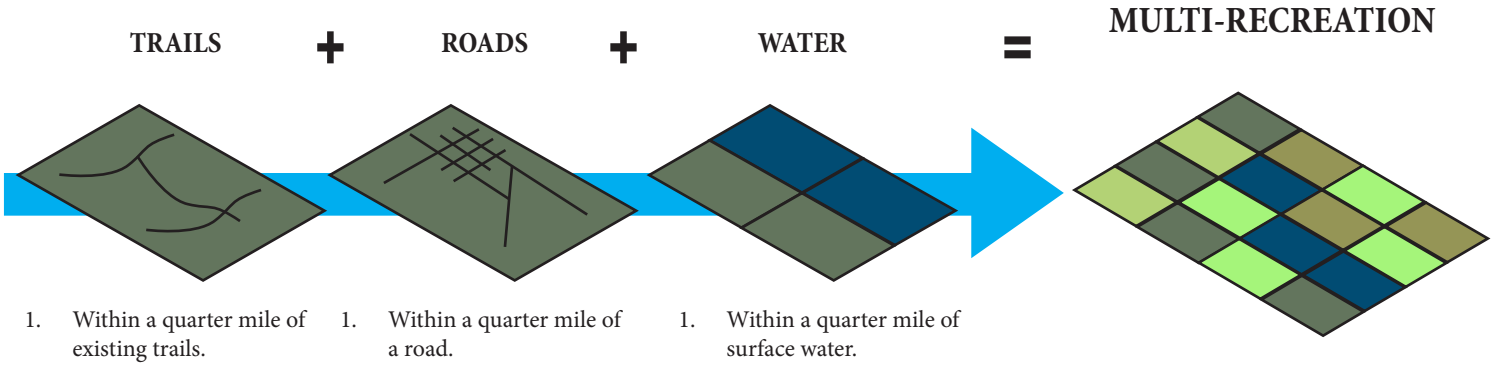
# MULTI-RECREATION ALLOCATION MODEL

## Description

Dispersed recreational activities such as camping, hiking, off-highway vehicle use, fishing, shooting, and biking attract residents and visitors to the watershed every year. Providing dispersed recreation opportunities can have positive benefits to the retail, hospitality, restaurant and convenience store businesses (Crompton, 2010). This model identifies the most suitable locations to expand dispersed multi-recreation access to meet the growing recreation needs of residents and visitors alike.

## Data, Layers, Criteria & Sources

The model was created by modeling data about existing trail locations, roads and surface water areas, including streams, reservoirs, wetlands and lakes.




1. Within a quarter mile of existing trails.
2. Not within a quarter mile of existing trails.

*Trails, Utah AGRC*

1. Within a quarter mile of a road.
2. Not within a quarter mile of a road.

*Road Centerline, Utah AGRC*

1. Within a quarter mile of surface water.
2. Not within a quarter mile of surface water.

*Lakes, Rivers & Streams, National Hydrography Dataset U.S. Geologic Survey; National Wetland Inventory, U.S. Fish & Wildlife Service*

## Discussion

Multi-recreational areas for hunting, camping, hiking, biking, and off-road driving exist throughout the watershed, including essential suitable areas near the Hardware Ranch Wildlife Management Area (see Figure 5.7). With the increasing population, future residents and visitors will have plenty of areas to recreate; however, multi-recreation activities must be balanced with the protection of wildlife and water to ensure that the area remains environmentally viable and attractive to recreationist.

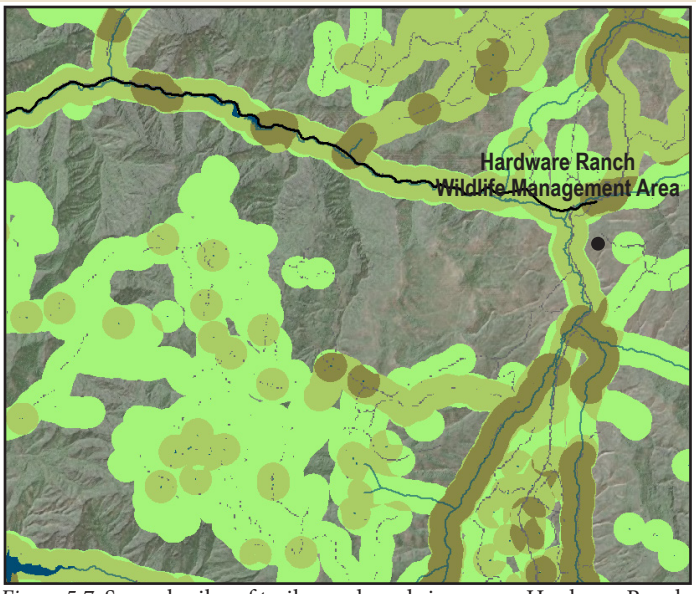
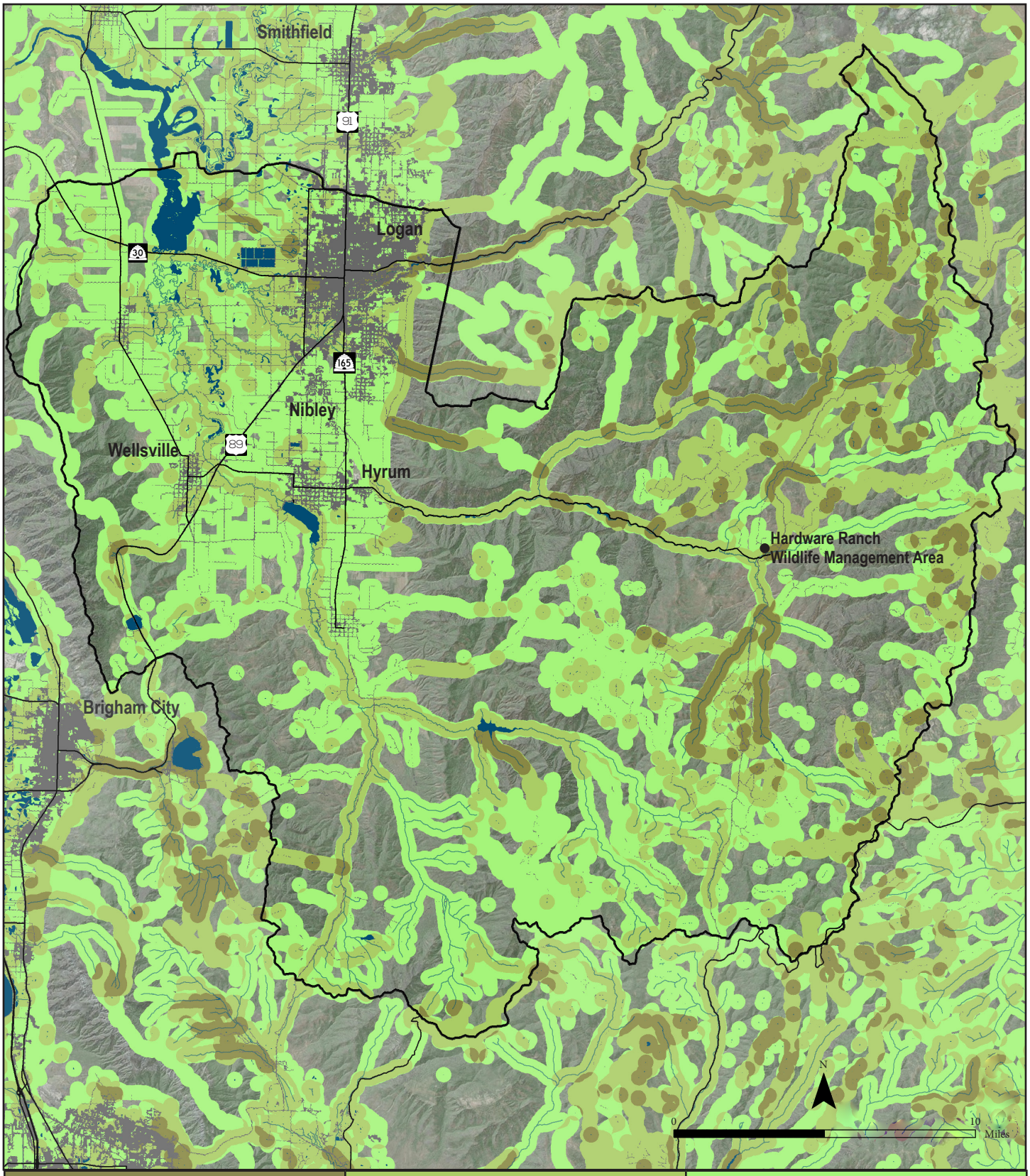



*Figure 5.7*. Several miles of trails, roads and rivers near Hardware Ranch are suitable locations to expand recreation areas for residents and visitors.




| TIER 1: ESSENTIAL | TIER 2: MODERATE | TIER 3: EXTENSIVE |
|---|---|---|
| Areas within 1/4 mile of roads, trails, and water | Areas with a combination of two of the three categories (roads, trails, and water) | Areas with one of the three categories (roads, trails, and water) |

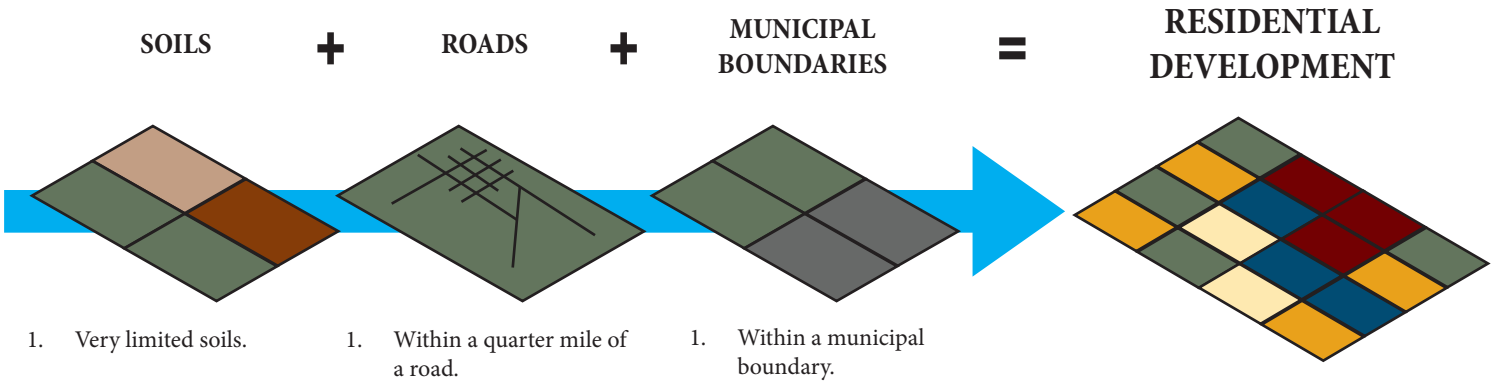
# RESIDENTIAL ALLOCATION MODEL

## Description

Increasing population will require an additional variety of single- and multi-family housing throughout the watershed. This model identifies the most suitable locations to develop residential housing.

## Data, Layers, Criteria & Sources

The model was created by combining soils best suited for buildings without basements, municipal boundaries, and areas within a quarter of mile of existing roads.




1. Very limited soils.
2. Somewhat limited soils.
3. Not limited soils.

*National Resource Conservation Service, Soil Survey Geographic Database*

1. Within a quarter mile of a road.
2. Not within a quarter mile of a road.

*Road Centerline, Utah AGRC*

1. Within a municipal boundary.
2. Not within a municipal boundary.

*City Boundaries, Utah AGRC*

## Discussion

After accounting for infill development, areas such as Nibley, Wellsville and Hyrum have great development potential due to the proximity to roads and buildable soil (see Figure 5.8). Population growth can be expected to increase more in these areas; however, this would cause a loss of farmland, which provides an economic base for the region and helps maintain the rural character of the valley.

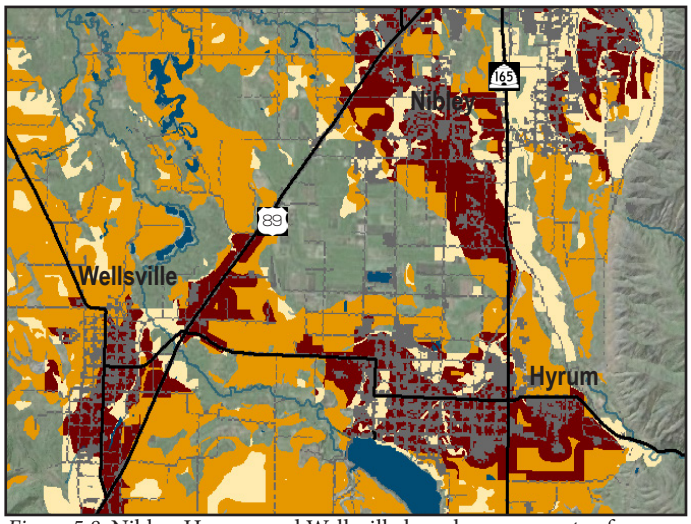
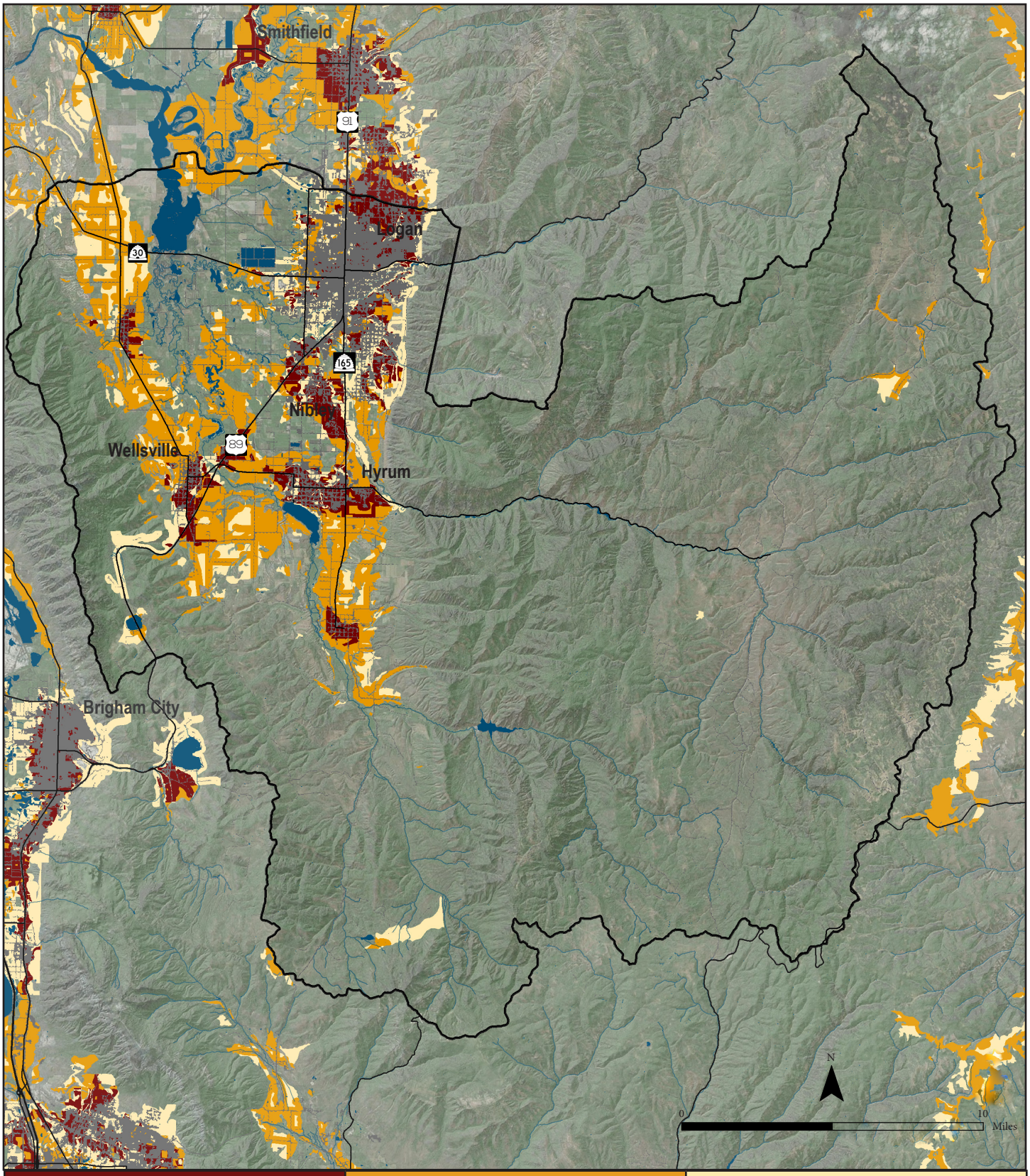



*Figure 5.8*. Nibley, Hyrum, and Wellsville have large amounts of suitable land for residential development.




| TIER 1: ESSENTIAL | TIER 2: MODERATE | TIER 3: EXTENSIVE |
|---|---|---|
| Areas with not limited soils and somewhat limited soils, within municipal boundaries, and within a 1/4 mile of a road. | Areas with not limited soils and/or inside municipal boundaries; or within 1/4 mile of a road with somewhat limited soils, within municipal boundaries, and within 1/4 mile of a road. Areas with not limited soils, somewhat limited and/or inside municipal boundaries or within 1/4 mile of a road. | Areas with very limited soils, inside municipal boundaries, and within a 1/4 mile of a road. Areas with somewhat limited soils, and no other requirements. |

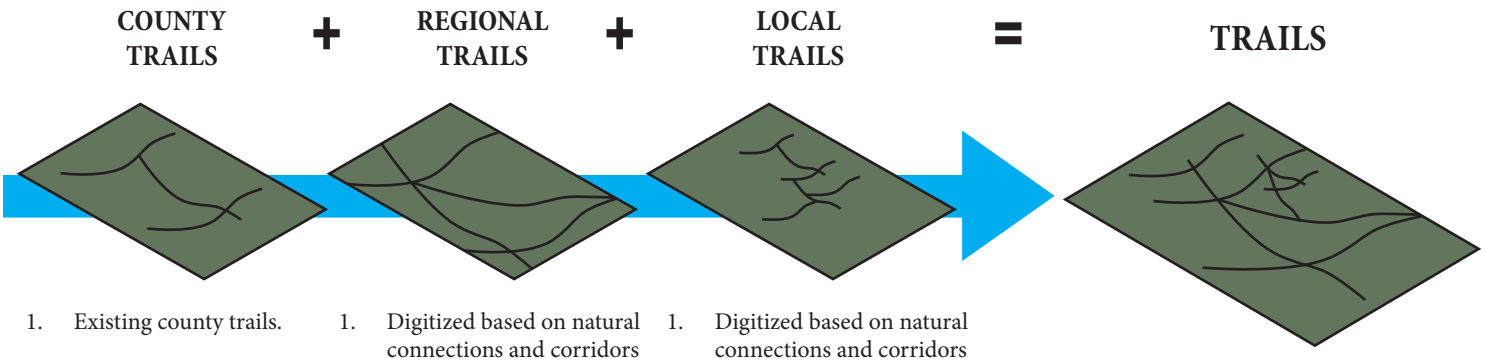
# TRAILS Allocation Model

## Description

Recreation has a positive impact to the regional economy (Gefre, 2017). Trails are an important aspect of recreation because they support activities such as hiking, biking, wildlife viewing and other forms of recreation. Trails also provide opportunities for people to commute to work or school, thereby reducing automotive trips and improving air quality. This model helps identify the most suitable current and future trail locations to support non-automotive recreation and commuting.

## Data, Layers, Criteria & Sources

The model was created by combing: existing and proposed county trails, proposed trails that would connect the study area with other recreation hubs in the northern Utah region (e.g., the Wasatch Mountain Range), and additional proposed trails for transport and connections within the study area (i.e., local trails).




1. Existing county trails.
2. Proposed county trails.

*Trails, Bear River Association of Governments*

1. Digitized based on natural connections and corridors following major streams, tree cover, existing paved and nonpaved roads, and connections to existing trails from other regions.

1. Digitized based on natural connections and corridors following minor streams, tree cover, existing paved and nonpaved roads, and connections to local mountain peaks.

## Discussion

As future growth expands across the watershed it is important to provide non-automotive trail connections for recreationist and commuters in the valley and the mountains. By following existing streams and connecting to prominent features such as peaks, the watershed can expand its current network of trails. Doing so will provide new transportation and recreational opportunities.

The southern half of the study area is underserved by trails, in comparison to the northern half. Developing trails in this area that connect back to southern Cache Valley would provide new, local recreational opportunities for these residents (see Figure 5.9). Extending these new trails into the northern half of the study area could provide alternative transportation connections between these regions. However, most of the land in the south end of the watershed is privately owned. As such, expanding trails into these areas would likely require public-private partnerships.

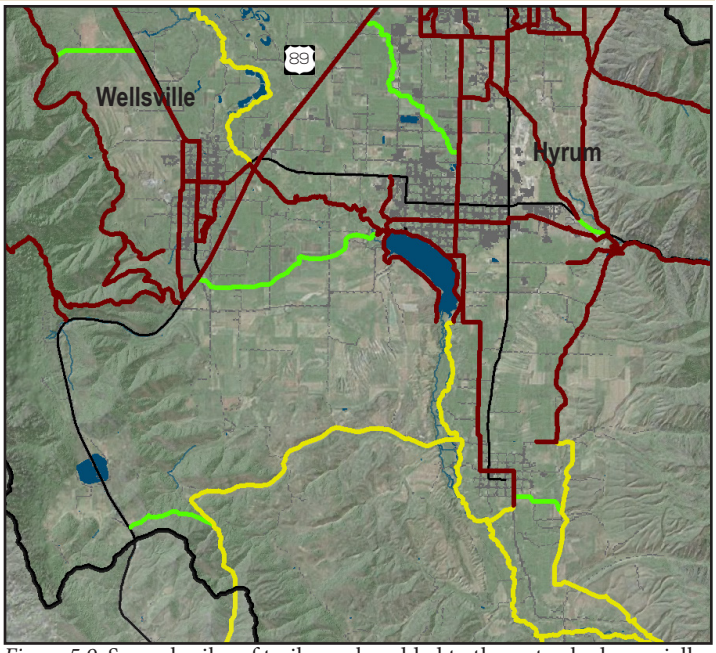
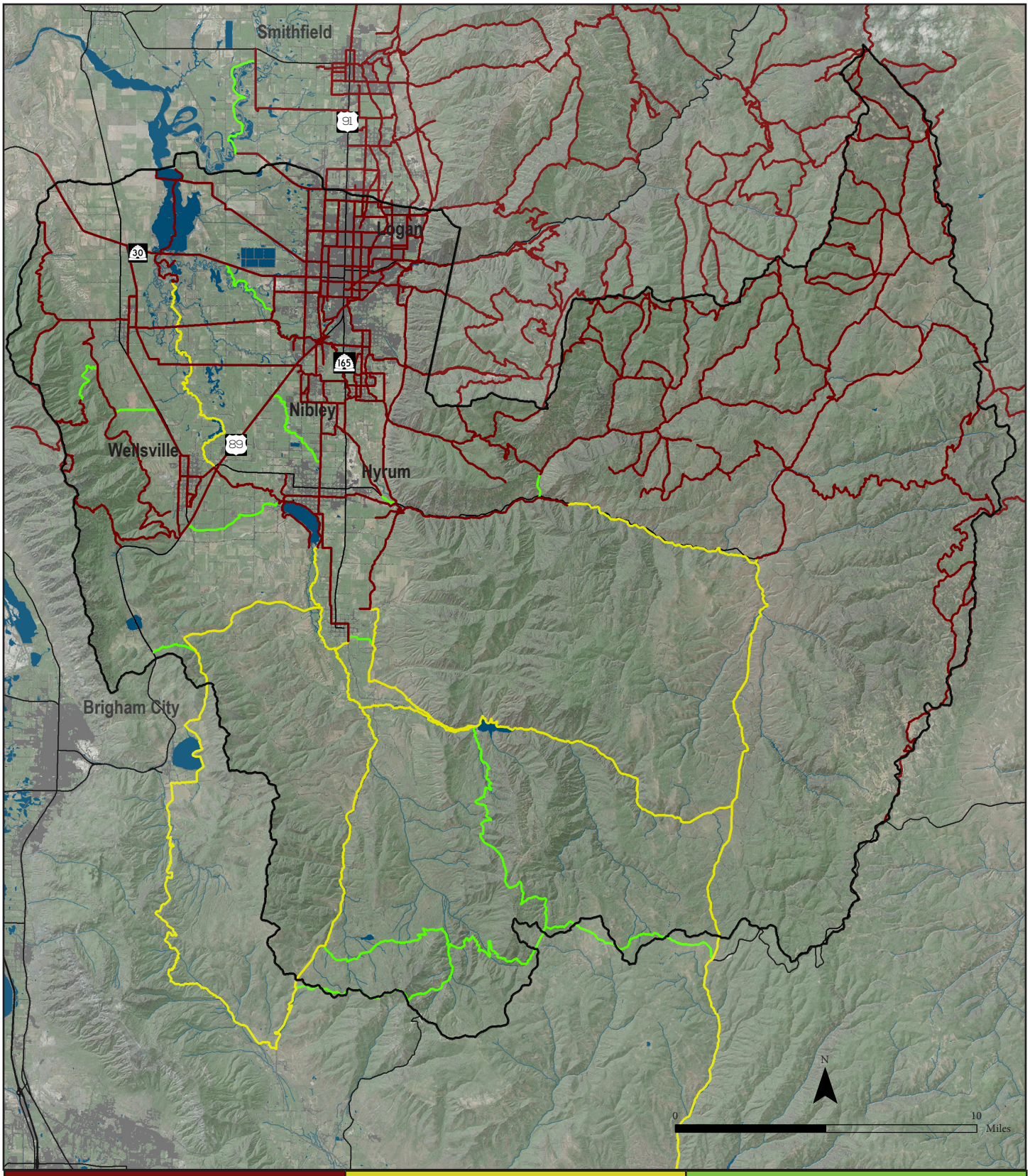



*Figure 5.9.* Several miles of trails can be added to the watershed especially in the southern portion connecting to areas outside the watershed like Ogden Valley.



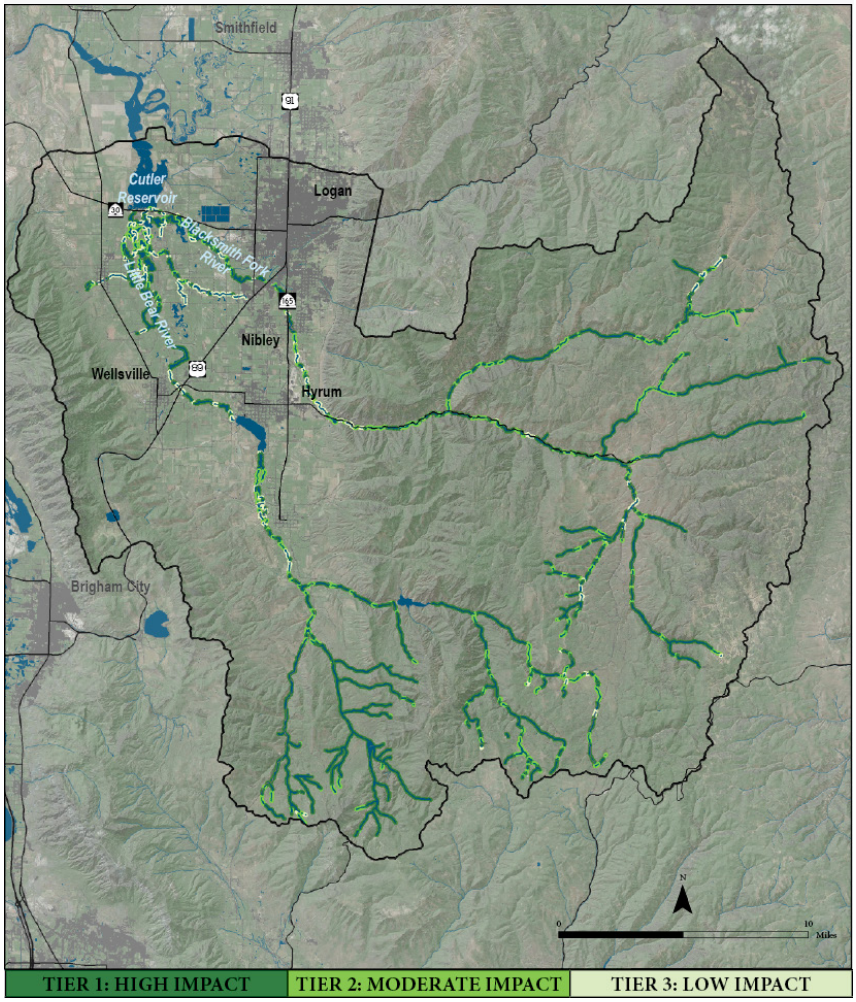

| TIER 1: ESSENTIAL | TIER 2: MODERATE | TIER 3: EXTENSIVE |
|---|---|---|
| Existing and proposed county trails. | Regional trail system connecting existing and proposed county trails to the region and along major river corridors. | Connector trails between the existing and proposed county trails and regional trails, and trails leading to major mountain peaks in the watershed. |

# ASSESSMENT MODELS

Assessment models identify areas that are important for the critical biophysical and biophysically-determined cultural systems of the study area. Biophysically determined cultural systems are those that depended predominantly on biophysical factors (e.g., vegetation cover and solar radiation), rather than engineered human systems, such as road networks and municipal zoning. In this way, assessment models are used in the Evaluations section of this report to assess the impacts of the proposed future land uses (i.e., the alternative futures).

Each assessment model includes up to three tiers: (1) high impact, (2) moderate impact, and (3) low impact. The tier 1 *high impact* category of each model includes those areas that are the most biophysically suitable for the system represented by each model. As such, non-complimentary land uses in these areas will have a high impact on the functions of those systems. The tier 2 *moderate impact* category of each model includes areas that have high biophysical suitability for the function of that system, but which are not critical to its essential operations. As such, non-complimentary land uses in these areas will have a moderate impact on the functions of that system. Finally, the tier 3 *low impact* category of each model includes all other areas that have some suitability for the function of that system. As such, non-complimentary land uses in these areas will have a low impact on the overall functions of that system.

## River Ecosystems Assessment Model




*(Left, top to bottom) The biophysical conditions of sinuosity, beaver dam potential and the presence of riparian vegetation determine current condition in the River Ecosystems assessment model.*

# Assessment model index

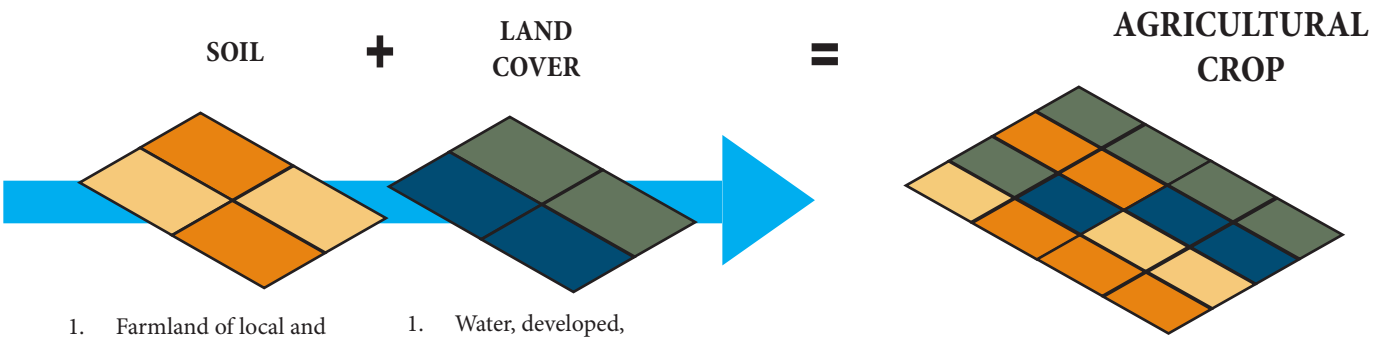
# AGRICULTURAL CROP ASSESSMENT MODEL

## Description

Agricultural production currently accounts for about 26% of the economy in the area (UACD, 2011). The primary crops produced in the area include fodder crops such as corn, alfalfa and other hay, as well as cereal grains such as oats, barley and wheat (USU Extension, 2006). These crops also largely account for the acres of farm fields that contribute to the rural character of Cache Valley. As population has expanded outwards, agricultural land has been developed for residential and commercial purposes. This model identifies current areas that produce agricultural crops and have fertile soils, in order to assess the impacts of future land uses allocations on the current agricultural production and character of the study area.

## Data, Layers, Criteria & Sources

The model was created by combing soil types and land cover data.




1. Farmland of local and statewide importance
2. Farmland of unique importance
3. Prime farmland if drained and/or irrigated

*National Resource Conservation Service, Soil Survey Geographic Database*

1. Water, developed, barren, forest, wetlands, shrubland, herbaceous
2. Planted/cultivated

*U.S. Geologic Survey, National Land Cover Database*

## Discussion

Several large areas of prime agricultural cropland are located throughout the southern, western and eastern portions of Cache Valley (see Figure 5.11). These areas contain cropland of statewide and local importance. Agricultural crop production has a strong presence in the valley, and if protected it would continue to contribute a significant portion to the regional economy and rural character that residents value. However, as population continues to grow outward, pressure to develop the cropland will increase, especially in areas around Wellsville, Logan and Hyrum.

This model is also used as an allocation model in order to allocate future agricultural crop production based on present use and soil conditions (see p. 19).

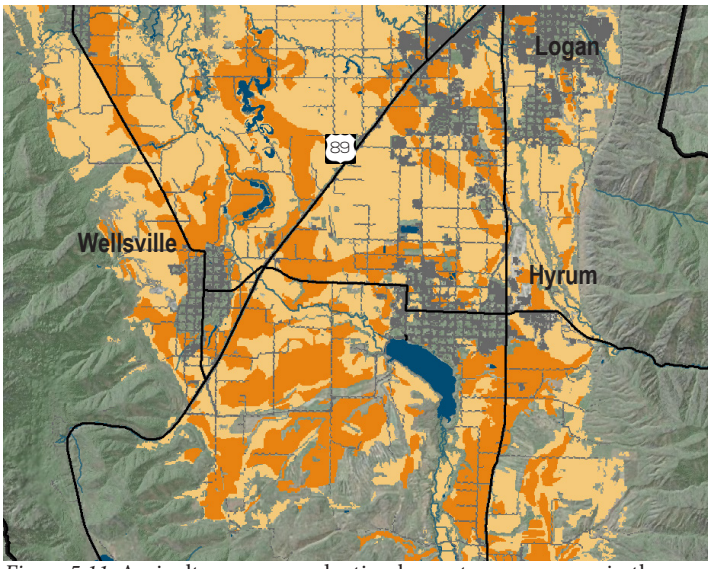
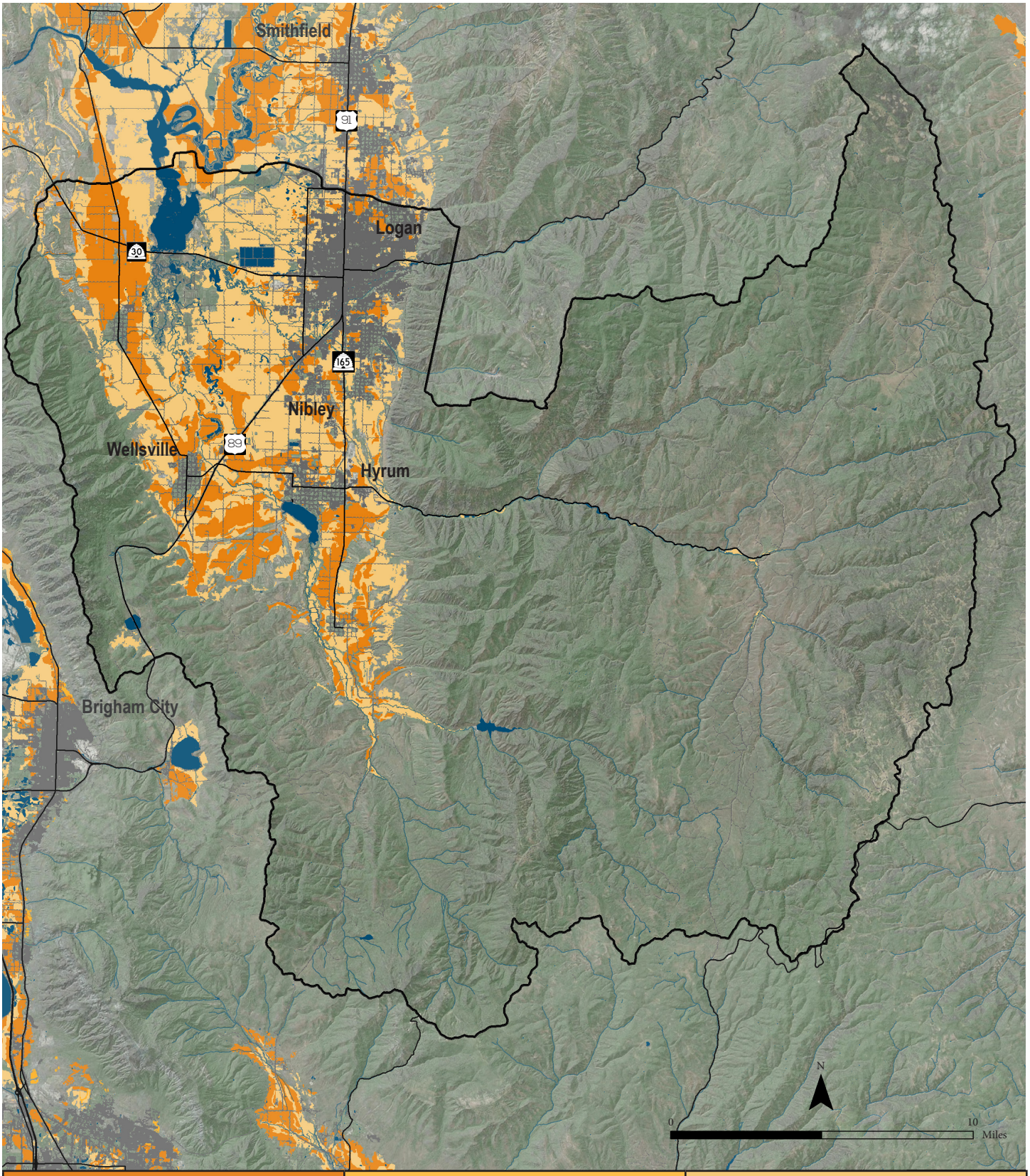



*Figure 5.11.* Agriculture crop production has a strong presence in the south and eastern portions of Cache Valley.




| TIER 1: HIGH IMPACT | TIER 2: MODERATE IMPACT | TIER 3: LOW IMPACT |
|---|---|---|
| Areas of prime farmland | Areas unique importance farmland | Areas of statewide and local important farmland |

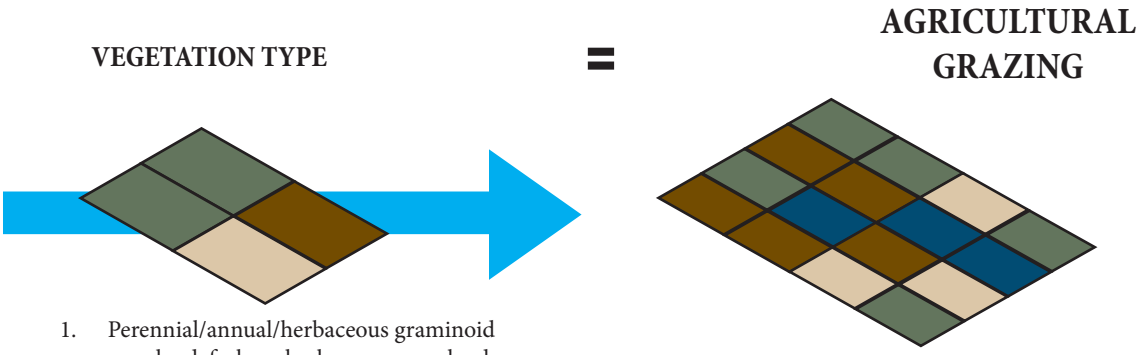
# AGRICULTURAL GRAZING ASSESSMENT MODEL

## Description

As with crop production, grazing has been an important component of the agricultural industry of the watershed since the early settlement of the area (Cache Valley Visitors Bureau, 2010). As such, it is closely related to the western heritage and rural character of the study area. This model assesses how proposed future developments will affect the most suitable vegetation for sheep, cattle, and other grazing livestock to continue to support the local economy and western heritage of the watershed.

## Data, Layers, Criteria & Sources

This model was created by reclassifying vegetation land cover data.




1. Perennial/annual/herbaceous graminoid grassland, forb, or herbaceous grassland vegetation.
2. Sparse vegetation/tree canopy
3. Sparse vegetation/tree canopy, or shrubland

*LANDFIRE Vegetation Cover, U.S. Forest Service and the U.S. Dept. of the Interior.*

## Discussion

Very good and good vegetation can be found throughout the valley and mountains of the watershed to support agricultural grazing. Sustaining high quality forage is dependent on practicing best management strategies, especially in riparian areas (Flieschner, 1994). The region in proximity to the Hardware Ranch Wildlife Management Area includes important grazing grounds for current land owners; however, wildlife such as sage grouse and elk compete for habitat and forage in this vegetated mountain plateau (see Figure 5.12). Additionally, grazing lands in the valley will have to compete with crops production and future development as the population increases.

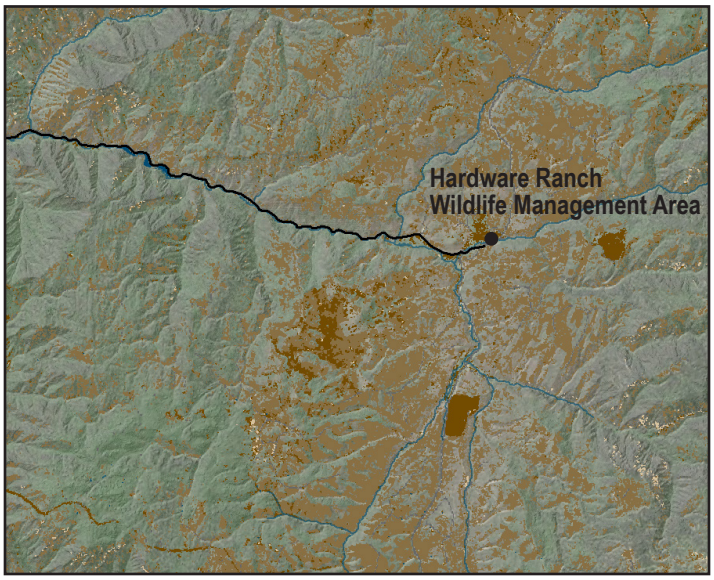
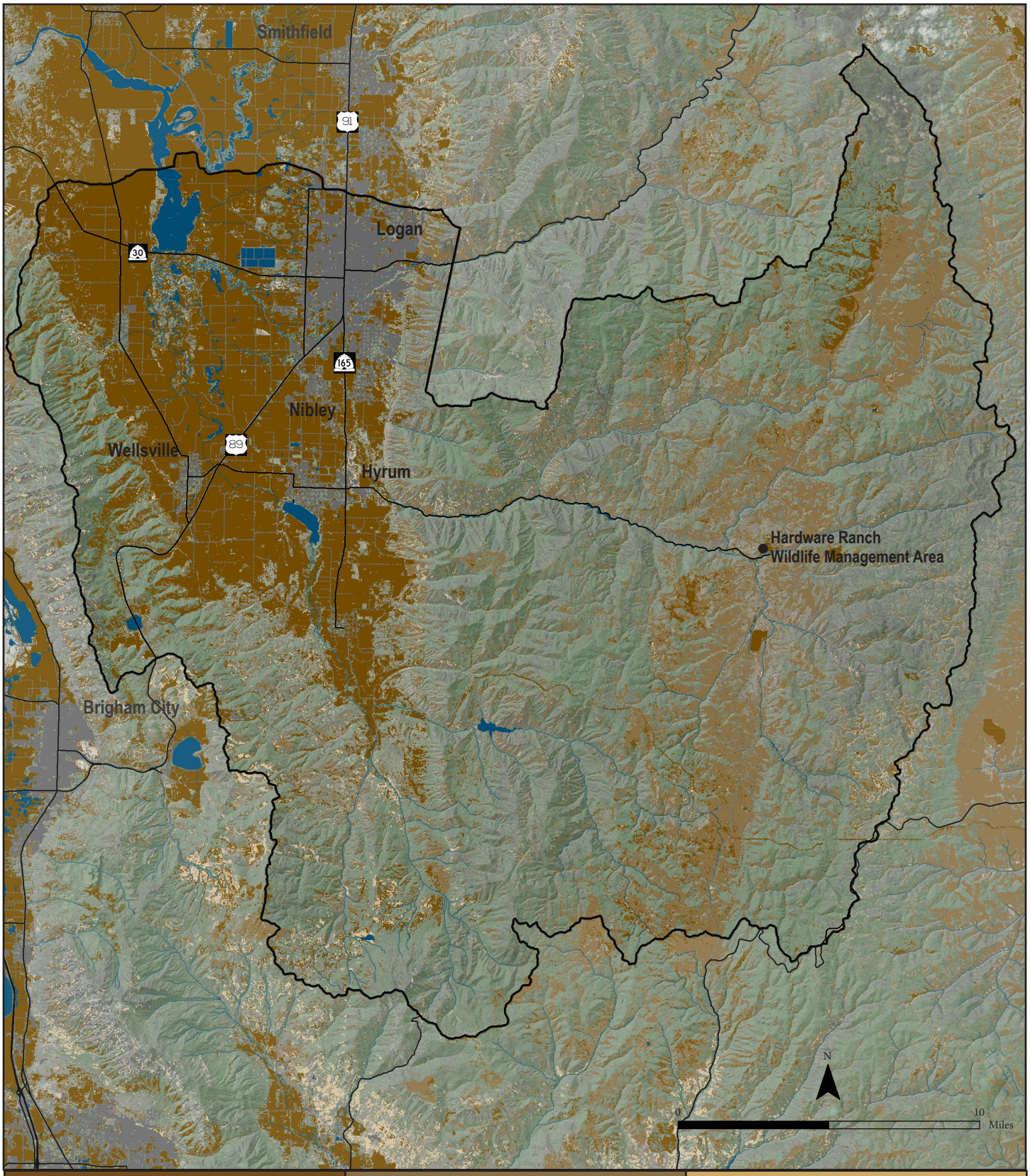



*Figure 5.12.* Although conditions would support grazing in the valley, policy and property ownership dictate that most grazing take place in the mountains.




| TIER 1: HIGH IMPACT | TIER 2: MODERATE IMPACT | TIER 3: LOW IMPACT |
|---|---|---|
| Areas with perennial graminoid grassland, annual graminoid, forb, or herbaceous grassland vegetation | Areas with perennial graminoid steppe vegetation | Areas with sparse vegetation, sparse tree canopy, or shrub land vegetation |

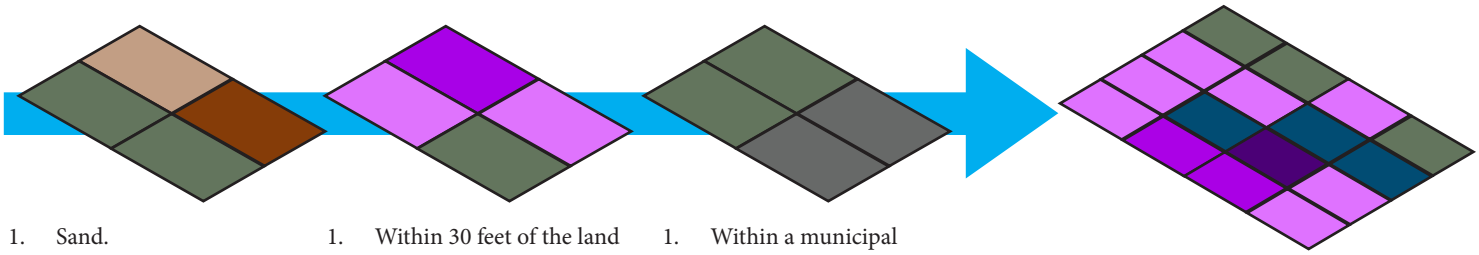
# GEOTHERMAL ENERGY ASSESSMENT MODEL

## Description

Geothermal energy is thermal energy emitted from the earth that can be captured and used to heat buildings. Geothermal energy can be harvested on a distributed scale via residential geothermal heat pumps, which serve as a reliable and inexpensive energy source over multiple decades (Lund et al., 2004). The use of geothermal heat pumps reduce natural gas heating in the watershed and would help improve local air quality. This model is used to assess whether proposed future developments will be in a suitable location for harnessing geothermal energy.

## Data, Layers, Criteria & Sources

The model was created by combing soil types, areas with a shallow water table and municipal boundaries.




1. Sand.
2. Loam.
3. Clay.

*National Resource Conservation Service, Soil Survey Geographic Database*

1. Within 30 feet of the land surface.
2. More than 30 feet from the land surface.

*National Resource Conservation Service, Soil Survey Geographic Database*

1. Within a municipal boundary.
2. Not within a municipal boundary.

*City Boundaries, Utah AGRC*

## Discussion

With many suitable locations in the watershed for geothermal, there is great potential for it to augment other heat energy sources for businesses and homes. In general, the areas with the most thermally conductive soils are located near water bodies such as the Cutler Reservoir (see Figure 5.13). Focusing on retrofitting development in highly conductive areas will produce the quickest and most cost effective shift to geothermal energy. Keeping future development within the boundaries of highly conductive soils will allow future development to be more sustainable.

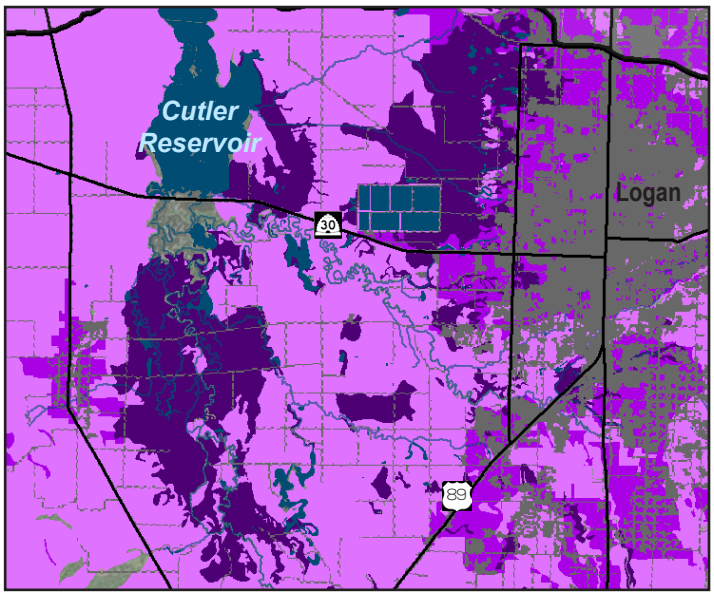
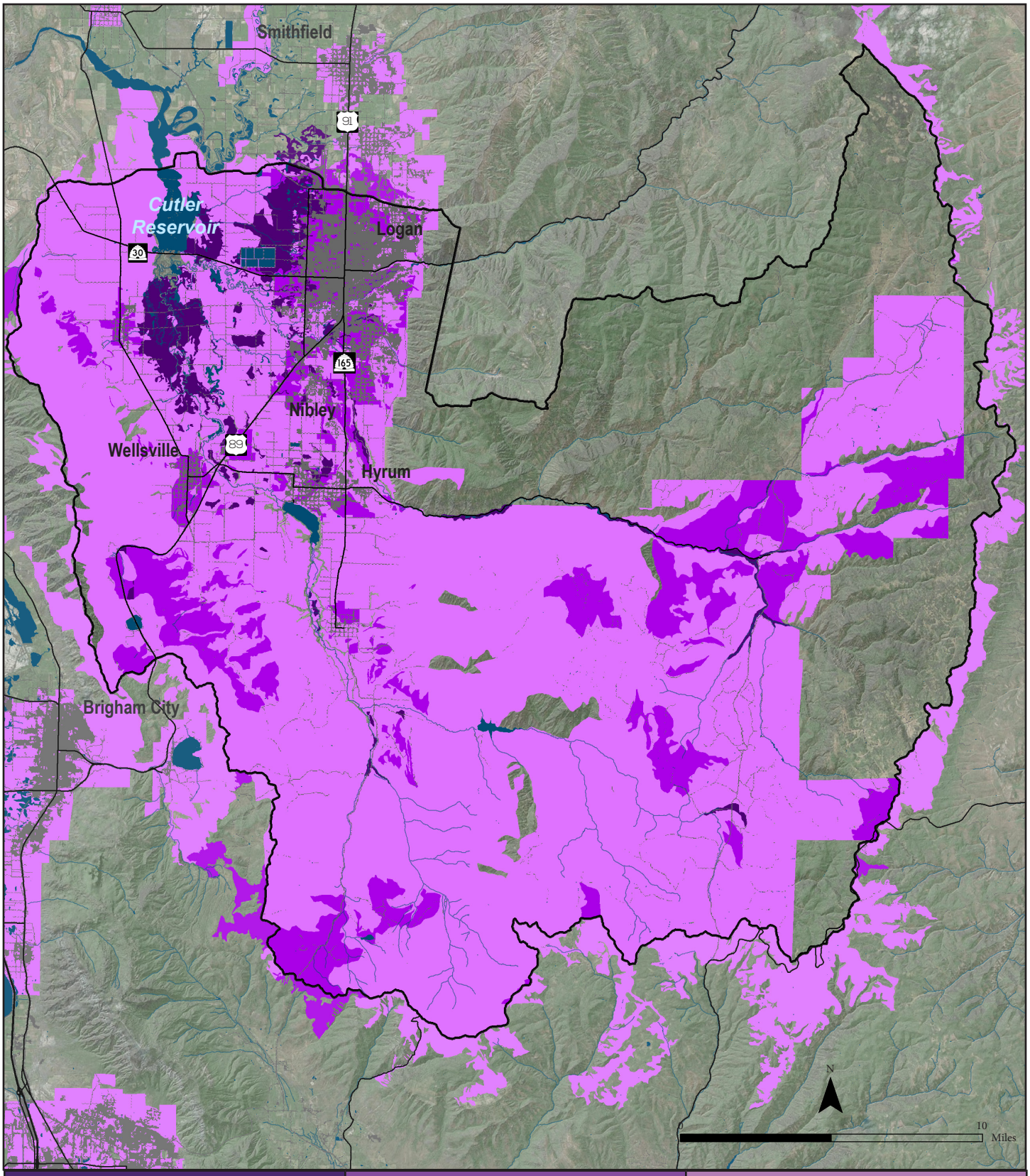



*Figure 5.13.* Geothermal conductivity is greatest near the Cutler Reservoir




| TIER 1: HIGH IMPACT | TIER 2: MODERATE IMPACT | TIER 3: LOW IMPACT |
|---|---|---|
| Areas where development can be retrofitted to utilize soils with very high thermal conductivity | Areas which can be developed in the future to utilize soils with very high thermal conductivity | Areas with soils suitable for geothermal use |

# GROUNDWATER ASSESSMENT MODEL

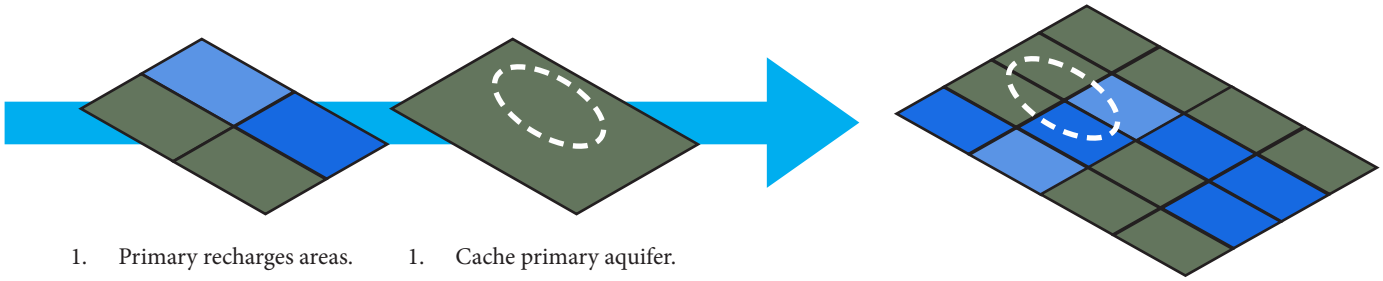
## Description

The watershed benefits from groundwater stored in aquifers throughout Cache Valley (J.U.B., 2013). The aquifers provide water for municipal and industrial uses. With population growth, developments may expand over recharge zones and runoff from roads may increase. As such, the threat of poor groundwater water quality and quantity will increase. This model is used to assess the impacts of proposed future developments on groundwater quality and quantity, and is based on the thickness of the confining layers between the surface and the principal aquifer. Confining layers consist of low-permeability sediment or rock above or below an aquifer (e.g. bedrock).

## Data, Layers, Criteria & Sources

The model was created by overlaying primary and secondary aquifer recharge zones with the primary aquifer for the watershed. Primary recharge areas have confining layers no thicker than 20 feet between the land surface and the surface water table and are highly susceptible to groundwater contamination, such as fertilizer from farm fields or runoff from roads. Secondary recharge areas have confining layers thicker than 20 feet.

**AQUIFER RECHARGE ZONES** + **AQUIFER** = **GROUNDWATER**



1. Primary recharges areas.
2. Secondary recharge areas.

*Recharge Zones, Utah AGRC*

1. Cache primary aquifer.

*Anderson et al., 1994*

## Discussion

Groundwater recharge areas are important to consider in future development plans to ensure clean groundwater for continued municipal and industrial uses. The foothills and valley-facing mountain slopes of the Bear River and Wellsville Mountains, such as those present in Logan and Millville, are the most suitable places for recharging the aquifers, due to the thinner confining layers present in these areas (see Figure 5.14). This also makes these areas more susceptible to groundwater contamination. Because the eastern foothills are attractive for future residential development and roads, protecting these areas for recharging clean groundwater will be important for future growth and development in the watershed.

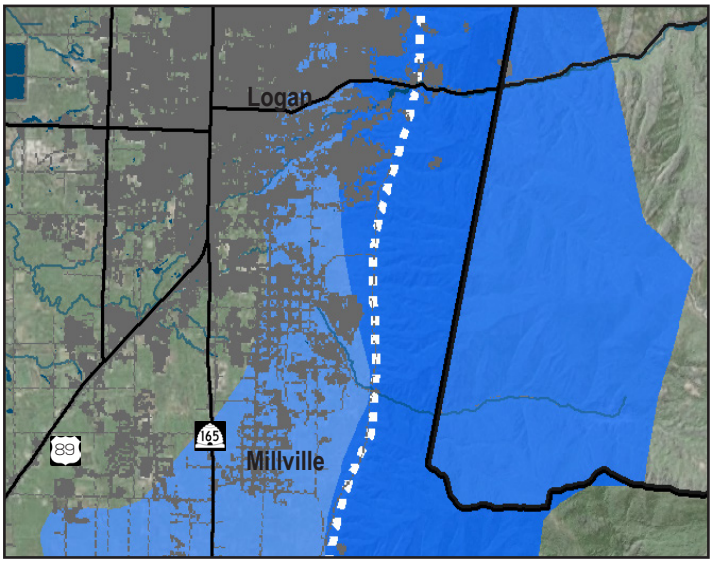
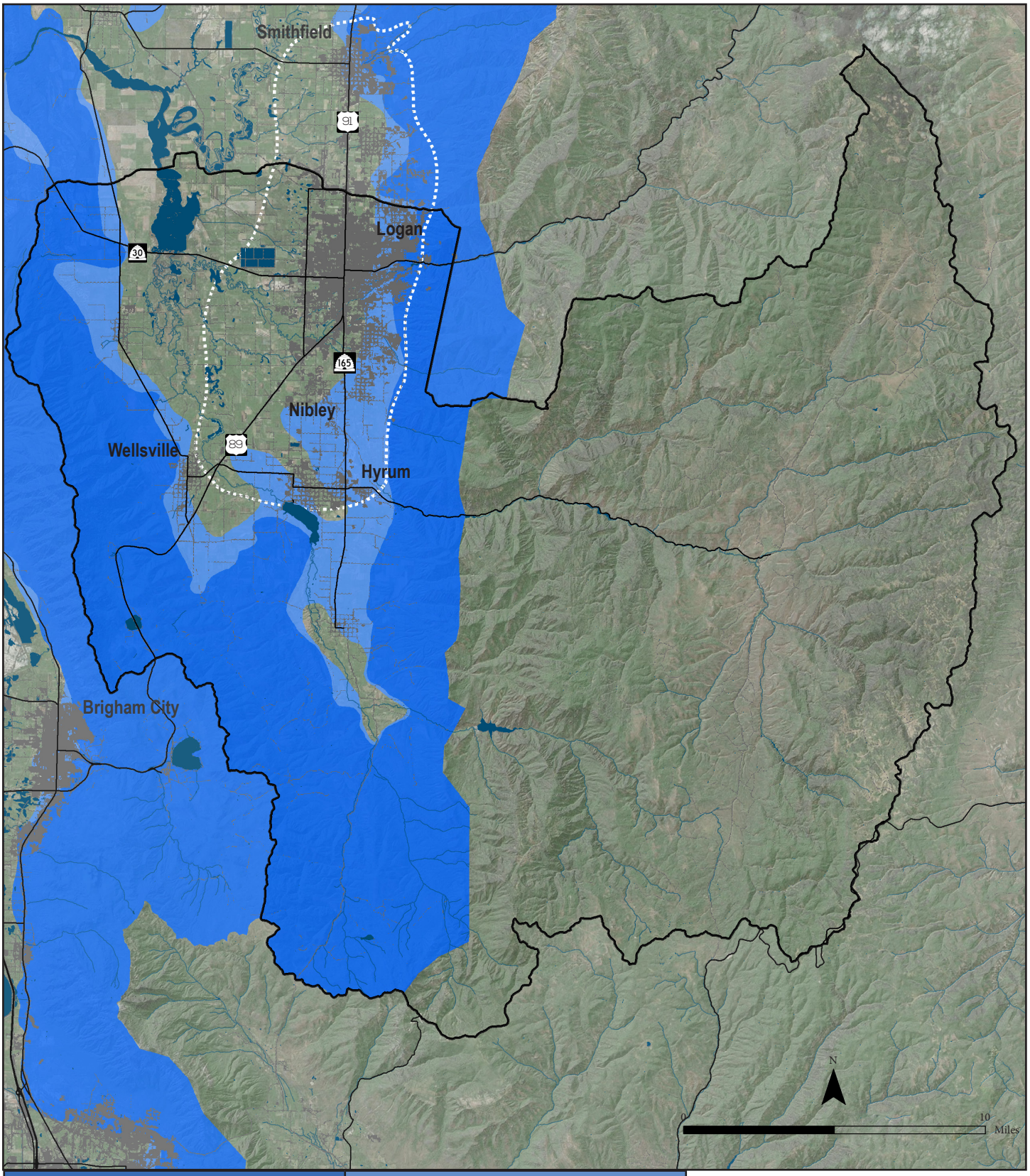



*Figure 5.14.* Aquifer recharge zones are primarily located in the bench areas of the watershed




| TIER 1: HIGH IMPACT | TIER 2: MODERATE IMPACT |
|---|---|
| Areas where there is a confining layer of 20 feet or less between the land surface and the surface water table | Areas where there is a confining layer of greater than 20 ft between the land surface and surface water table |

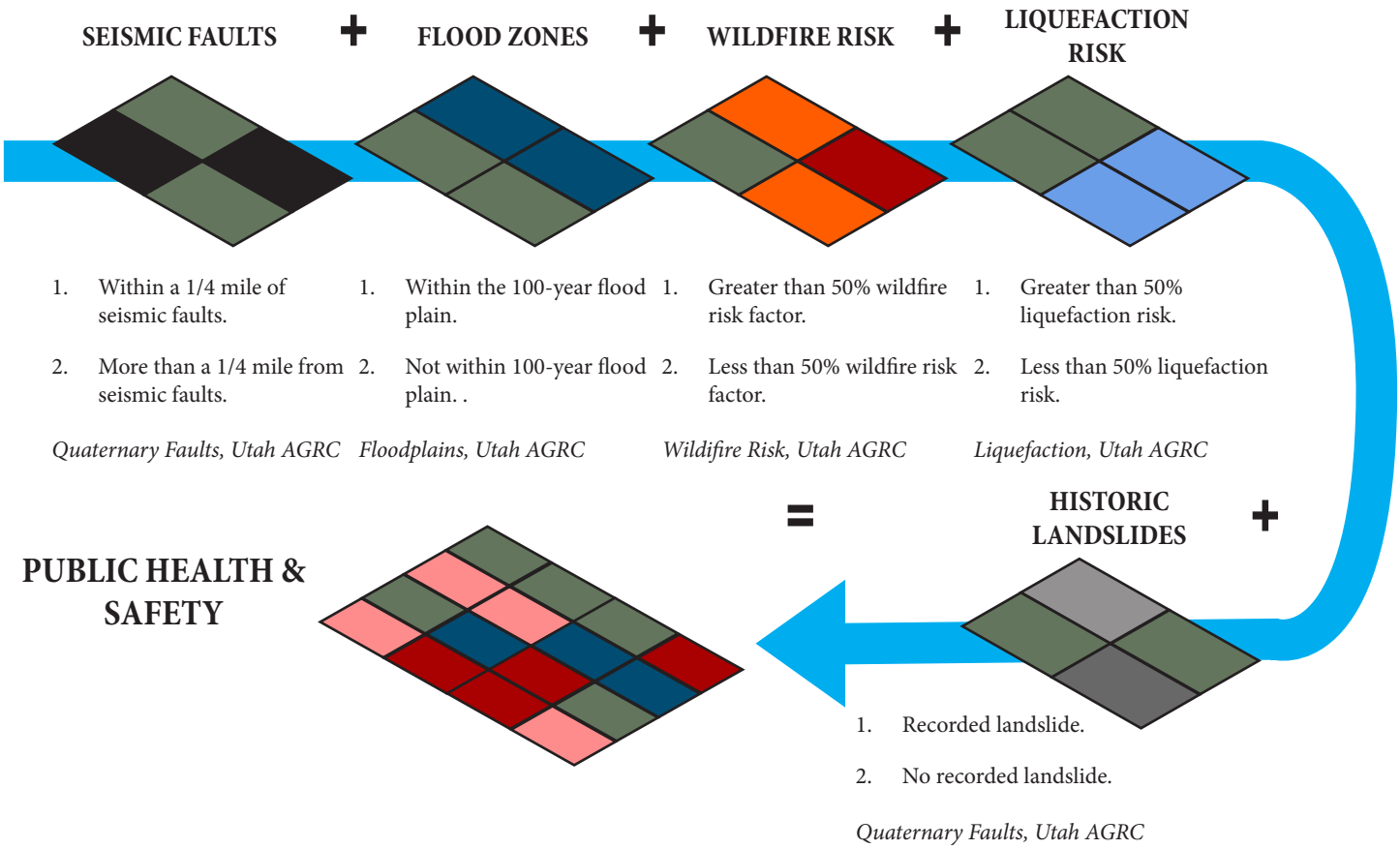
# PUBLIC HEALTH & SAFETY ASSESSMENT MODEL

## Description

Natural hazards, such as flooding, earthquake, wildfire and landslides pose a risk to public health and safety. To reduce liability, injury and death, it is important to ensure that development is restricted in these areas. This model identifies the areas where persons and property are at risk due to natural disasters, including earthquakes, flooding, wildfire, liquefaction and landslides.

## Data, Layers, Criteria & Sources

The model was created by combining seismic fault areas, flood zones, wildfire risk areas, liquefaction risk areas and historic landslide locations.




## Discussion

As the population increases, demand for developable land may move into areas of higher risk to public health & safety. High risk areas such as Cutler Reservoir and along the lower Little Bear River are prone to flooding and liquefaction, making these areas more suitable for agriculture or conservation than they are for permanent development (see Figure 5.15). Despite the risk of earthquakes, landslides and wildfires, residents continue to build on the foothills surrounding Cache Valley, where there are fault lines and wildfire risk adjacent at the wildland urban interface.

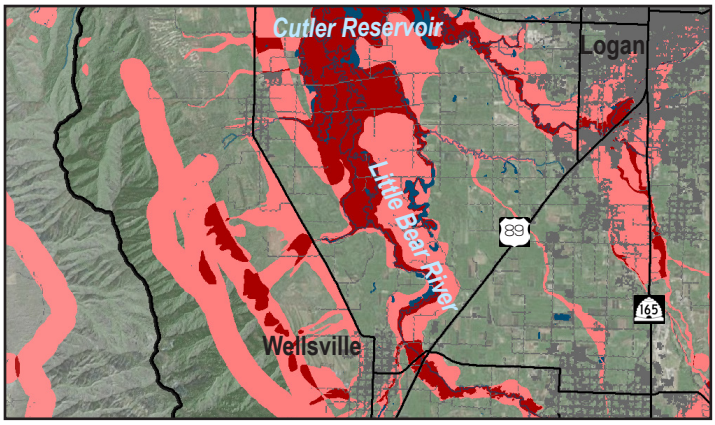
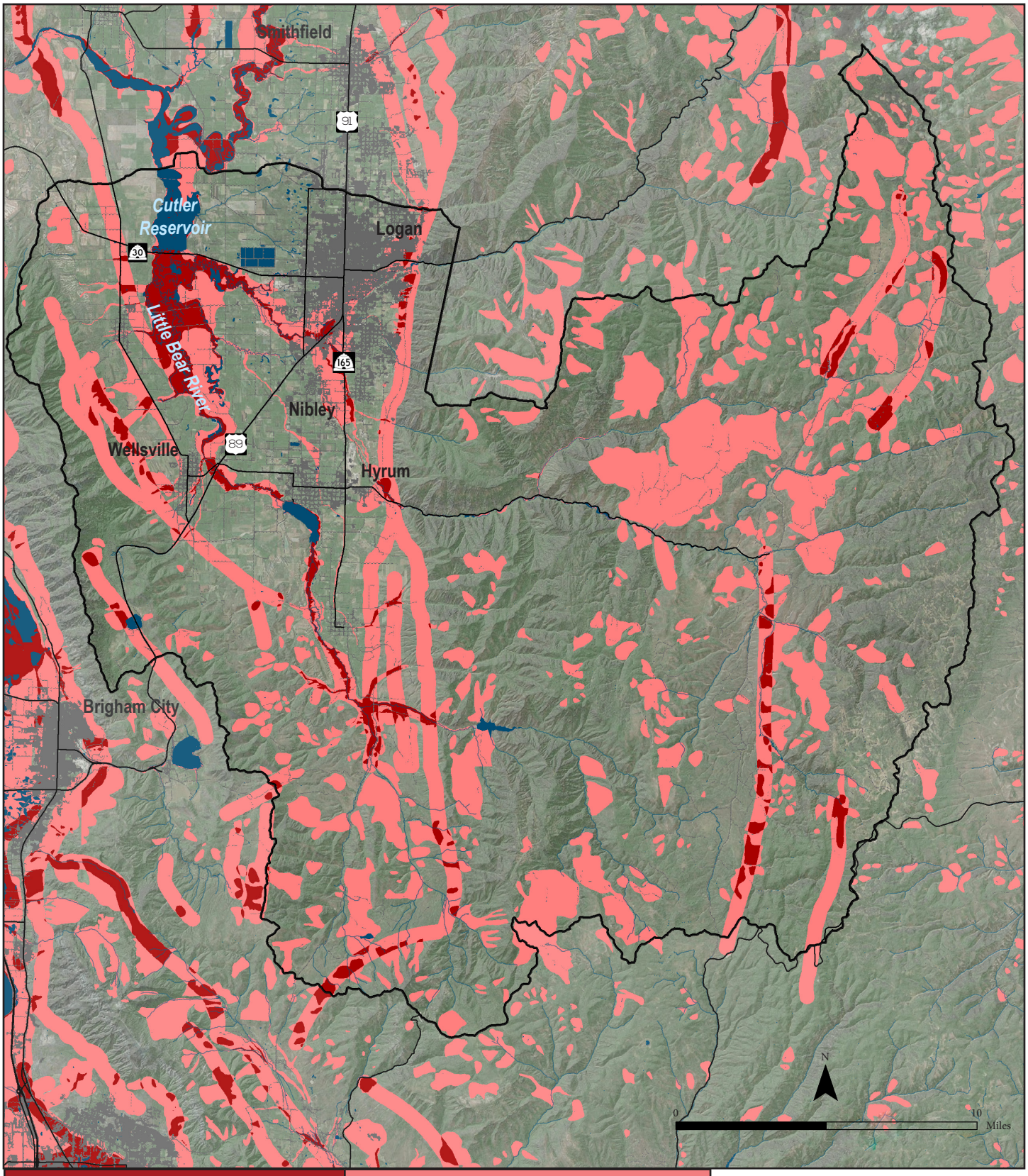



*Figure 5.15.* High impact areas are concentrated near the Cutler Reservoir.




| TIER 1: HIGH IMPACT | TIER 2: MODERATE IMPACT |
|---|---|
| Areas at risk for two or more natural disasters (earthquake, flooding, wildfire, liquefaction, or landslide) | Areas at risk for only one natural disaster |

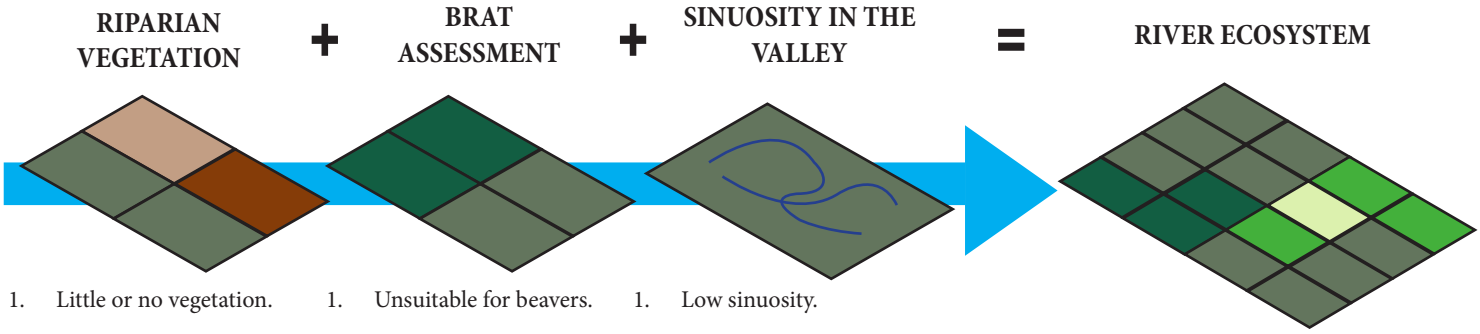
# RIVER ECOSYSTEM ASSESSMENT MODEL

## Description

River ecosystems provide fish and wildlife habitat, clean water and recreational opportunities for the residents of the study area. In general, slow moving, low turbidity and cool water conditions support these opportunities in the mountains and valley. In this way, this model is used to assess the impacts of proposed future land uses on the capability of river ecosystems to provide habitat, water quality and recreational opportunities, such as fishing for the area's iconic Bonneville cutthroat trout.

## Data, Layers, Criteria & Sources

In general, river sinuosity—the curve, bend or meander in a stream—slows water movement and so decreases turbidity. Similarly, beaver dams slow water movement and also decrease turbidity by filtering sediment. Finally, vegetation slows water movement and also creates shade canopy. Therefore, this model was created by assessing riparian vegetation, the Beaver Restoration Assessment Tool (BRAT) and the sinuosity of the river meanders in the valley.




1. Little or no vegetation.
2. Adjacent riparian vegetation.
3. Robust and/or canopy riparian vegetation.

*ESRI satellite imagery*

1. Unsuitable for beavers.
2. Beaver habitat possible with restoration.
3. Established beaver populations.

*BRAT (Dr. Joe Wheaton, USU Watershed Sciences Department), Utah AGRC*

1. Low sinuosity.
2. Mid or high sinuosity.

## Discussion

In general, most of the watershed has average to prime river ecosystem habitat, especially in the upper reaches of the watershed and the undeveloped stretches of the Little Bear River (see Figure 5.17). Sub-average habitat is mostly present near residential or commercial developments, where stream banks may have been rerouted and/or fortified, as well as adjacent to industrial-scale agricultural activities, such as large dairy farms.

As development expands outward from the cities, stretches of the Little Bear and Blacksmith Fork Rivers with prime habitat may be at risk of habitat degradation. This would threaten the viability of these stretches of the river to support wildlife and provide recreational opportunities.

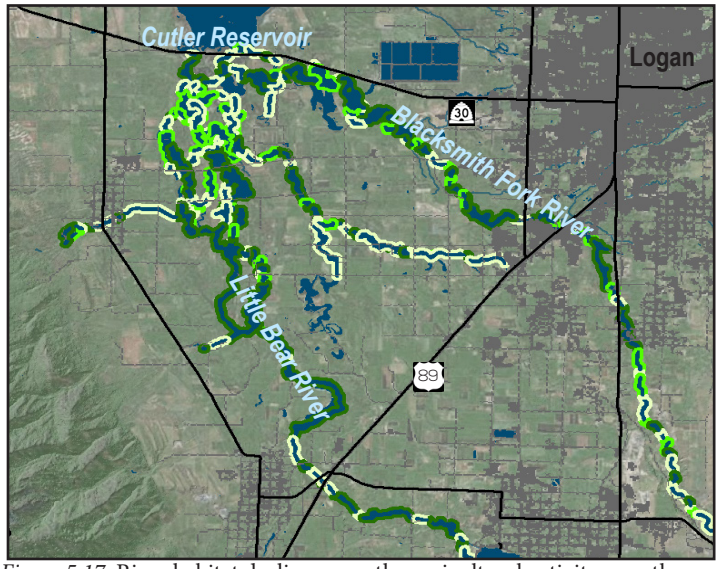
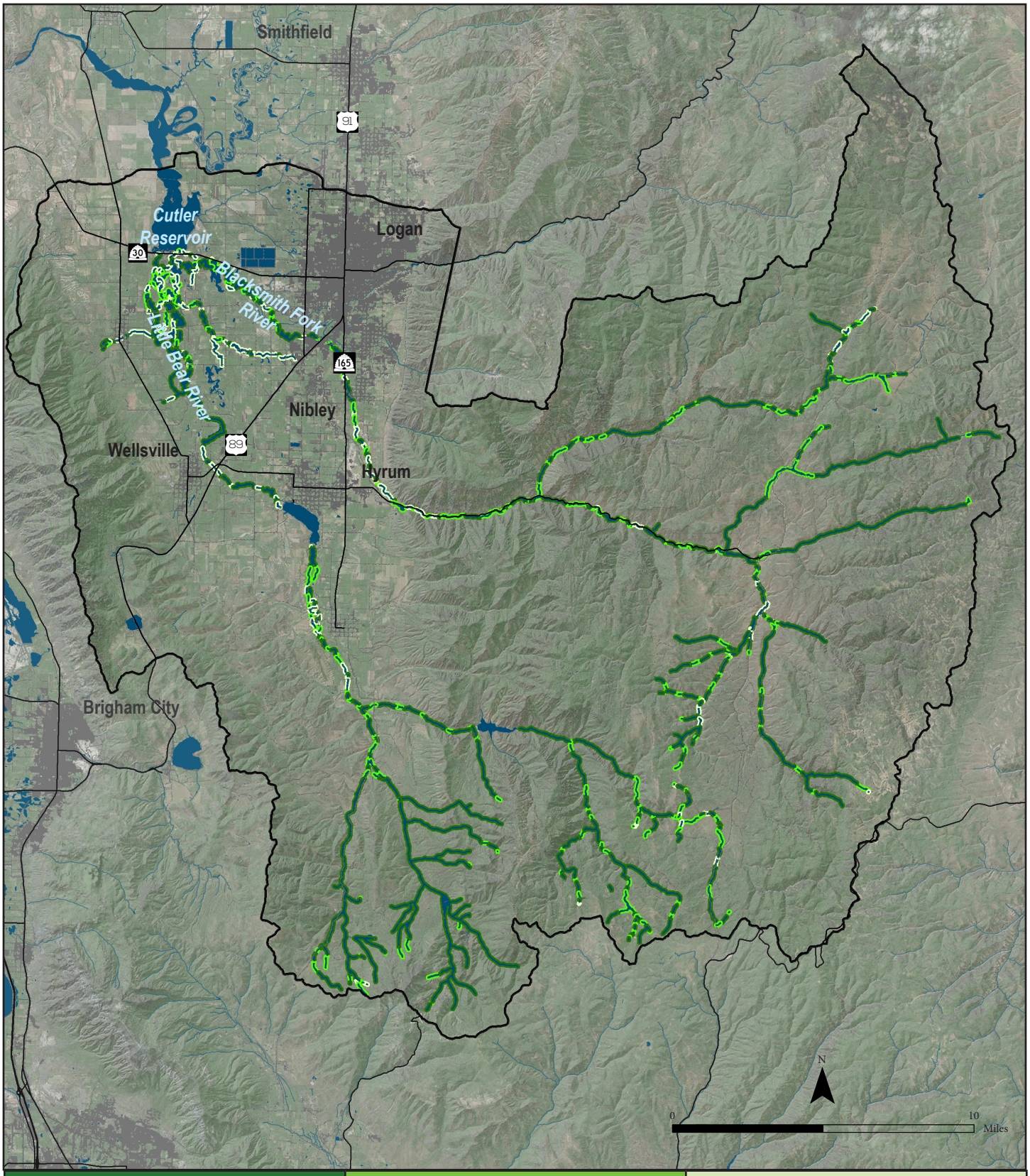



*Figure 5.17*. River habitat declines near the agricultural activity near the Cutler Reservoir.




| TIER 1: HIGH IMPACT | TIER 2: MODERATE IMPACT | TIER 3: LOW IMPACT |
|---|---|---|
| Areas with high occurrence of in-valley sinuosity, high potential for and/or occurrence of beaver dams; and high instance of robust riparian vegetation | Areas with medium occurrence of in-valley sinuosity, low occurrence and/or high potential for beaver dams; and high chance of some riparian vegetation | Areas with low occurrence of in-valley sinuosity; low occurrence and/or potential for beaver dams; and sparsely distributed riparian vegetation |

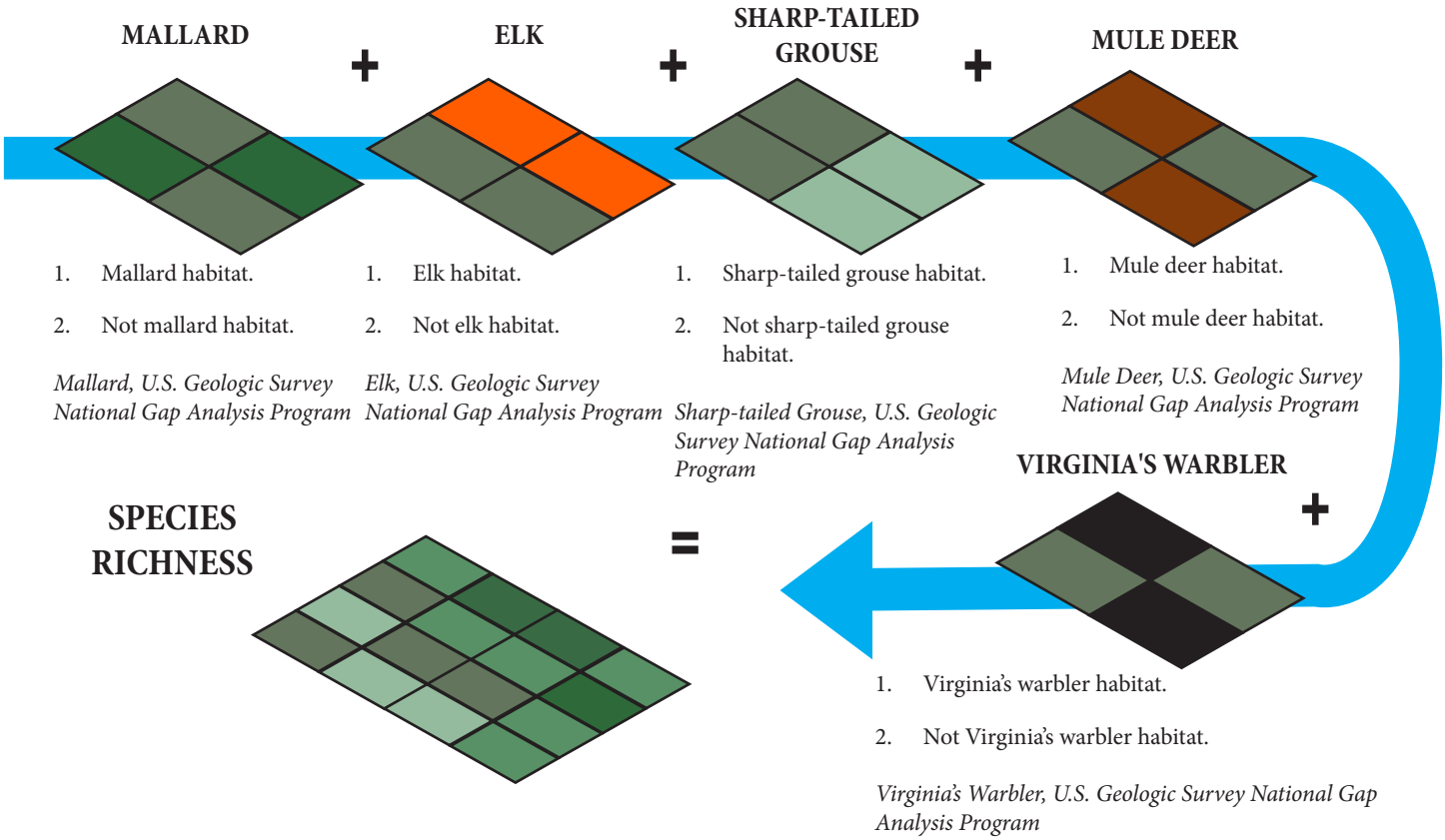
# SPECIES RICHNESS ASSESSMENT MODEL

## Description

Wildlife species are important to protect for aesthetic, ecological, educational, historical, recreational and scientific value (Endangered Species Act, Section 2). The species richness model uses data about indicator species to identify important areas for conservation. Indicator species are those whose presence "indicates" stable ecological conditions (Miller et al. , 1998). The indicator species of the study area include: mule deer, elk, Virginia's warbler, mallards, and sharp-tailed grouse (A. Brewerton, personal communication, December 1, 2015).

## Data, Layers, Criteria & Sources

The model was created by combing the habitat range for the mallard, elk, mule deer, sharp-tailed grouse and Virginia's warbler.




## Discussion

The Bear River Mountains provide excellent habitat for the native species of the study area. However, in Cache Valley, roads, farmfields and towns have fragmented habitats, reducing the presence of most species (see Figure 5.18). Most remaining habitat in the valley is concentrated around river corridors and wetland areas, such as the Logan River, where it enters the Cutler Reservoir. As such, these areas should be targeted to enhanced conservation, as the population and development grows in the watershed.

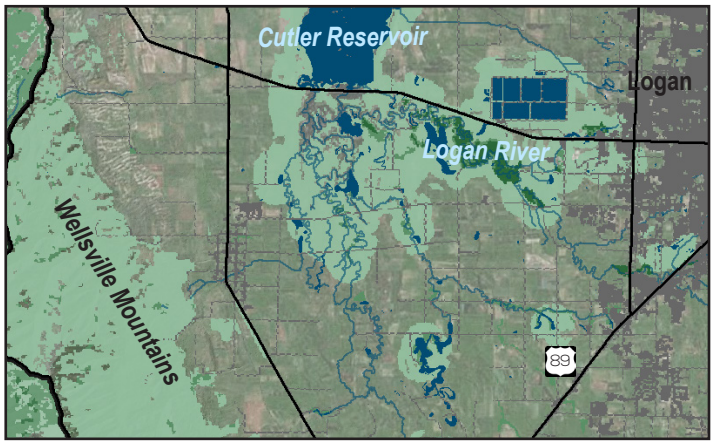
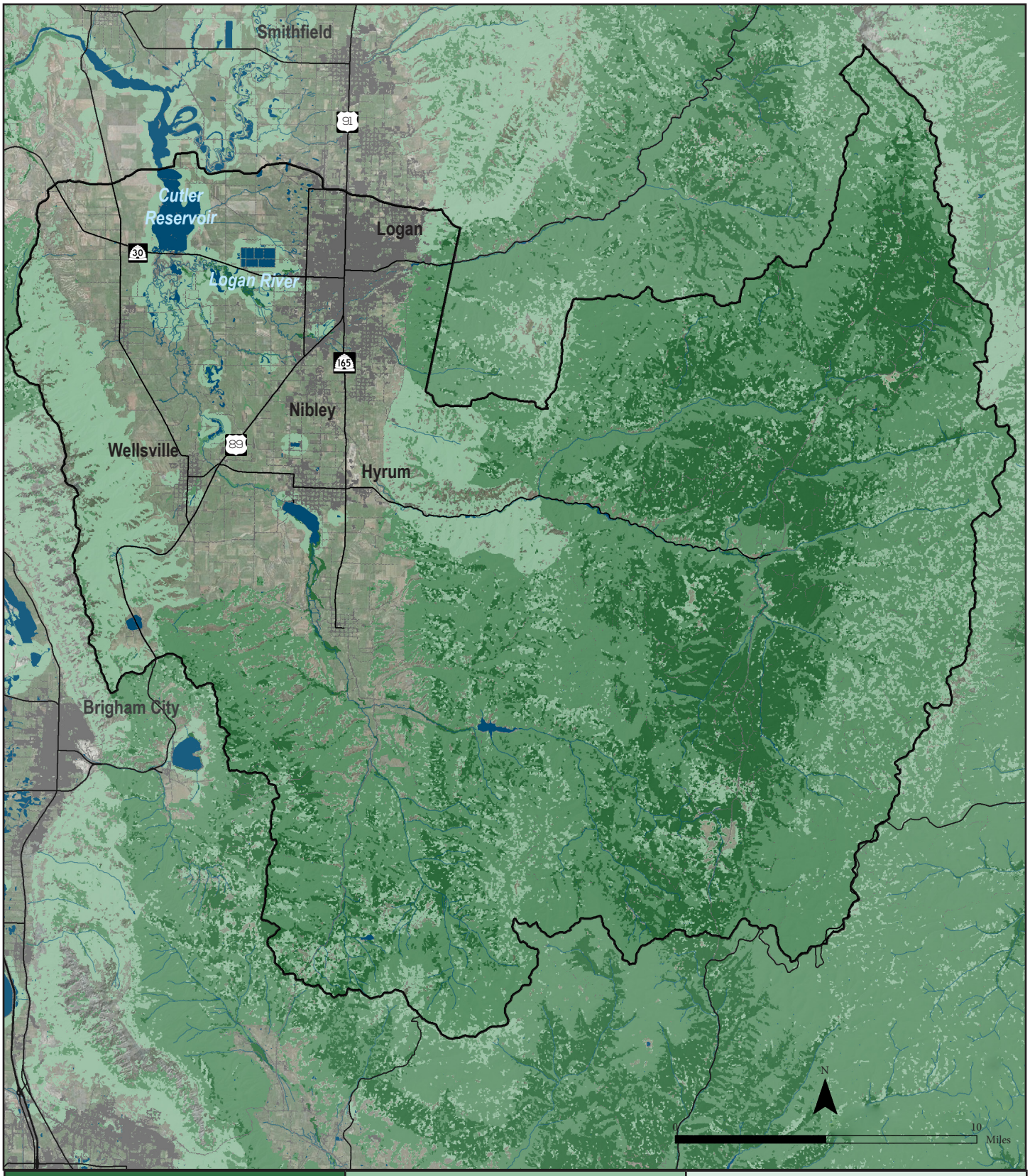



*Figure 5.18.* There is large potential for Conservation near the Cutler Reservoir




| TIER 1: HIGH IMPACT | TIER 2: MODERATE IMPACT | TIER 3: LOW IMPACT |
|---|---|---|
| Areas with a combination of four or five indicator species' habitats | Areas with a combination of three indicator species' habitats | Areas with a combination of two indicator species' habitats |

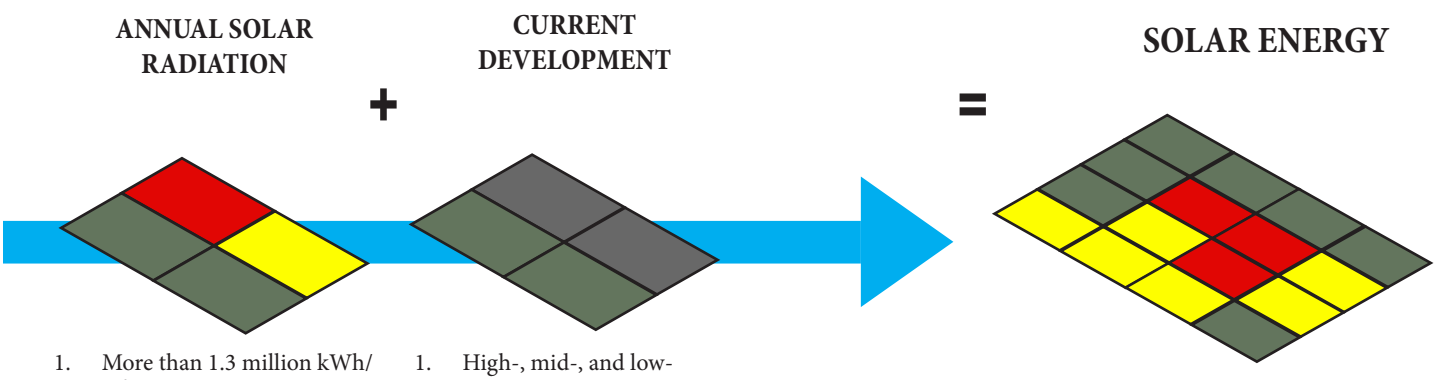
# SOLAR ENERGY Assessment Model

## Description

Solar energy emitted from the sun can be captured and produced into electricity via photovoltaic panels. Solar energy produced by photovoltaic panels is emissions free and already price competitive with coal and natural gas production on a centralized, utility scale (Parkinson, 2015). Replacing nonrenewable energy such as natural gas and coal with renewable energy sources such as photovoltaic can also reduce urban heat island effects and conserve water (Golden et al., 2007). This model is used to assess the suitability of proposed future developments to harvest solar energy.

## Data, Layers, Criteria & Sources

The model was created by combining current development with areas that receive above mean annual solar radiation.




1. More than 1.3 million kWh/m².
2. Less than 1.3 million kWh/m².

*Area Solar Radiation tool in ESRI ArcMap 10.3.1*

1. High-, mid-, and low-density development.
2. No development.

*U.S. Geologic Survey, National Land Cover Database*

## Discussion

The majority of Cache Valley receives above mean solar radiation for the overall study area (see Figure 5.16). Due to the mountainous topography of the study area, this overall average solar radiation is less than the average for Utah in general (Roberts, 2009). However, it is still greater than the average for Germany, which, in 2013, had installed 7.5x the total solar capacity of the U.S.A. (Perlin, 2013), despite being about 10,000 mi² smaller than the state of Montana. As such, most of the undeveloped areas in the Cache Valley are suitable for utility scale photovoltaic development, and the already developed areas within the valley are prime locations for dispersed, rooftop development.

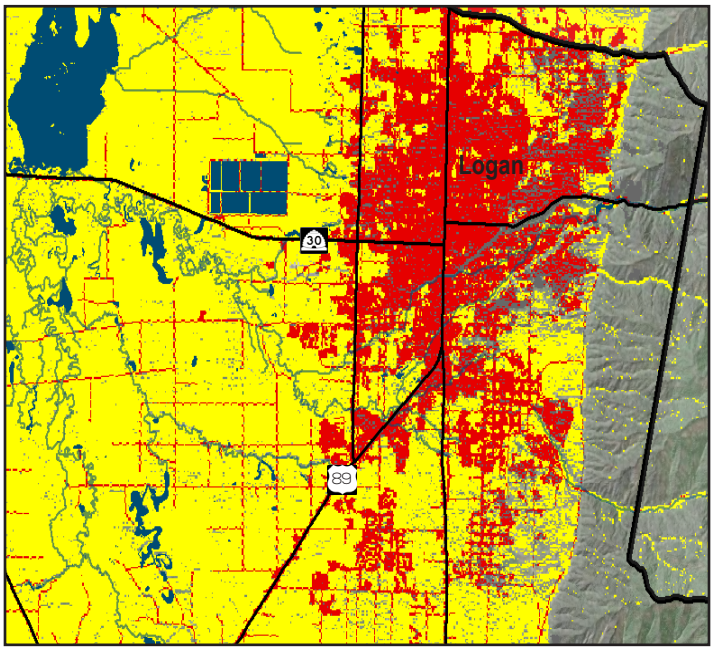
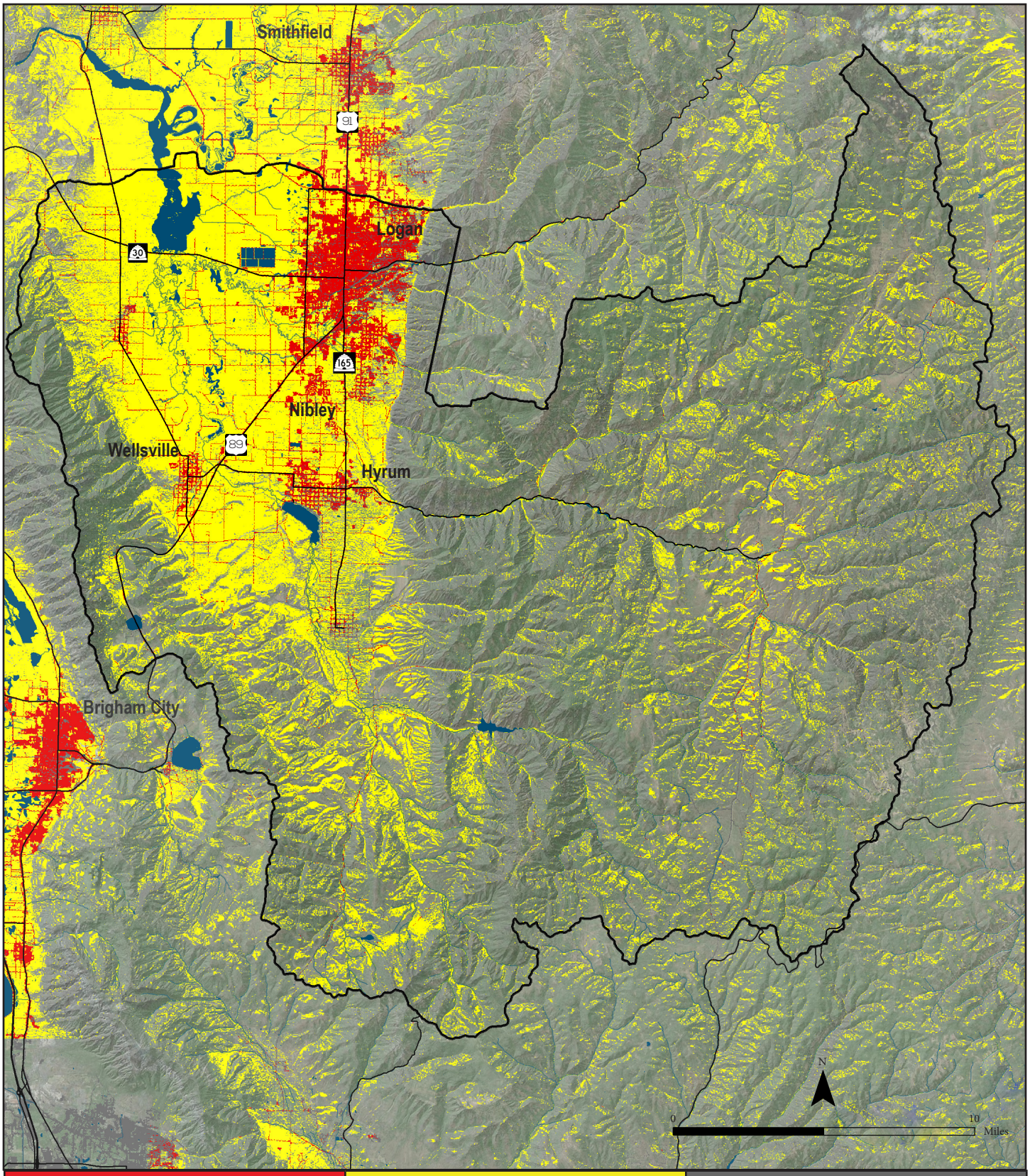



*Figure 5.16*. Existing rooftops in Cache Valley receive solar energy that is currently largely unharvested.




| TIER 1: HIGH IMPACT | TIER 2: MEDIUM IMPACT | TIER 3: LOW IMPACT |
|---|---|---|
| Currently developed areas that receive above mean solar radiation | Currently undeveloped areas that receive at least mean annual solar radiation | Currently developed areas that receive less than mean annual solar radiation |

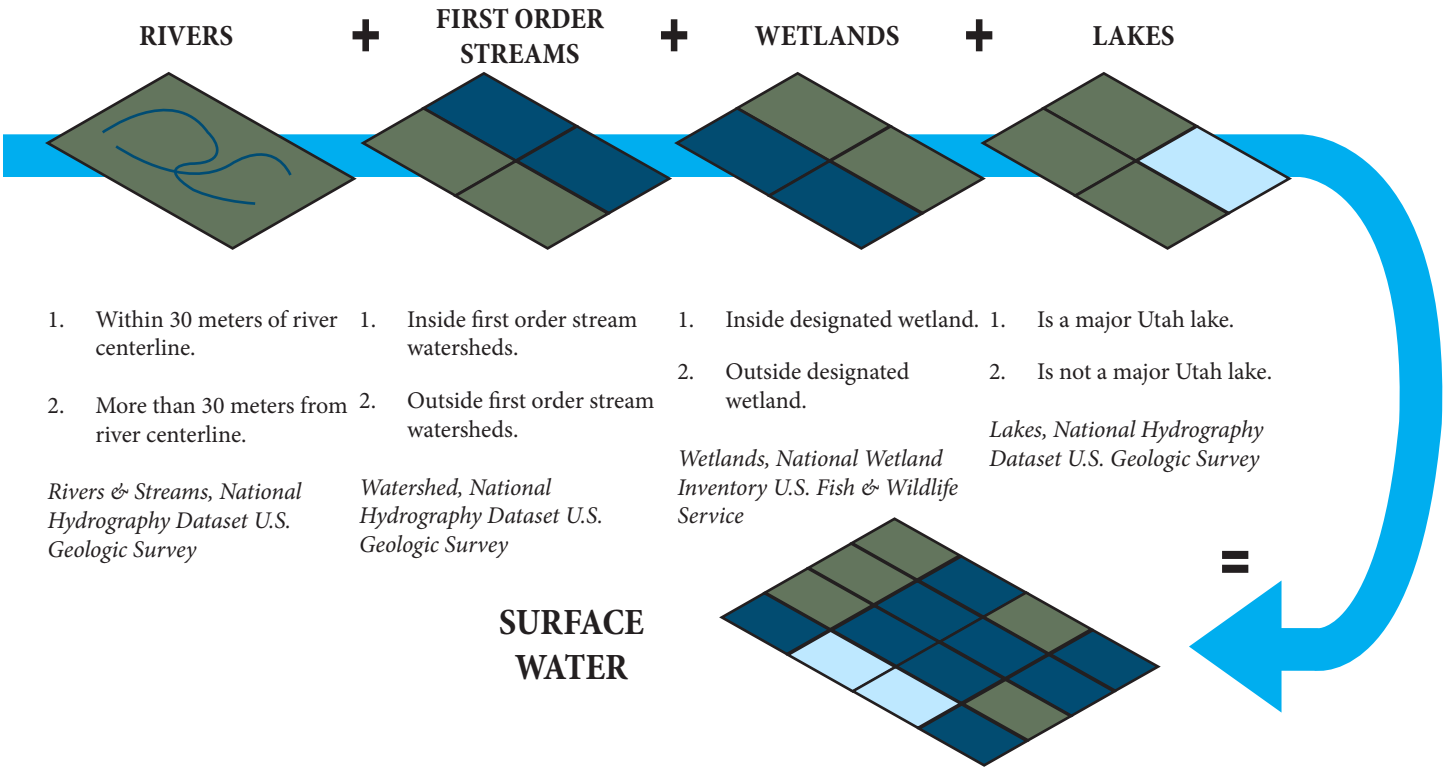
# SURFACE WATER ASSESSMENT MODEL

## Description

Water is a vital resource supporting the environment, municipalities, industries, and agriculture. Due to the semiarid climate of the watershed, capturing and storing runoff is important to support those resources in late summer and early fall. The surface water models is used to assess the impacts of proposed future land uses on the surface water quantity and quality of the study area.

## Data, Layers, Criteria & Sources

The model was created by combing rivers, first order streams, wetlands and lakes.




## Discussion

Left unprotected, surface water quality and quantity could decline in the watershed. Development within the higher areas of the study area may diminish first order streams and would thus have the greatest impact on the surface water quality. These critical areas are primarily located around mountain peaks and ridges. Additionally, rivers, wetlands and lakes in the valey also contribute significantly to overall surface water quality in the study area (see Figure 5.19).

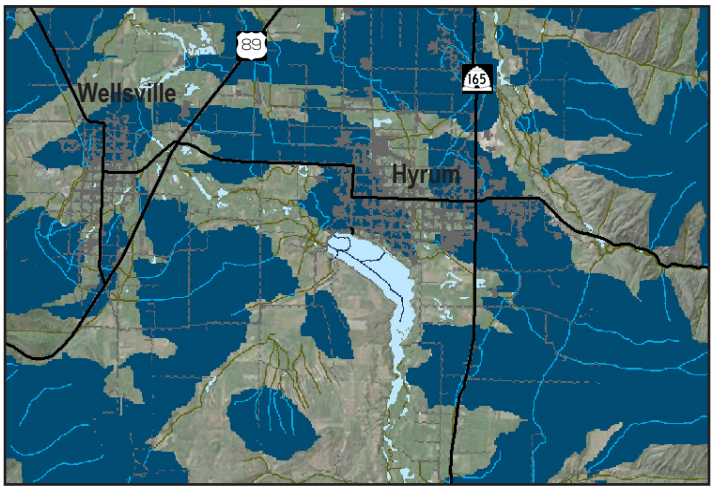
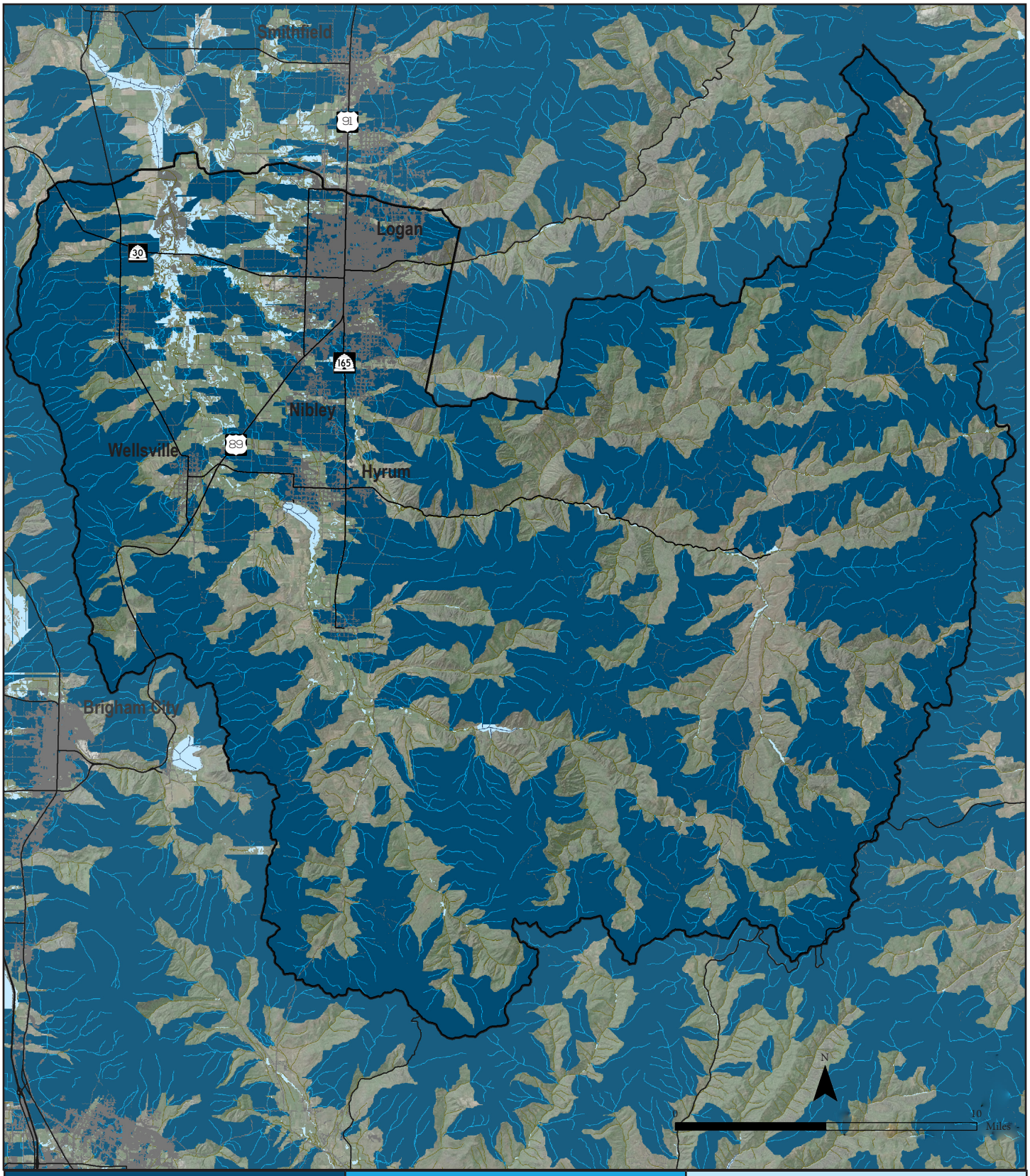



*Figure 5.19.* While most first order streams are located along the ridges of the mountain areas, some patches are also located in the valley.




| TIER 1: HIGH IMPACT | TIER 2: MODERATE IMPACT | TIER 3: LOW IMPACT |
|---|---|---|
| Watersheds serving the first order streams within the watershed | Waterways within the watershed serving first order streams | Wetlands outside first order watersheds |

# CHAPTER 5: ALTERNATIVE FUTURES

## What are alternative futures?

Alternative futures are snapshots of how the study area could develop by the year 2040. These visions for the future are based on different scenarios of change for the study area, which especially reflect the challenges of population growth and climate change. The scenarios were developed from the information identified in the stakeholder meetings and additional research of the Research and Analysis section of this study. They include: no change (i.e., maintaining the status quo), agricultural conservation, natural systems conservation, and recreational development. An alternative future was prepared for each of these scenarios. The four alternative futures are listed on the next page.

## How should they be used?

In terms of the overall bioregional planning process, alternative futures are visions of how the study area may develop, based on the modeling of the different scenarios of change. In this way, each alternative future may serve as a vision. Current stakeholders may choose to steer towards or away from these visions by pursuing the strategies that they perceive as producing the most desirable outcomes.

Each alternative future involves its own opportunities and constraints. In practice, stakeholders may select desirable aspects from each future in order to develop their own vision for the study area.

The alternative futures are evaluated based on three metrics: impacts on systems, impacts on issues and land use change. These metrics are meant to provide further context for identifying the strengths and weaknesses of each future.

## How were they built?

Because the scenarios of change for each future emphasized different issues in the study area, the priorities of the land use allocations (i.e., allocation models) was unique for each future. For example, natural systems issues (e.g., biodiversity, air quality and water quality) were top concerns of the Self Sufficient Cache alternative future. As such, the conservation land allocation was a top priority for this future. In this way, any area that contained multiple land uses was designated, by default, to the highest priority land use. The full range of land uses used in the construction of the alternative futures, in alphabetical order (see Figure 6.1).

### Alternative Futures Land Use Allocations

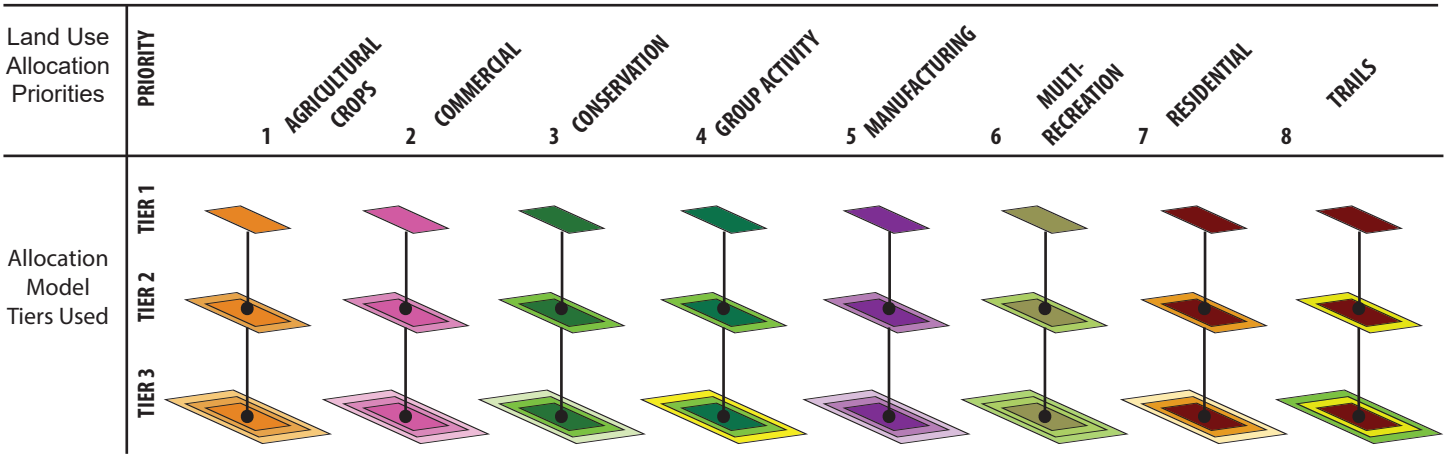



*Figure 6.1.* Tiering Process Diagram

# Alternative Futures

# BUSINESS AS USUAL

## Maintaining the status quo

### *Narrative*

*As you enter the valley you discover a sprawling city interrupted by patches of agricultural land. The valley feels like one continuous city, despite being comprised of many different municipalities. Suburban housing is plentiful and shopping centers are easily accessible by car throughout the valley. This is the Business as Usual (BAU) future.*

### Development sprawls deeper into the open space

With a focus on maintaining current lifestyles, this future allows developers the most freedom. Housing expands outward instead of upward, creating a continuous reach of low-density development. As municipalities run out of space, they simply annex more. This could cause the municipalities to merge together forming a borderless pattern of development.

Much of the new development may likely occur on lands that are currently used for agriculture. Prior to municipal expansion, the outskirts of current municipalities could be developed mostly into single family, suburban housing. The areas in closer proximity to city centers could be developed with higher density units, such as apartment complexes, especially in Logan near Utah State University.

*Residential development could expand until it meets unyielding farm owners*

The mountain benches around Cache Valley may also be further developed with large, single family homes. Development on the benches could reduce wildlife habitat, thus increasing conflicts with mule deer and other species. Further bench development could also reduce groundwater recharge potential and increase the chances of groundwater contamination. These changes could result in the stakeholders of the study area becoming increasingly dependent on storage and withdrawals from the area's rivers.

### Public transit grows slower than the population

If current development patterns continue, additional dispersed, single-family housing could require networks of new county roads. The construction of these roads could put further strain on county and municipal budgets. This strain could make it even more difficult to install alternative transportation options, such as bus rapid transit or light rail. As such, personal vehicles may likely remain the dominant transportation form. With the doubling of population expected by 2040, traffic may also double in the city centers of the study area, especially Logan, unless new highway


*The scenic, high elevation areas of the valley are already under pressure by development*

infrastructure is developed. Longer drive times, greater distances traveled, and continued dependence on personal vehicles could also have a negative effect on air quality. As such, the severity of winter inversion may also likely increase, resulting in more severe "red" days.


*Winter inversions, like the one pictures here, trap pollution in the valley air*

## Recreation impacts increase in severity

In lieu of comprehensive plans to manage recreation impacts, especially in the southern half of the Bear River Mountains, new backcountry roads and dispersed motorized recreation could increase. These activities could not only reduce habitat for wildlife such as mule deer, black bear and elk, but may also likely result in more litter and erosion in the sensitive, first order watershed regions of the study area. Furthermore, additional unmanaged access could result in the dispersion of invasive species.

Additionally, lack of public transportation combined with

*Without comprehensive recreation and transportation plans, recreation conflicts could increase throughout the study area, especially at trailhead parking.*

population growth may likely increase the demand for parking at public trailheads, creating access conflicts for most recreation types.

## Education and service economy replaces agricultural production

In this future, Cache Valley may continue to process meat and dairy products on an industrial scale. However, less of the feed for these animals may be produced within the watershed. As such, the agricultural section of the region's current economy may likely decrease. However, with increasing population, retail service opportunities, as well as job opportunities related to Utah State University, could increase.

# How was it built? Land Use Allocations

The diagram below shows the different land use allocation models and tiers used to assemble the Business as Usual future (see Figure 6.2). The highest priority allocation models were used to "clip" the models that followed them, e.g., the only conservation areas that are displayed in the final model are those that did not overlap with any of the other models used.

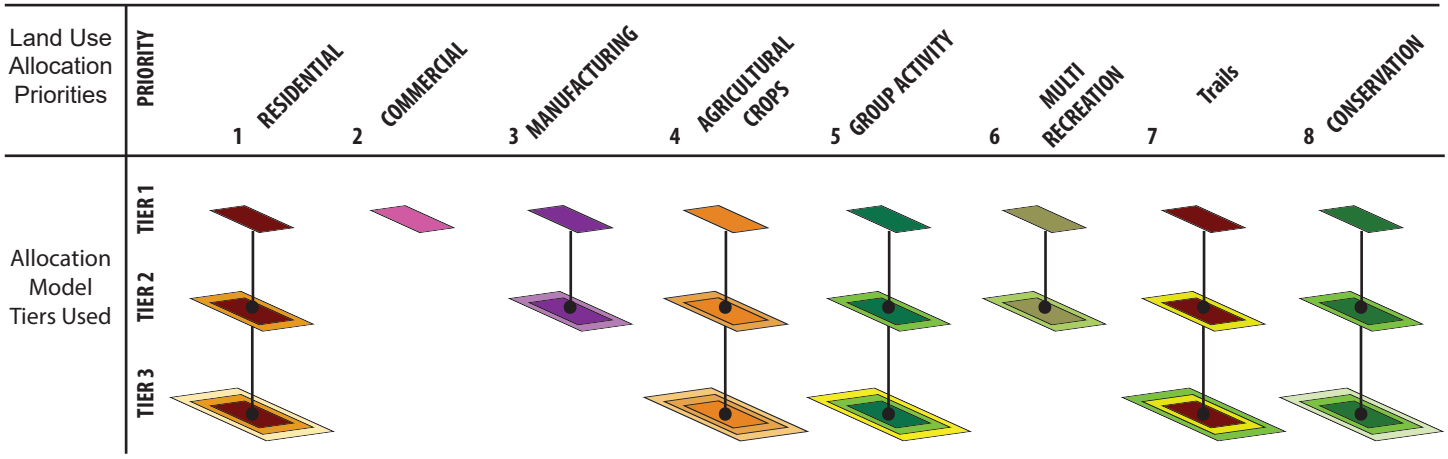
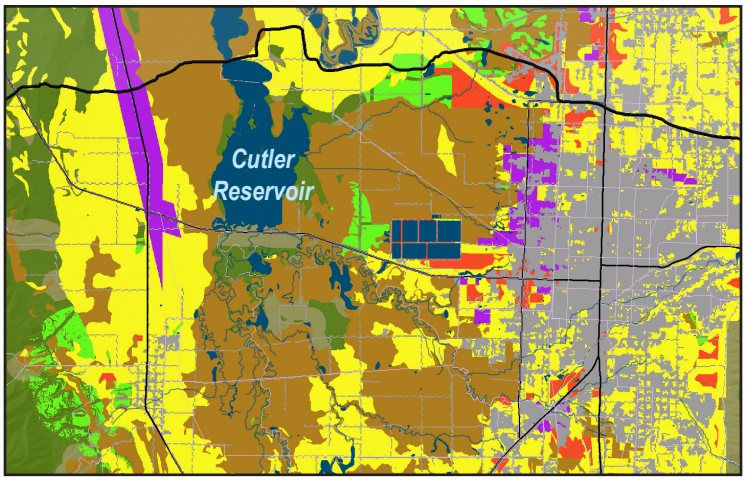


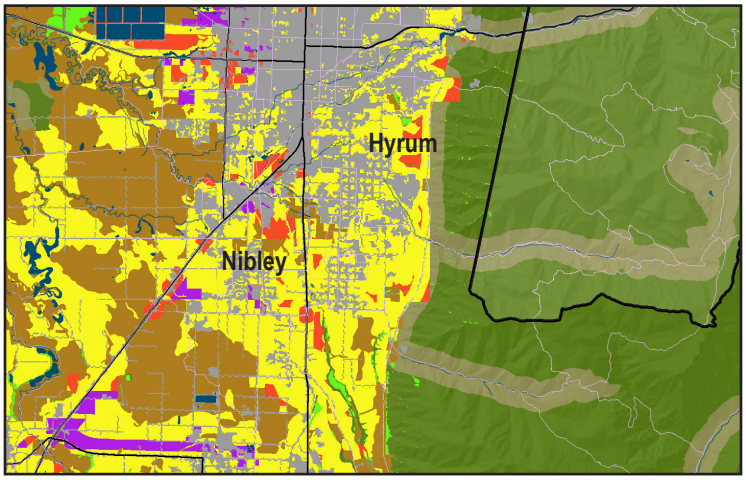

*Figure 6.2.* The allocation model tiers used to build the Business as Usual alternative future

# Areas of Special Interest



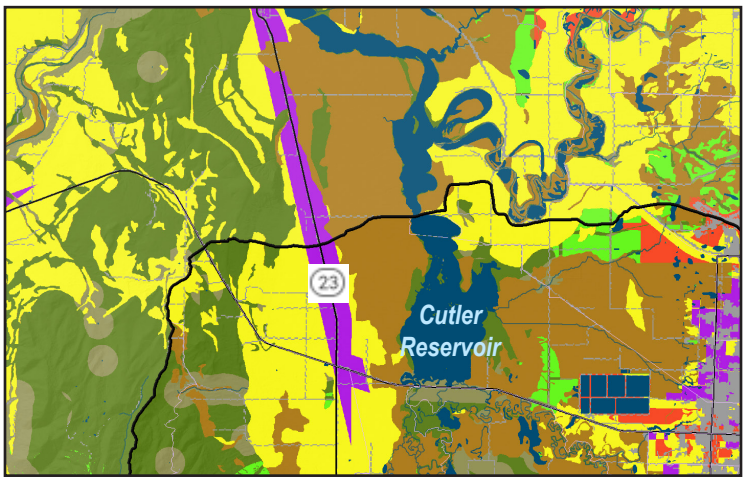

## Wetlands Surrounding Cutler Reservoir

Pressed by residential and commercial development, agriculture could continue and possibly increase in and around wetland areas, such as those located near the Cutler Reservoir. Agricultural runoff, compounded by the increase in impermeable surfaces throughout the valley, could continue to negatively affect water quality. If the intensity of agricultural activities increases in wetland areas, vegetative buffers could decrease, further degrading surface water quality.




## The Benches

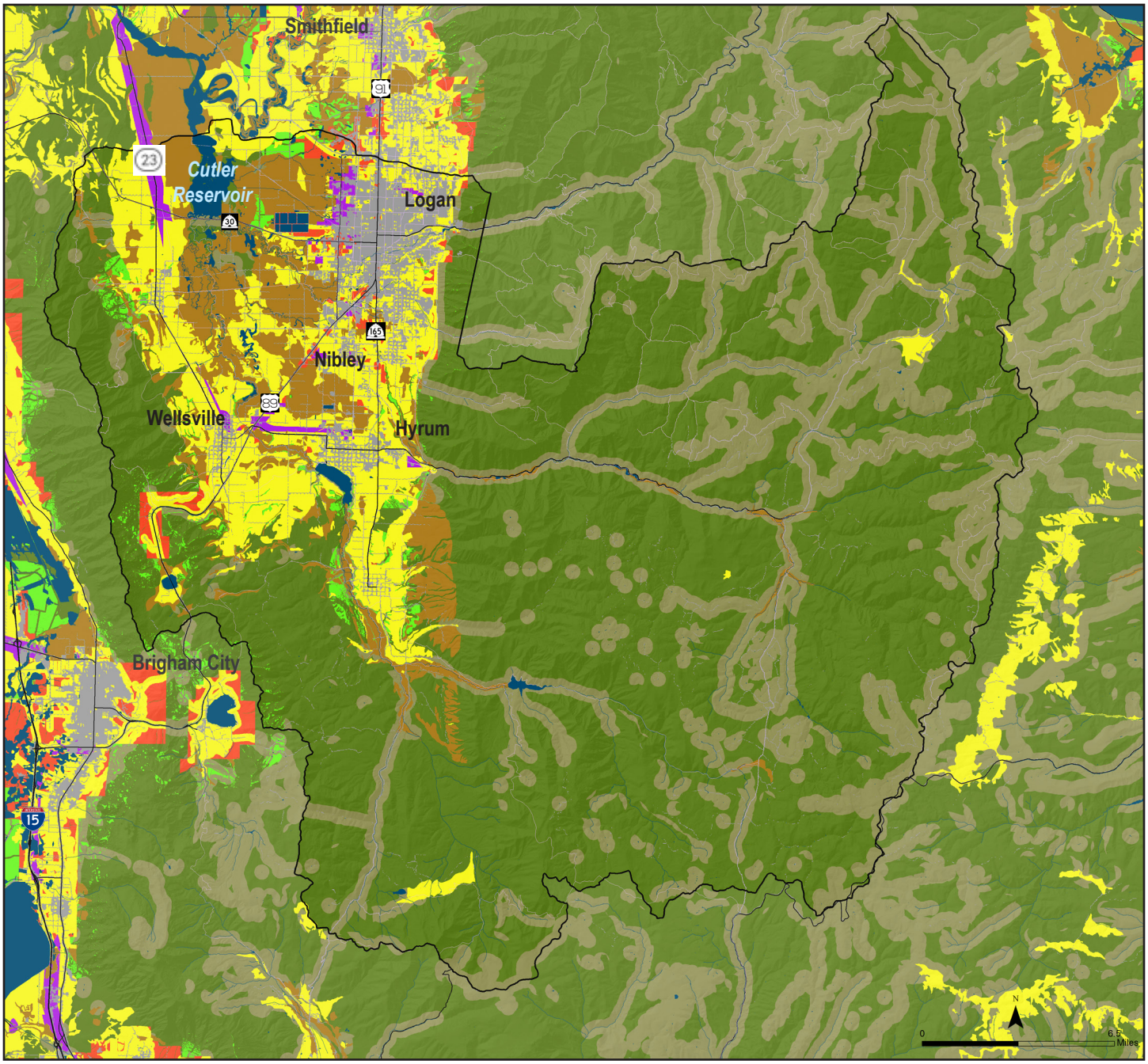
Although population will likely double, this future does not entail any significant strategies to control the density of new housing. As such, based on current trends, new housing may be dominated by dispersed, single family home development throughout Cache Valley. The only real limitation to this development may be physical restrictions, such as slope. Physical conditions along the benches of the valley are not prohibitive. As such, these areas may likely be desirable locations for new developments. Large scale development in these areas may have a significant impact on the visual character of the valley, as well as the potential for groundwater recharge.




## East Side Manufacturing Corridor

Route 23, which runs along the eastern extent of Cache Valley, has high potential for manufacturing development in the northern portion of the study area. The increase in population along with the decrease in the agricultural sector of the existing economy may provide a workforce for companies that wish to manufacture in the area. Manufacturing uses in this area could provide new economic opportunities, but also potentially cause agricultural, habitat, air quality, water quality and scenic quality conflicts.

Figure 6.3. Enlargements of important components of Business as Usual.




## LEGEND

- Existing Development
- Manufacturing
- Commercial
- Residential
- Conservation
- Agriculture
- Group Recreation
- Multi-Recreation
- Trails

## Shifting Landscape Character

Expansive development and habitat degradation could precipitate a substantial shift in the identity of Cache Valley (see Figure 6.4 shown later in this chapter). Whereas it is currently characterized by agricultural productivity and access to uncrowded, dispersed recreation, the study area in this future could largely be characterized by suburban living. Additionally, conflicts for recreation access may likely increase, causing crowding that could be similar to what currently occurs in the recreation areas along the Wasatch front. Additionally, without comprehensive management plans for the privately owned areas in the southern extent of the Bear River Range, dispersed, motorized recreation could have negative impacts on habitat and recreation quality.

This future provides a baseline against which the other futures may be compared. By comparing the other futures, stakeholders can identify the strengths and weaknesses of each alternative.

# System Impacts Assessment Model Evaluations

*Neutral* **AGRICULTURAL CROPS**

Some crop area could be lost to residential and commercial development. However, the lack of major conservation would allow for agricultural activity to continue in potentially sensitive areas of the watershed.

*Impairment* **AGRICULTURAL GRAZING**

Grazing areas throughout the watershed could be negatively affected by development and dispersed motorized recreation.

*Impairment* **GROUNDWATER**

Residential development on the east bench could produce more impervious surface in the aquifer recharge zone and increase chances of significant contamination.

*Neutral* **PUBLIC HEALTH AND SAFETY**

Residential development could expand into some flood plains, but largely avoid wildfire risk areas.

*Impairment* **RIVER ECOSYSTEMS**

Residential development and agricultural could continue or increase in riparian areas. This could result in reduced habitat and diminished water quality.

*Impairment* **SPECIES RICHNESS**

Existing habitat could be further fragmented and diminished by new development and dispersed motorized recreation.

*Impairment* **SURFACE WATER QUALITY**

Increased agriculture in the wetlands around Cutler Reservoir could introduce even more nitrates to the surface water.

*Neutral* **GEOTHERMAL ENERGY**

There could be areas within the new development that could have the option of utilizing geothermal energy, but this would accomplished by coincidence, not design.

*Improvement* **SOLAR ENERGY**

Expansive, sprawling development could produce more square roof footage, which would be suitable for harvesting solar energy.

# Issues Impacts Qualitative Evaluations

*Neutral* **AGRICULTURE**

Agriculture could continue in the valley, but some important agricultural land could be reallocated to other uses, such as residential and commercial development.

*Impairment* **BIODIVERSITY**

Without a concept for wildlife protection, habitats could become fragmented. The benches could be developed for residential uses, and dispersed motorized recreation in the mountains could fragment existing habitat.

*Improvement* **POPULATION GROWTH**

The population would able to grow with few policy restrictions other than existing municipal zoning ordinances. Large, dispersed, single-family homes could be accommodated by this future.

*Impairment* **AIR QUALITY**

New development and vehicle traffic could exacerbate existing air quality issues. Sprawling development could mean more vehicle miles traveled each day, which could result in poorer air quality during winter inversions.

*Neutral* **ECONOMY**

This future could accommodate manufacturing and commercial economic growth in the valley. Such growth could require a shift in the rural character of the valley.

*Neutral* **RECREATION ACCESS**

Access to recreation could be limited by new private developments. Recreation access conflicts could increase in the mountains, and could be resolved by further developing these areas for high-impact recreation potential.

*Impairment* **RECREATION IMPACTS**

This future may not involve significant strategies to contain and/or mitigate recreation impacts. It could also leave a significant portion of the Bear River Range open to private development that is not currently under United States Forest Service Management.

*Impairment* **TRANSPORTATION**

Expanding residential development could likely increase the need for transportation infrastructure while simultaneously straining municipal and county budgets.

*Impairment* **WATER QUANTITY**

Reducing aquifer recharge potential on the East bench of the valley could result in a reduction of available well water while demand simultaneously increases with population growth.

*Impairment* **RURAL CHARACTER**

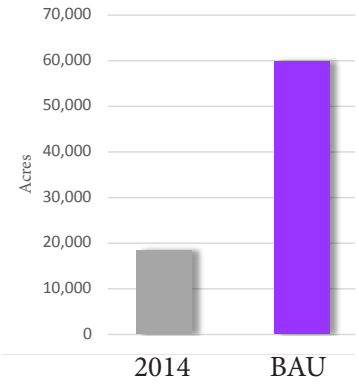
Expanding residential development, reduced agriculture and increased human impact in the mountains could produce a significant shift in the character of the valley, away from rural toward urban.

*Impairment* **WATER QUALITY**

Agricultural activity in the wetlands, combined with new sources of erosion and impermeable surfaces from development, could potentially increase pollution of the surface and groundwater of the region.

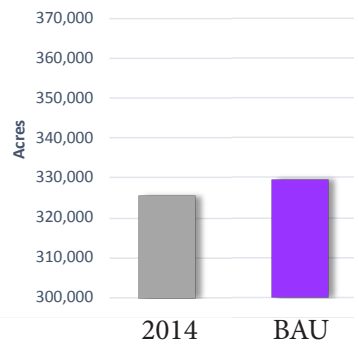
## Land Use Change Quantitative Evaluations

### DEVELOPMENT



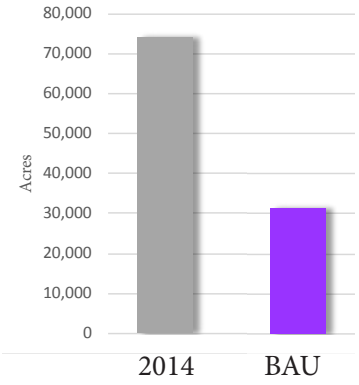

Sprawling development could continue in direct proportion to demand.

### CONSERVATION



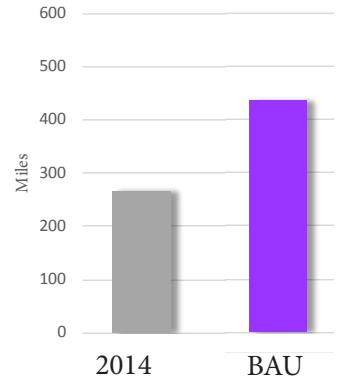

Currently, there are large areas in the mountains that are not under local, state or federal conservation management, but which experience light use impacts. Unprotected, a doubling of population could produce significant impacts in these areas.

### AGRICULTURE




Allowing expansive residential and commercial development could reduce a substantial amount of agricultural land.

### TRAILS




Trail systems could grow, mainly being located in the mountains, where residential and commercial development could produce less significant obstacles to right-of-way.

*Figure 6.4.* Land Use Change graphs for Business as Usual (BAU).


# SELF-SUFFICIENT CACHE

## Maximizing landscape functions

### *Narrative*

*Leaving the office on a summer day, you ride a bicycle along an urban trail that passes your neighborhood corner store before reaching the turn for your home. You stop at the store and select some local produce. The adjacent shelves are stocked with regionally renowned artisan meat and cheese products. Cinnamon teal and white-faced ibis are not an uncommon sight flying overhead the building. Sightings are even more common during afternoon walks or bike rides through the sprawling Cutler Reservoir nature preserve. The periphery of the preserve is spotted with the occasional industrial complex, similar to the one which contains your office. These complexes often host sought-after technology and other new industry firms. Many of the career employees that work for these firms are recruited directly from Utah State University. Regardless of their origin, they are attracted by the area's small town lifestyle; the hunting, fishing, and other outdoor recreation opportunities found in the mountains; the agrarian, riparian, and wetland scenery of the valley; and the rest of the charge-free ecosystem services provided by the intact, connected conservation areas throughout the region.*

### Ecosystem services

The Self-Sufficient Cache future (SSC) is based on maximizing the efficiency of human and biophysical systems in the study area. In this context, "efficiency" is defined as producing the greatest sustained benefit, for multiple generations, at the lowest overall cost. As such, SSC involves cultivating functional, aesthetically-pleasing natural areas, developing small-scale communities based on natural suitability (as opposed to human preference), and shifting from industrial to local-scale agricultural production.

Functional landscapes provide ecosystem services for the residents that live within their watershed. Ecosystem services are defined as "the benefits people obtain from ecosystems" (Millennium Ecosystem Assessment, 2005). They can come in many forms, from wetlands that sequester carbon and improve water quality/quantity, to wooded landscapes and rustic mountain vistas, which provide mental health benefits and increase property values (Alcock et al., 2013; Finholm, 2016).


*The pictured wetland area (south of Logan City) was left intact during the construction of a new Walmart. At the cost of a few extra parking stalls, the intact wetland functions as a storm drain, micro-park, and habitat for multiple beaver.*

### Harvesting natural value

The most important allocation for SSC is conservation. Currently preserved mountain areas must stay that way to preserve higher-order watershed functions. Doing so could provide benefits across the biophysical systems, especially surface water, groundwater and species richness. Additionally, current agricultural areas that are in or near the Cutler Reservoir should be put into conservation. Conserving these areas could increase water quality and quantity, provide new recreation opportunities such as hunting, fishing and birdwatching. Enhanced natural scenery and increased recreation potential could likely increase property values throughout the study area in the long term.

## Mixed-use development

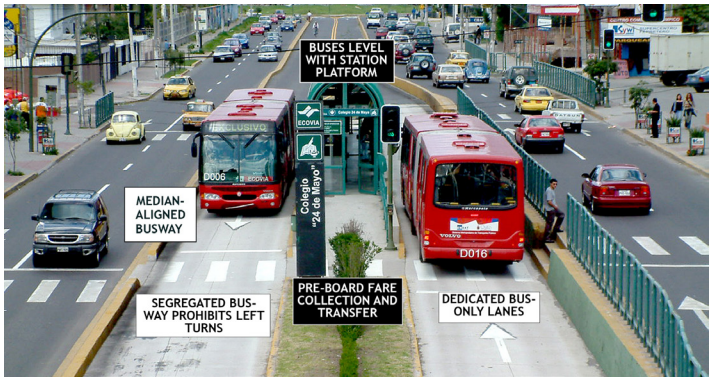
Within the built environment, SSC depends on public services and small, local economies. This means mid-high density developments with integrated commercial services (e.g., small grocery and hardware stores). As such, new residential areas in this future should include commercial services.

*Small businesses like Island Market in south Logan can provide walkable options for small shopping trips.*

This future allows for small expansions of the existing city centers with most new development opportunities occurring in small, dispersed clusters throughout Cache Valley. Development in these small clusters would have the effect of producing many small town "hamlets." Each of these hamlets would have the opportunity to develop its own unique town identity.

## Alternative transportation

In order to prevent increased car traffic as a result of the dispersed development, SSC is dependent on bus rapid transit, bike shares, and/or other alternative transportation services. These should also reduce the need for additional, ecosystem-fragmenting roadways. Especially in the southern half of the valley, wildlife corridors should be established through agricultural lands and across transportation routes, which would allow wildlife in the mountainous areas to reach the Cutler Reservoir.




*Bus rapid transit systems can be as little as half the cost to install as light-rail systems, and can be up to 20% less expensive to operate (Bonsell, 1987)*

## Agriculture: paradigm shift

Finally, in order to preserve some of the study area's agricultural assets and provide local options for its consumers, SSC requires a shift from mostly industrial-scale agricultural activity to mostly local-scale. This means shifting irrigated production from animal fodder such as alfalfa and corn to fruits and vegetables. This shift could bring additional benefits, as fruits and vegetables generally require less water and area to produce similar or greater nutritional value (Mekonnen & Hoekstra, 2012; Ranganathan, 2016).

# How was it built? Land Use Allocations

The diagram below shows the different land use allocation models and tiers used to assemble the Self-Sufficient Cache future (see Figure 6.5). The highest priority allocation models were used to "clip" the models that followed them, e.g., the only residential areas that are displayed in the final model are those that did not overlap with the tier 3 conservation model.

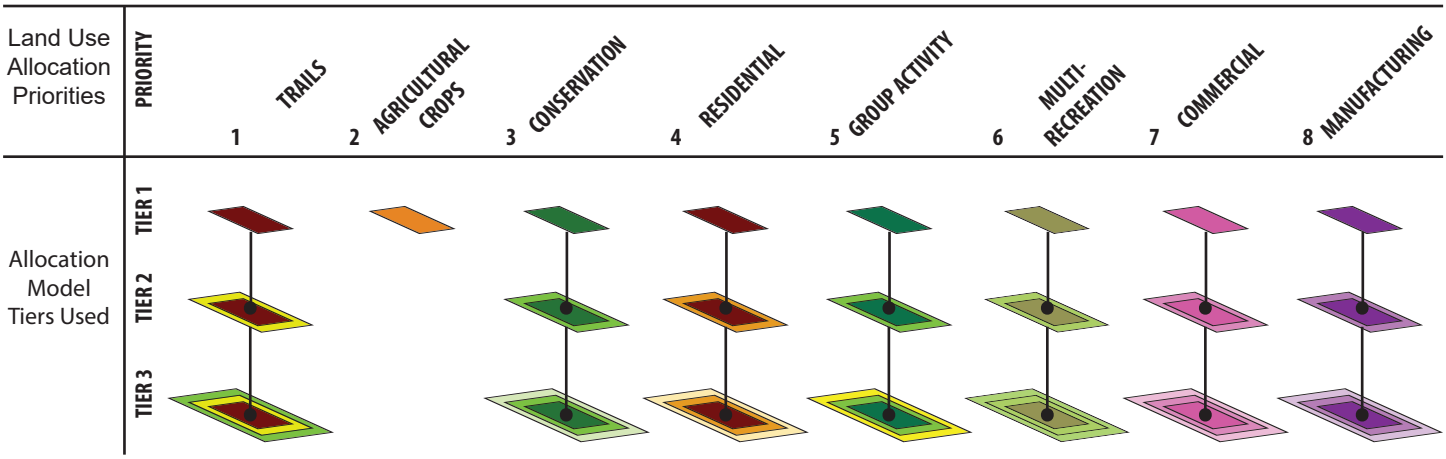
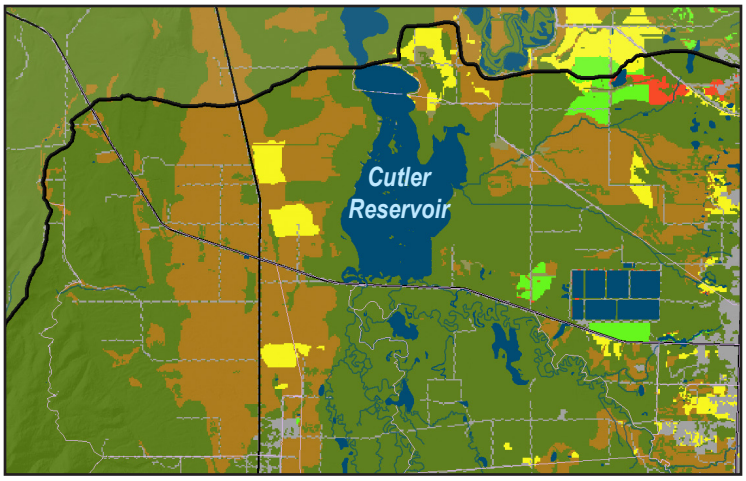


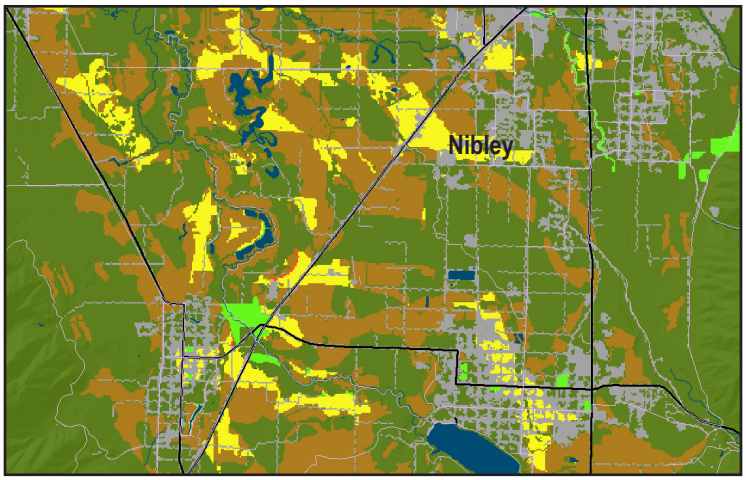

*Figure 6.5.* The allocation model tiers used to build the Self Sufficient Cache alternative future

# Areas of Special Interest




## Cutler Reservoir

Transitioning the areas around the Cutler Reservoir from agriculture to conservation could produce many new ecosystem service benefits. These include habitat for waterfowl and other animals, which could bring new opportunities for hunting and birdwatching. Similarly, new trails could be built around the reservoir for jogging, hiking and biking. These opportunities, in turn, could draw businesses and increase property values in the yellow areas of new development. Finally, conserving the riparian areas around the Cutler Reservoir could have a positive impact on surface water quality and lacustrine habitat, which could further increase the recreational potential of the area for paddling and fishing.




## New Development

New residential areas (i.e., the yellow areas) in this future are mostly dispersed throughout the central valley, where conservation is at its lowest priority. This could create clusters of new "hamlets," which should contain their own essential services (e.g., grocery stores or markets) and be connected by alternative transportation routes. Having clusters of new, small developments, could promote the development of unique town identities, a quality of life aspect that is currently under threat by the low density development pattern that is exists today.

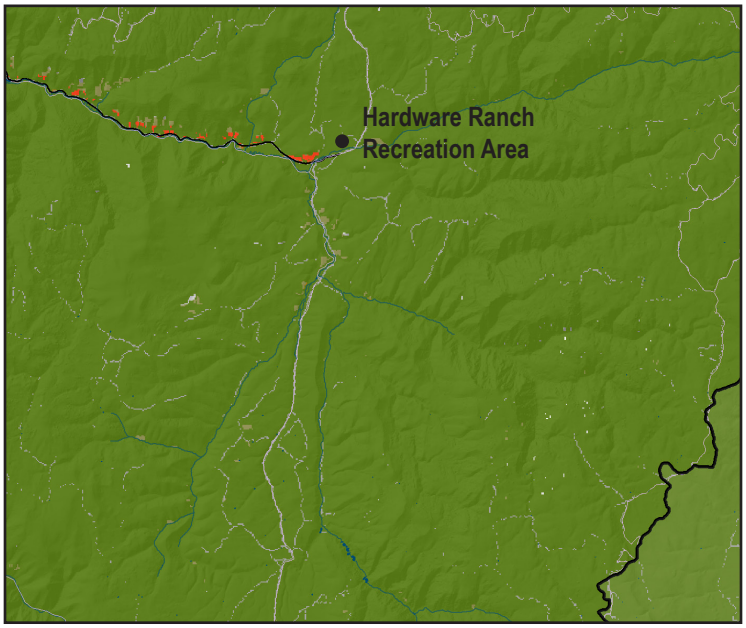
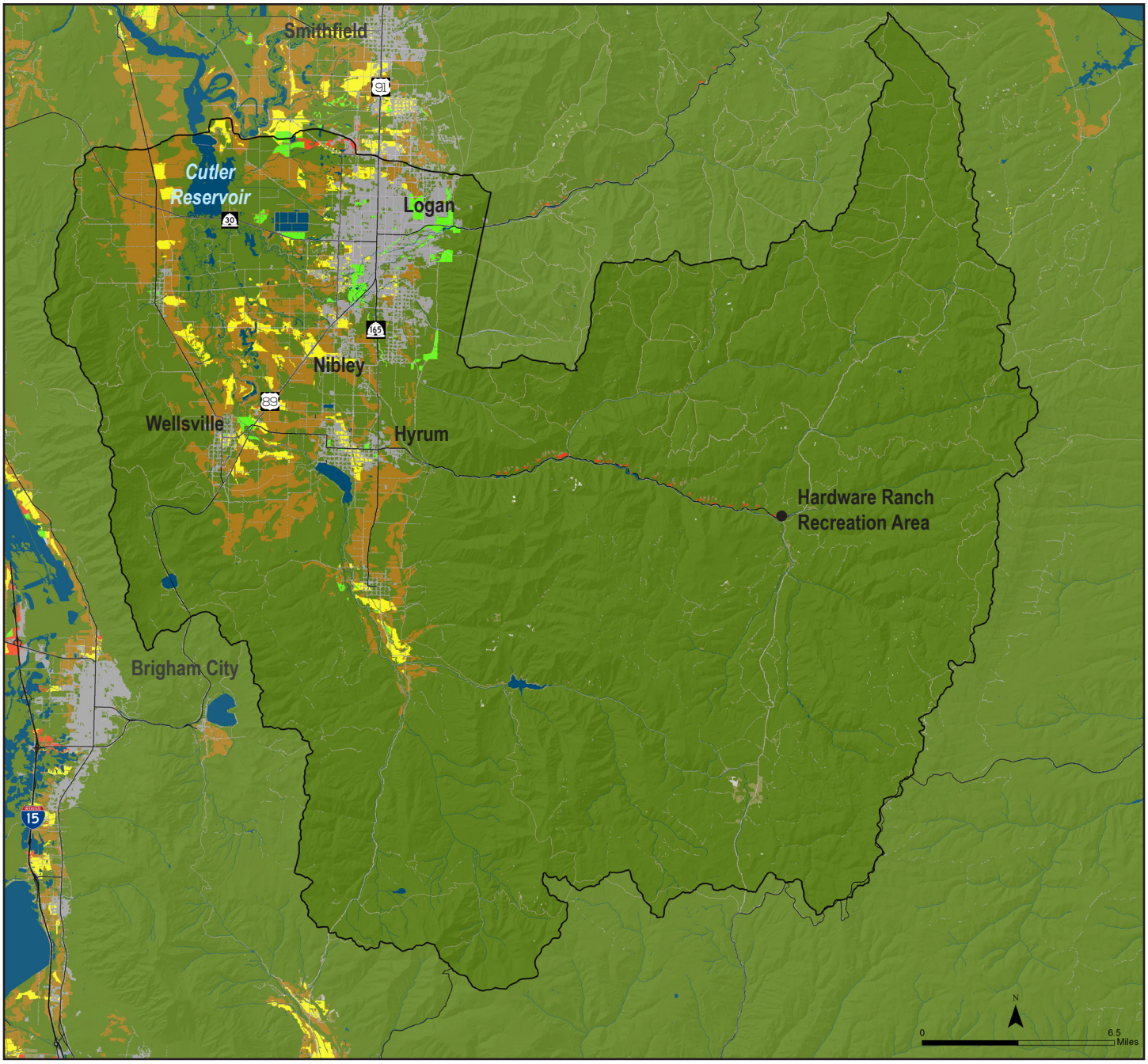



Figure 6.6. Enlargements of important components of Self Sufficient Cache.

## Conservation Partnerships

In order to preserve habitat in the large, privately owned areas in the southern extent of the Bear River Range, such as those near the Hardware Ranch Recreation Area, managers may have to work cooperatively with landowners to develop conservation easements or other strategies to protect the lands from being fragmented by dispersed motorized recreation or other uses. The Utah Department of Natural Resources Landowner Permit hunting program is one such strategy, which can be used to encourage landowners to keep private holdings together in large parcels, as well as to meet certain stewardship criteria (Utah Department of Natural Resources, 2015). Conserved lands in the mountain ranges could also be managed for multiple uses, ensuring continued grazing opportunities for ranchers, as well as enhanced opportunities for dispersed, non-motorized recreation. Public-private partnerships could also be utilized to secure conservation easements or other conservation interventions around the Cutler Reservoir.




## LEGEND

- Existing Development
- Manufacturing
- Commercial
- Residential
- Conservation
- Agriculture
- Group Recreation
- Multi-Recreation
- Trails

## Cache Valley looks within its own borders

In the SSC future, Cache Valley may be characterized by diverse town identities that are connected by their shared utilization of the many ecosystem services provided by in watershed. As such, all currently undeveloped areas capable of producing significant ecosystem services should be transfered to conservation, except where they overlap with prime farmland. This may likely result in future developments in the mountains being limited to those adjacent to existing roads, and the transition of much existing agricultural land in the valley to conservation (see Figure 6.7 shown later in this chapter). Conservation areas could still be managed for multiple uses. So, some rotational grazing may be implemented in the newly conserved areas of the valley. However, this change would be accomplished by policy, and is not incorporated in the metrics utilized to evaluate this future. Prime farmland is prioritized above conservation, due to the necessity of preserving agriculture in the valley. This land should be used to grow high-nutrition crops, rather than livestock fodder. Overall, these changes should enhance quality-of-life for the stakeholders of the study area, as well as draw in new residents.

# System Impacts Assessment Model Evaluations

*Impairment* **AGRICULTURAL CROPS**

The agricultural paradigm in this future calls for current production to transition away from fodder crops. This could result in a large net loss of agricultural crop lands.

*Neutral* **AGRICULTURAL GRAZING**

The new conservation lands in this future could be managed for multiple uses. As such, the effect of the future on grazing would be a matter of policy.

*Improvement* **GROUNDWATER**

The new conservation lands in this model could protect all currently undeveloped groundwater recharge areas.

*Neutral* **PUBLIC HEALTH AND SAFETY**

Although new development would be located purely on the criteria of maximizing ecosystem services, the proposed new developments do not entail new health and safety risks.

*Improvement* **RIVER ECOSYSTEMS**

The transition of agricultural lands in the valley to conservation could have a positive impact on riparian vegetation while also reducing agricultural runoff.

*Improvement* **SPECIES RICHNESS**

Additional conservation lands could provide extensive new habitat, which would have a positive impact on species richness.

*Improvement* **SURFACE WATER QUALITY**

As with the River Ecosystems model, the transition of riparian areas from agriculture to conservation could have a positive impact on surface water quality.

*Neutral* **GEOTHERMAL ENERGY**

New mixed-use communities could access geothermal energy for heating, but this future specifically avoids development in high water table areas, where there is the greatest thermal conductivity.

*Neutral* **SOLAR ENERGY**

New mixed-use communities could incorporate rooftop solar to reduce dependence on fossil fuels, but no areas are set aside to produce solar energy on a utility scale.

# Issues Impacts Qualitative Evaluations

*Impairment* **AGRICULTURE**

This future proposes a radical agricultural shift that may produce overall greater nutritional output. However, it could involve a steep reduction in the quantity of currently cultivated lands.

*Improvement* **BIODIVERSITY**

New conservation lands could increase both terrestrial and aquatic biodiversity.

*Neutral* **POPULATION GROWTH**

Current 2040 population projections could be accommodated by this future, but at a slightly higher density.

*Improvement* **AIR QUALITY**

The newly conserved areas could produce more biomass. Additionally, more mixed-use development and alternative transportation options could reduce personal vehicle emissions.

*Neutral* **ECONOMY**

This future calls for the transition to new modes of economic production, such as artisan agricultural products and catering to technological industries.

*Neutral* **RECREATION ACCESS**

This future mostly accommodates dispersed, non-motorized outdoor recreation. It does not intentionally enhance opportunities for motorized, field sport, or other, non-dispersed recreation types.

*Neutral* **RECREATION IMPACTS**

Most of the recreation in this future could be backcountry and/or dispersed, which would not lend to active strategies to control recreation impacts.

*Neutral* **TRANSPORTATION**

This future calls for alternative transportation routes and wildlife corridors to mitigate the negative transportation effects of dispersed new communities.

*Improvement* **WATER QUANTITY**

Conserving the aquifer recharge areas and limiting the amount of new impervious surfaces in the valley could have an overall positive impact on water quantity.

*Neutral* **RURAL CHARACTER**

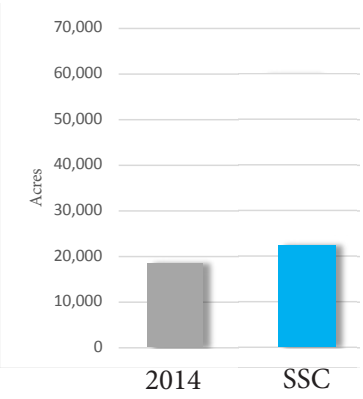
This future could produce more of a wilderness character than the rural agricultural character that is currently present in the developed regions of the study area.

*Improvement* **WATER QUALITY**

The conservation of recharge areas, first order watersheds, and riparian areas in this future could have a positive impact on water quality.

## Land Use Change Quantitative Evaluations

### DEVELOPMENT

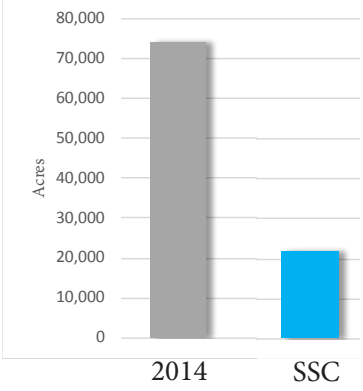



This future involves a slight increase in total developed area. As such, the urban areas of the watershed could be developed to a higher density. Doing so could allow for the new, dispersed communities to accommodate mixed use development.

### CONSERVATION

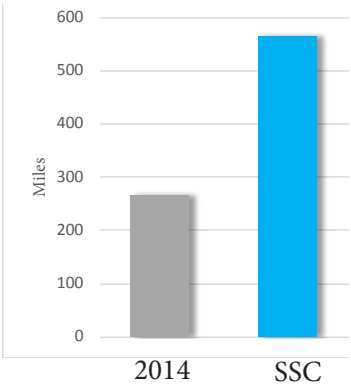

This future requires a large increase in the total amount of conserved land in the watershed. Much of this conservation should take place on current agricultural lands in the valley.

### AGRICULTURE




The total amount of agricultural land in this future may likely be reduced. However, this future encourages the transition of remaining agricultural lands away from animal fodder, towards more nutritious crops.

### TRAILS




This future takes advantage of all the proposed new trails. Doing so could provide opportunities for alternative transportation and dispersed recreation.

*Figure 6.7*. Land Use Change graphs for Self Sufficient Cache (SSC).

# CITY-CITY, COUNTRY-COUNTRY

## Preserving the farmlands, mountains, and distinct community

http://bit.ly/2keSNhQ

### *Narrative*

*Winding your way down the Wellsville Mountains through Sardine Canyon you emerge to see a familiar site: vast expanses of farmland intertwined with lush riparian vegetation followed by the Logan Front and the rugged Bear River Mountains in the distance.*

*The City-City, Country-Country (CCCC) future is centered on preserving the rural character—the farmlands, mountains and distinct communities—that make the Blacksmith Fork-Little Bear Watershed unique. The future consists of more densely populated cities surrounded by agricultural fields, and protected riparian corridors and mountains*

*Farmfields help define the rural character that is valued by many of the residents of the study area.*

### Preserving Rural Character

To keep the cities distinct and unique, service boundaries could be implemented to limit future development to current municipal areas only. Service boundaries would restrict growth by limiting the infrastructure and services (e.g. roads, sewer, emergency services) that can be built or offered in the rural areas. This could reduce infrastructure costs and allow communities to save money (Thompson, 2013). The savings could then be allocated to an agriculture/natural lands (e.g., water, undeveloped non-agricultural land) preservation fund, called the Rural Fund.

### Absorbing Growth

As of 2014, approximately 80,000 people live in the study area with an average of housing density of 1.65 units per acre (U.S. Census, 2014). In order to accommodate a doubling of population, while also conserving current agricultural lands and natural areas, the housing density of the study area would have to increase to an average of 2.3 units per acre. Additionally, in order to preserve the unique identify of each town, new growth should be distributed proportionately across communities. While the overall housing density may be an average of 2.3 units per acre, this average housing density of each municipality could vary among municipalities. For example, municipalities such as Logan and Hyrum could have higher units per acre than the 2.3 average and communities such as Mendon and Paradise would have lower units per acre than 2.3 (see Figure 6.8).

Figure 6.8. At 8.5 units per acre, Logan would need to reach that density to accommodate a doubling of the population.

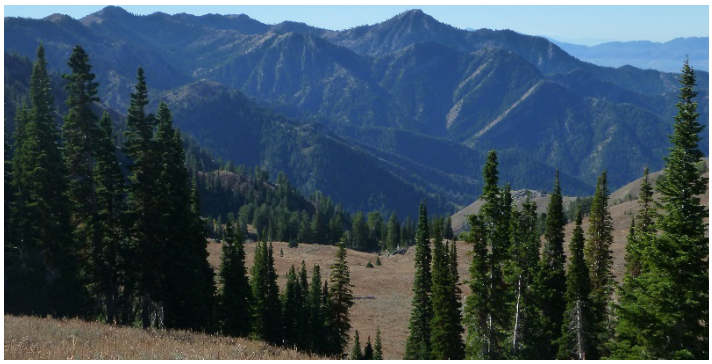
## Maintaining Agriculture

Service boundaries could help keep growth from overtaking agricultural croplands and the large livestock operations that are currently prominent characteristics of the study area. The Rural Fund could provide financial assistance to farmers and ranchers to keep their lands in agricultural production, or it could be used to purchase farm lands for conservation at market price. As a stipulation of the fund, farmers could be required to grow high nutritional value crops such as fruits, vegetables and native grasses.

The Rural Fund could also be used to move farms and development out of sensitive areas, such as riparian zones (i.e., vegetated areas adjacent to water) and floodplains (i.e., lowlands adjacent to rivers). These mitigation zones would improve impaired waterways and restore natural landscape functions. The Rural Fund would also help maintain and protect other sensitive areas, including the mountains.

## Preserving the Mountains

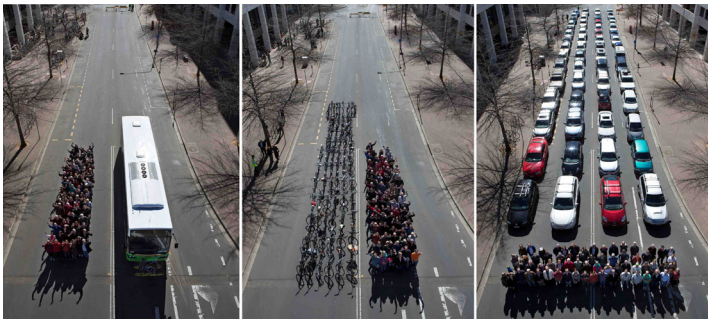
Keeping federal lands under federal management could help ensure the protection of recreation, wildlife, and natural resources. However, current management structures could be adjusted to manage the possible increased recreation impacts of a doubling population. These could include fee zones and permits for high impact recreation (e.g. off-highway vehicle use).



*The Bear River Mountains offer many opportunities for recreation while also preserving wildlife, vegetation and water.*

## Alternative Transportation

Commuter rail, bus rapid transit, and bicycle and pedestrian paths may all be made more viable by limiting service boundaries. If implemented, these transit options should help improve air quality. In addition to options in the valley, e.g., the mountainous stretches of the area, could also benefit from additional public transit options.



*Offering a variety of alternative transportation options in the watershed, including bus and bicycle trails, should serve more residents while reducing air pollution.*

# How was it built? Land Use Allocations

The diagram below shows the different land use allocation models and tiers used to assemble the City-City, Country-Country future (see Figure 6.9). The highest priority allocation models were used to "clip" the models that followed them, e.g., the only conservation areas that are displayed in the final model are those that did not overlap with tier 3 agricultural crops.

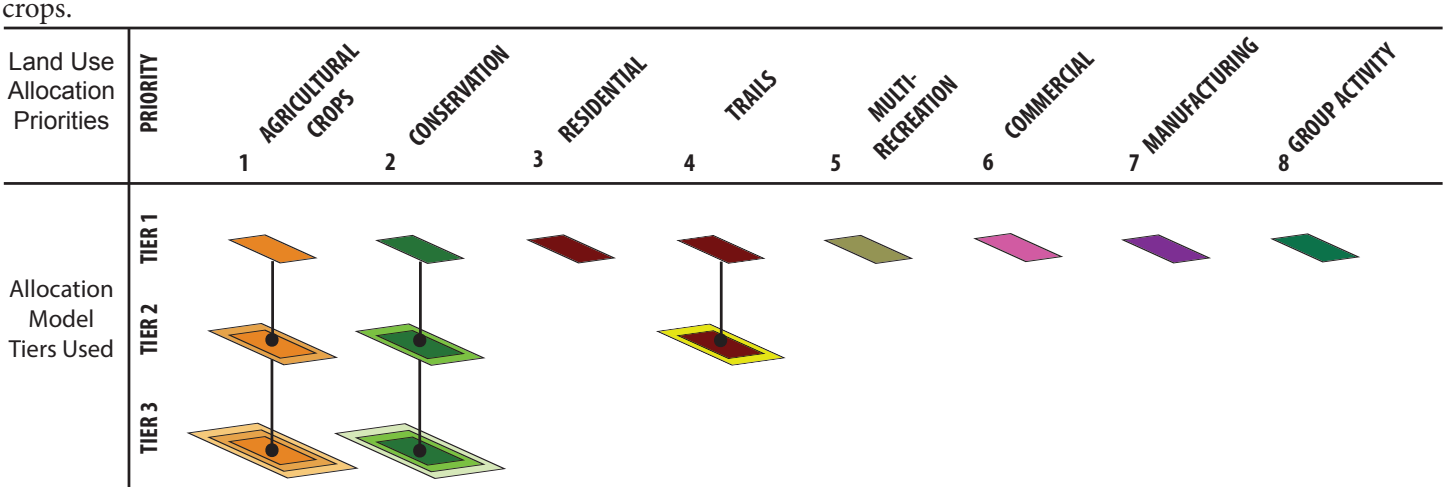
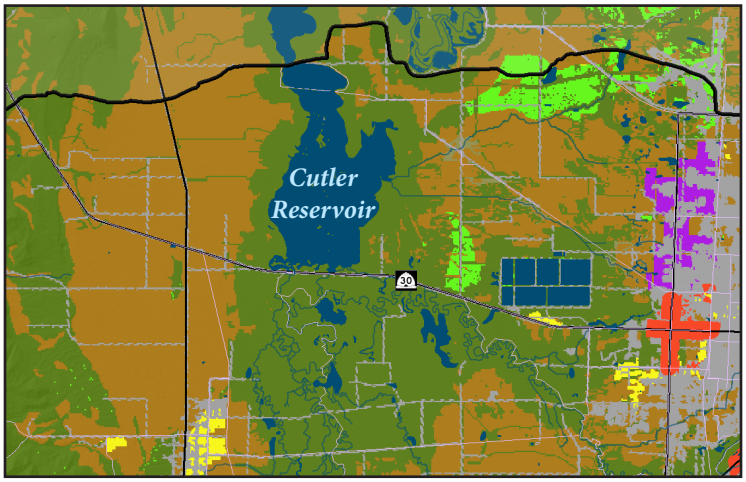


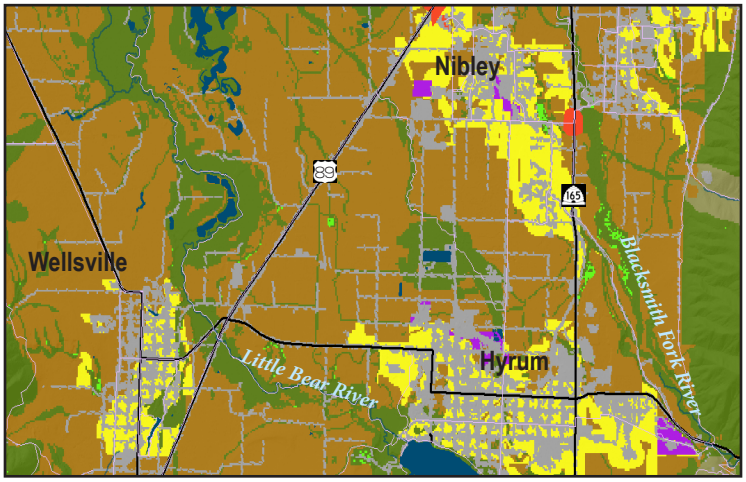

*Figure 6.9.* The allocation model tiers used to build the City-City, Country-Country alternative future

# Areas of Special Interest




## Wetlands & Agriculture

To improve water quality and wildlife habitat, agriculture (i.e., the brown areas) should be removed from sensitive areas along the rivers and reservoirs in Cache Valley. Areas such as Cutler Reservoir are important for migratory birds and support recreation activities including canoing, birdwatching, and hunting. Further, removing agriculture from the sensitive riparian areas would likely reduce agriculture runoff from fields and cattle manure, thus improving water quality and vegetation adjacent to rivers and reservoirs.




## Distinct Communities

By containing growth to current municipal boundaries, Nibley, Hyrum and Wellsville could maintain their separate, unique identities. Containing growth could also help maintain agriculture between the communities, which would allow for agriculture to remain a reliable economic driver and rural characteristic of the valley. Another benefit of limiting municipal expansion could be to preserve waterways such as the Little Bear and Blacksmith Fork Rivers. This could help the rivers regain their natural meander, and improve wildlife and water quality.

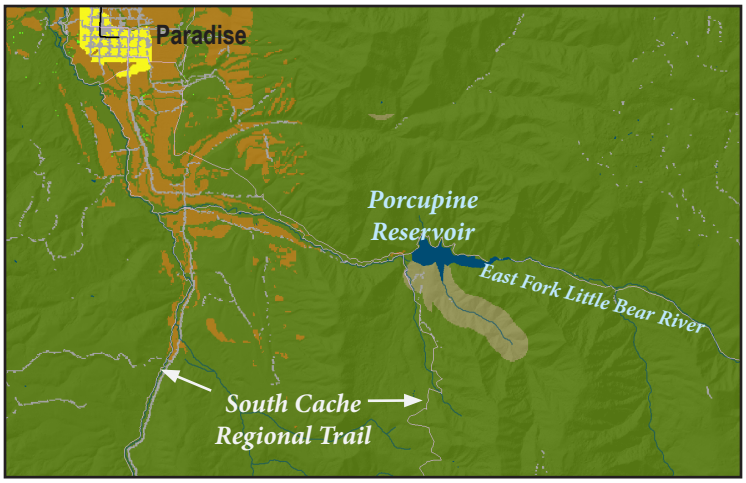
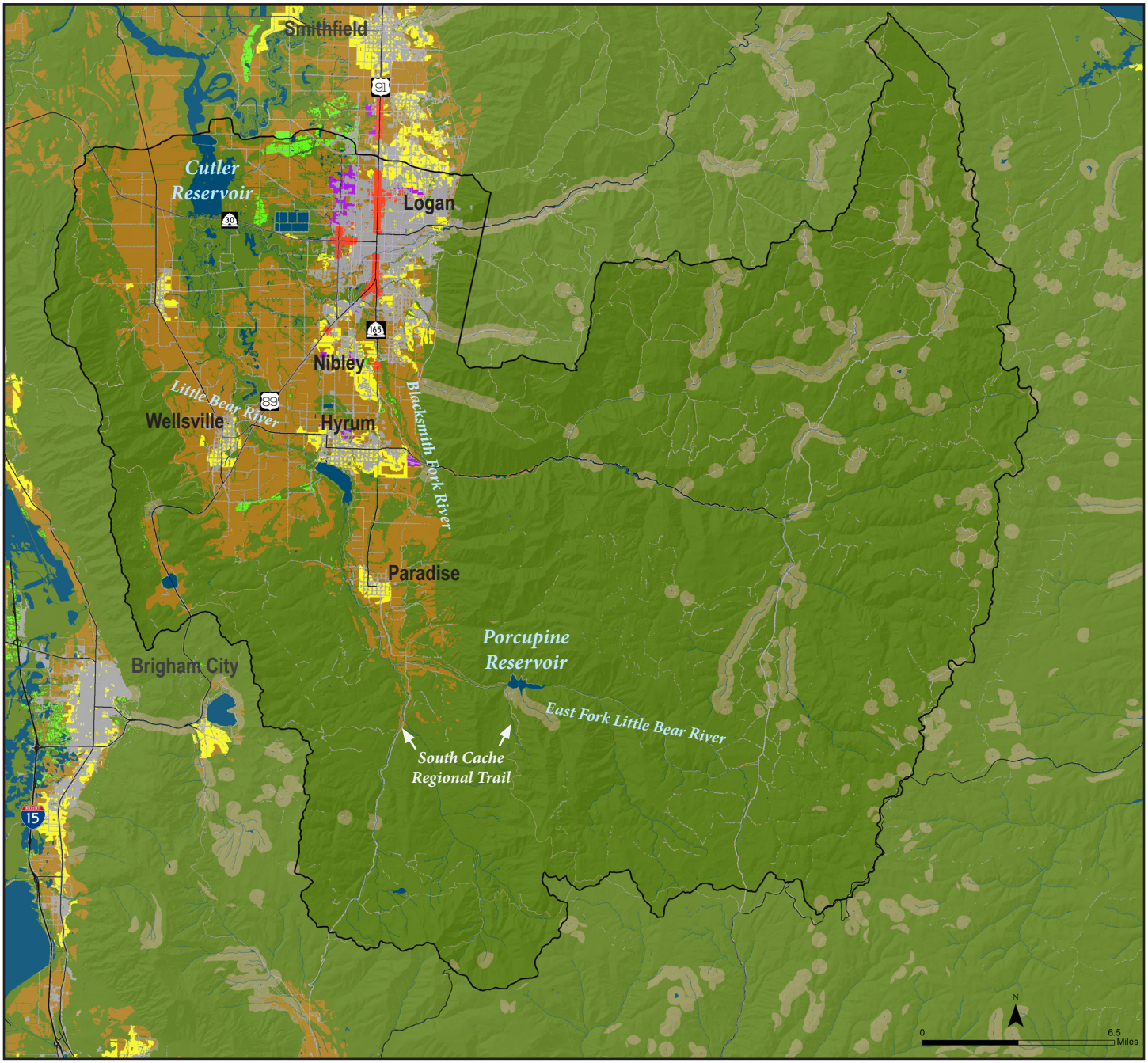



Figure 6.10. Enlargements of important components of City-City Country-Country.

## Recreation Access

Recreation facilities could open up currently little-utilized areas such as the south end of the valley near Paradise. A South Cache Regional Trail could connect resident and visitors to Porcupine Reservoir and the nearby East Fork Little Bear River, where Chinook salmon spawn in the fall. Public campgrounds and boat launches throughout the study area could help reduce recreation access conflicts due to growing population. The trail could continue into the southern spur of the Cache National Forest, connecting users into Ogden Valley, another regional recreational spot. The regional trail could allow local residents to bike, camp, fish and hike without being dependent on a vehicle to reach multiple access points.




## LEGEND

- Existing Development
- Manufacturing
- Commercial
- Residential
- Conservation
- Agriculture
- Group Recreation
- Multi-Recreation
- Trails

## City, Country & Mountain Recreation

New commercial development, like new residential development, should be concentrated within existing municipalities. Commercial development could be focused in high-traffic corridors, such as sections of Main Street in Logan City, as well as along major highway corridors. Also as with residential development, new commercial developments should be partially accommodated by increasing the unit density of existing developments. Industrial/manufacturing growth could occur in pockets around Logan and Hyrum, potentially providing jobs and economic stability for the region. Agriculture would remain in the valley, but shifted from sensitive water areas such as the center of the valley where the Blacksmith Fork, Logan, Little Bear and Bear Rivers meet. This would result in a net loss of agricultural land but improve water quality (see Figure 6.9) Recreational trails could be expanded in the mountains, which should provide connectivity between the valley and public lands.

# System Impacts Assessment Model Evaluations

*Improvement* **AGRICULTURAL CROPS**

Restricting growth to current municipal boundaries could preserve existing farmlands. In some areas, agriculture could be expanded to take advantage of fertile soil.

*Improvement* **AGRICULTURAL GRAZING**

Farmland and the Bear River Mountains could continue to support grazing practices. Additionally, conservation areas could support grazing with best management practices.

*Neutral* **GROUNDWATER QUALITY**

Development could remain within municipal boundaries, avoiding important groundwater recharge zones located along the foothills of the mountains.

*Improvement* **PUBLIC HEALTH AND SAFETY**

Limiting growth to existing municipal boundaries could prevent new development from expanding into natural hazard areas. The removal of development from floodplains should further reduce risks.

*Improvement* **RIVER ECOSYSTEMS**

By removing agriculture from riparian and adjacent surface water areas, the river ecosystems in these areas may return to their natural functions.

*Improvement* **SPECIES RICHNESS**

Restoration of riparian areas in this future would increase species richness. High-impact recreation activities may be restricted to designated areas, and Central Cache Valley could remain undeveloped.

*Impairment* **SURFACE WATER QUALITY**

Agriculture and development would continue to occur, producing more runoff potential than is present in the other alternative futures.

*Neutral* **GEOTHERMAL ENERGY**

Current and new development could take advantage of geothermal energy in municipal zoned areas, but development may likely be restricted in areas with high thermal conductivity.

*Neutral* **SOLAR ENERGY**

Current and new development could take advantage of solar energy in municipal zoned areas, but higher density developments would produce less overall roof area than in other alternatives.

# Issues Impacts Qualitative Evaluations

*Improvement* **AGRICULTURE**

Agriculture is central to maintaining the rural character and economic production in this future, and could be preserved through economic interventions such as the Rural fund.

*Neutral* **BIODIVERSITY**

The addition of conservation areas in the valley could help maintain current populations of species, but gains could be offset by continued agricultural practices.

*Neutral* **POPULATION GROWTH**

This future could accommodate a doubling of population by 2040, but current unit density would have to increase.

*Neutral* **AIR QUALITY**

Dense cities and improved transportation facilities could improve air quality, but continued farming practices and rural development may offset some of those gains.

*Improvement* **ECONOMY**

Adding recreation areas while preserving agriculture would allow for these current economic drivers to continue or increase. Meanwhile, distinct municipalities may encourage the development of town centers.

*Neutral* **RECREATION ACCESS**

Mountain recreational areas may be expanded to meet the needs of the growing population, but this future does not focus on adding recreation areas in the valley, such as for sports fields and city parks.

*Improvement* **RECREATION IMPACTS**

Recreation fees may support restoration and the conservation of natural areas such as the mountains and rivers. Designated high-impact recreation zones may reduce the impacts of dispersed recreation.

*Improvement* **TRANSPORTATION**

Alternative transportation options including trains, buses and trails could provide diverse options for residents and visitors to move into and around the watershed.

*Neutral* **WATER QUANTITY**

New residents and businesses would likely increase water consumption for these purposes. Simultaneously, agricultural supply must be maintained. New demand could be offset by improved agricultural technology such as drip irrigation and protecting aquifer recharge areas.

*Improvement* **RURAL CHARACTER**

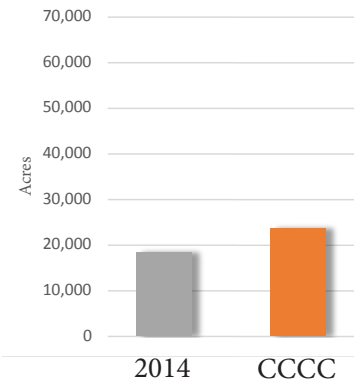
Current rural character could be preserved by containing growth to current municipal areas, maintaining agriculture and protecting natural areas.

*Neutral* **WATER QUALITY**

Development should not expand into important recharge areas, and agriculture could be removed from riparian areas. However, continued agricultural practices may still impact water quality.

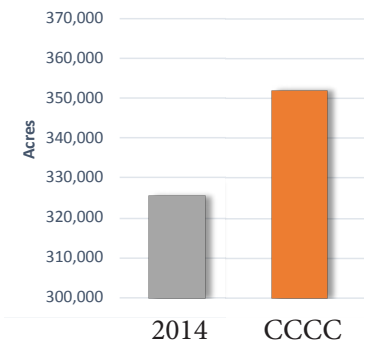
## Land Use Change Quantitative Evaluations

### DEVELOPMENT



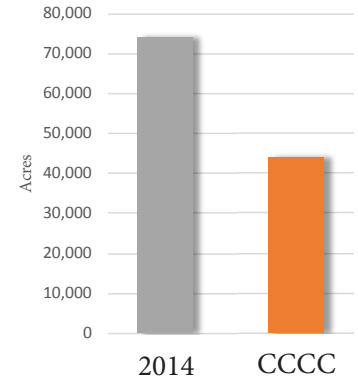

Development could slightly increase as it expands to the edges of current municipal areas. In order to accommodate growth, density would increase in most cities and towns.

### CONSERVATION



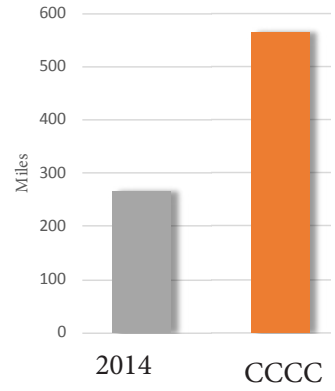

Conservation areas along rivers, reservoirs and wetlands could replace agricultural lands in the valley. The mountainous areas could continue to be under the conservation land use designation.

### AGRICULTURE




Agriculture could decrease in sensitive areas and within municipalities, but active strategies may be employed to preserve all agriculture that occurs outside of these areas.

### TRAILS




This future should take advantage of all the proposed new trails. Doing so could promote opportunities for alternative transportation and recreation.

Figure 6.11. Land Use Change graphs for City-City Country-Country (CCCC).

# TRAILHEAD TO THE OUTDOORS

## Creating Extensive Recreational Opportunities

### *Narrative*

*Driving into the valley, much has changed. Agriculture is not as prominent as it was 20 years ago, but there are many parks, fields and other non-agriculture open spaces throughout the valley. The cities are denser and the buildings are a little taller. Retail operations, restaurants and other service industries have expanded in most of the town centers. Although there are more people, fewer cars are on the road due to increased pedestrian, cycling and other alternative transportation opportunities. Each town center is contained within a belt of parks, playing fields and green spaces, and intersected by a network of trails that connects through the valley and into the mountains.*

### Recreational Opportunities

Trailhead to the outdoors (THO) is a recreation focused future that provides extensive recreational opportunities. These opportunities may occur both in Cache Valley and in the surrounding mountains, and take the forms of parks, playing fields, trail connections, river access, camping, hiking, biking, and off-highway vehicles (OHV) use. The towns in this future could be denser and enclosed by greenbelts — areas of vegetation, forest, or parkland surrounding a community. Extensive trails would connect the valley with the mountains, providing pedestrian and OHV access.

### Share economy: reducing traffic and increasing tourism

This future aims to shift from an agriculture based economy to a recreation based economy. Bike, car and house sharing programs could contribute an accommodations-base for this transition by providing stakeholders and visitors with access to amenities for a set time or distance.

When coupled with low cost infrastructure such as bike lanes, bike shares have been proven to reduce urban car traffic (Anderson, 2015). This would augment the trail systems and ease the pressure of increased visitorship on current infrastructure.

Effective marketing campaigns may draw visitors to take advantage of these programs. The “Mighty 5” campaign, which was recently conducted by the State of Utah, is an example of such a marketing campaign. After initiating this effort, Utah national parks experienced visitor increases of over 20% (O’Donoghue, 2016). An example of a campaign slogan for Cache Valley could be "Town & Wild," highlighting the small town lifestyle and multiple wilderness areas of the study area.

### Programs and Events

Community oriented events and programs can highlight the recreation assets of the area and increase local interest, which could result in increased support for a recreation/tourism based economy.

One possible community event could be a Trail Day, when community members could volunteer to build or maintain a trail. Studies have shown that community-oriented trail events increase local usage of trail systems (e.g., Brownson et al., 2000).

Finally, an example of an event that could garner both national and local interest could be to seek to host a smaller version of the Outdoor EXPO or Outdoor Retailer show. The Outdoor Retailer show is a biannual event that takes place in the Western U.S. and produces a $45 million

economic impact (Reimers, 2017). However, top retailers in the outdoor recreation business have shown concerns over support in Utah to rescind several recent national monument designations (Reimers, 2017). By being a leader in public lands conservation for recreational access, and by highlighting the study area's small towns and wilderness area assets, Cache Valley could garner support from Utah's outdoor industry, which could further increase its potential to become a recreational hub.

## Consistent Wayfinding

Lastly, creating consistent signage throughout the valley could help to unify the area and make it a recognizable destination. Consistent signage creates identity and coherency for trails systems. It also helps to improve wayfinding through the area.

One potentially iconic trail system in the study area is the Great Western Trail, which spans from Canada to Mexico and passes through the Bear River Mountain Range. By increasing access to this trail and providing commercial services in near proximity to trail access, the study area could eventually tap into a "trail town" economy, as is in the case of those that exist along the Appalachian, Pacific Crest and Continental Divide National Scenic Trails.

## Green belts

An important component of cultivating a dominant outdoor recreation character for Cache Valley should be to preserve open space in non-agriculture capacities. These areas could be developed as parks or sports fields or left open to dispersed recreation, and serve as corridors for the trails system, which should connect the green belt open spaces, providing linkages between the parks, city centers and additional recreational opportunities in the mountains.

*Green belt areas could include small parks similar to the existing Merlin Olsen Park in south Logan.*

By moving toward this future, agriculture may lessen but not disappear. Remaining agriculture may largely be located within the western and southern portions of the valley. Recreation would become a major economic engine. In order to have the largest economic impact, the new recreation economy should expand commercial operations as well as amenities and services. New commercial development should be focused along the Main Street of each municipality. This development offers each municipality the opportunity to develop a unique character, incorporating recreation assets and adding diversity and interest to the regional character.

# How was it built? Land Use Allocations

This model employed the "clip" priority method in addition to selective edits to uncover desired land uses. The priority for the different land uses are included below (see Figure 6.12). However, due to the selective edits, modifications were made to the tiers of some of the allocation models in order to better represent this future.

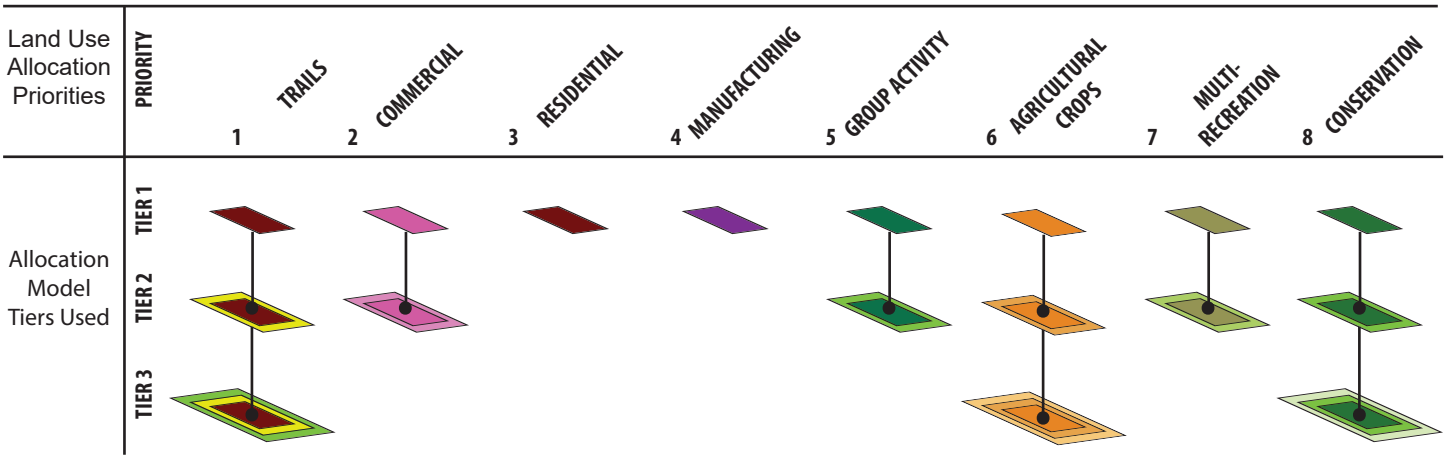
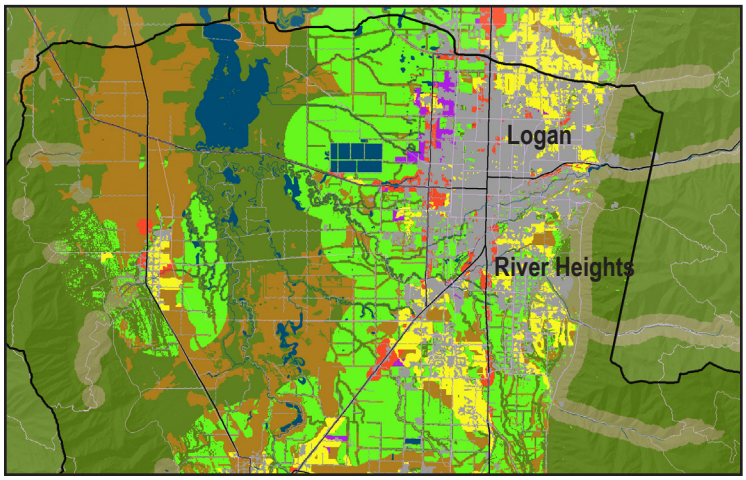


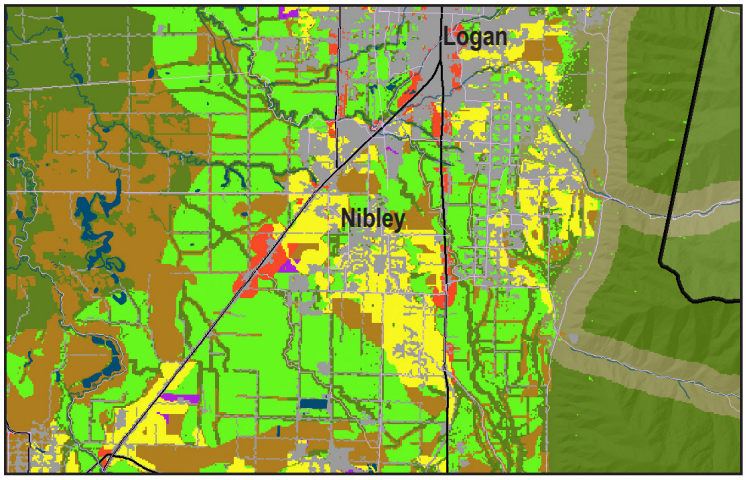

*Figure 6.12.* The allocation model tiers used to build the Trailhead to the Outdoors alternative future

# Areas of Special Interest



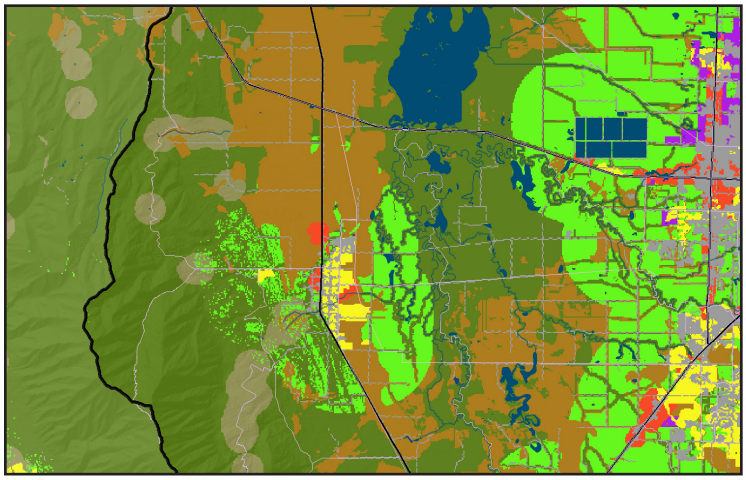

## Green Belt

Green belts of parks and non-agriculture open space (neon green areas on map) should be developed around the city centers of Cache Valley. In addition to providing recreational opportunities, these parks could provide environmental benefits, such as carbon sequestration, which may enhance current air quality. Parks within the green belts would provide different amenities, from playgrounds to open fields and sports fields, which could provide opportunities for both passive and active recreation.




## Focused Commercial

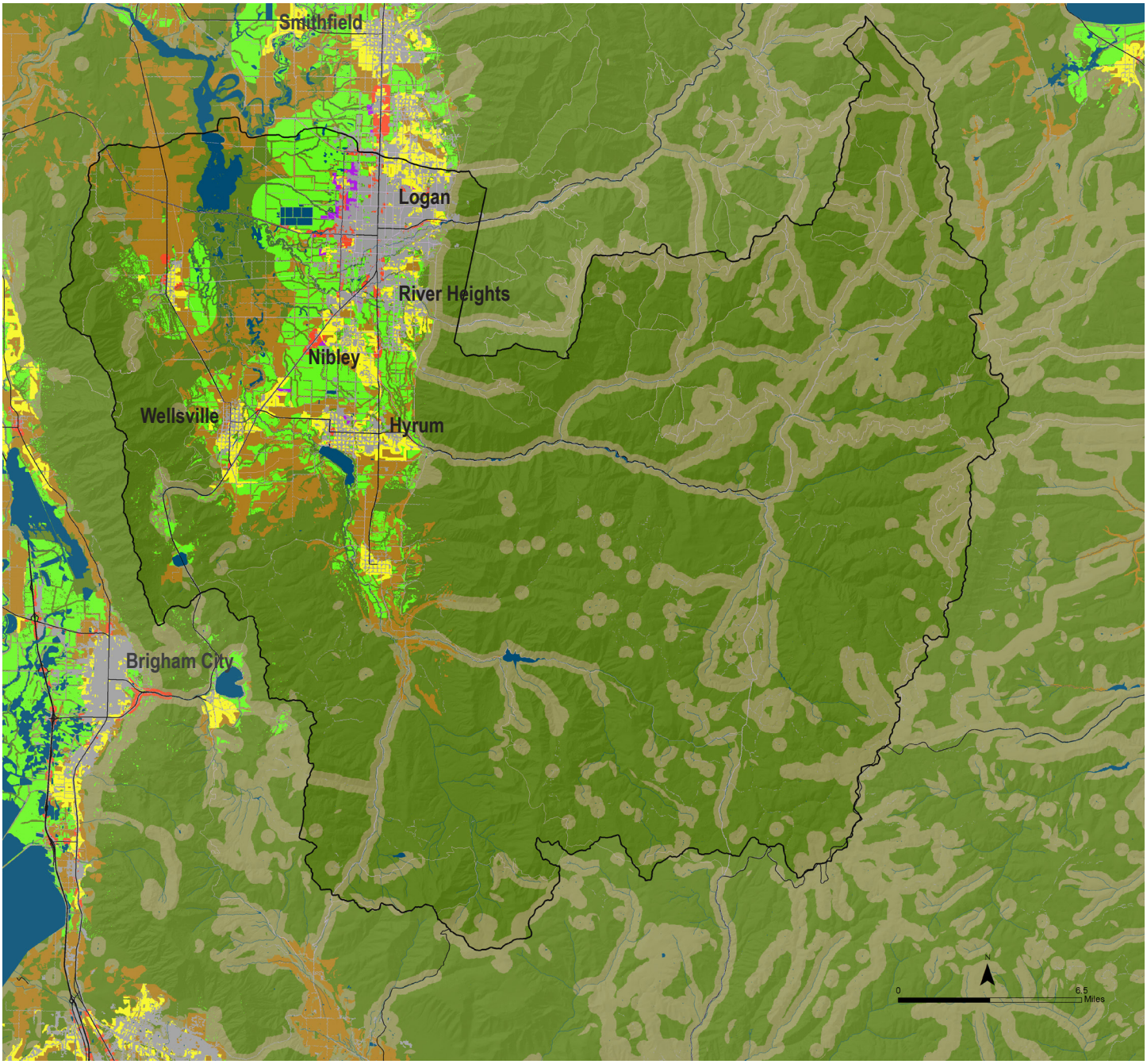
A shift towards a recreation economy and increases in tourism may provide new commercial opportunities. Commercial development in this future could be centered around major intersections and along major roads to create commercial hubs and districts. By doing so, the commercial opportunities are clustered into retail and service districts. The "Y" intersection at the south end of Logan, for example, could function as the commercial district for a new downtown for Nibley.



## Agriculture on the West Side

Agriculture could still exist in the valley (i.e., the brown areas), however, its extent would likely be reduced. Remaining crop lands may primarily located in the west side southern portions of the valley. Most of the crop land in the eastern portion of the valley may be converted to park and other recreation uses.

Figure 6.13. Enlargements of important components of Trailhead to the Outdoors.




**LEGEND**

- Existing Development
- Manufacturing
- Commercial
- Residential
- Conservation
- Agriculture
- Group Recreation
- Multi-Recreation
- Trails

## Recreation Hub

This future aims to develop a recreation based economy by building on the recreational assets that already exist in the study area. This future allows for substantial growth in conservation lands and trails to support that economy (see Figure. 6.14). Urban growth should be contained within municipal boundaries and the cities surrounded by green space and parks. These parks and green spaces should provide aesthetic quality and urban recreation opportunities, which should benefit residents overall and may draw tourists. Additionally, commercial districts may be established with dominant recreation themes, such as a fly-fishing-oriented district in Hyrum, near the entrance to the Blacksmith Fork canyon. A shuttle system could move residents and visitors around the study area and to trailheads and other recreation opportunities in the mountains. This could decrease the traffic on city streets and within the canyons.

# System Impacts Assessment Model Evaluations

*Impairment* **AGRICULTURAL CROPS**

Agricultural crops could be reduced due to transfers to green belts around town centers.

*Neutral* **AGRICULTURAL GRAZING**

Effects to agricultural grazing may be neutral because current uses may be maintained in the mountainous regions of the study area.

*Neutral* **GROUNDWATER**

There is no specific effort to preserve groundwater quantity/ quality involved with this future, although the green belts could prevent some development in aquifer recharge areas.

*Neutral* **PUBLIC HEALTH & SAFETY**

Although there is no particular strategy to address public health and safety that is unique to this future, proposed new development areas do not impact health and safety risks.

*Improvement* **RIVER ECOSYSTEMS**

River ecosystems may be enhanced due to the transition of agriculture to green space where riparian areas intersect the green belts.

*Neutral* **SPECIES RICHNESS**

Although a significant amount of area may be transfered to green belts, recreation activities are meant to occur in these areas, which could conflict with ideal habitat conditions.

*Neutral* **SURFACE WATER QUALITY**

Although riparian areas should be transfered to green belts, runoff from fertilized park landscapes in the green belts could negatively affect water quality.

*Neutral* **GEOTHERMAL ENERGY**

Although new developments may take advantage of geothermal energy, new development areas are not allocated specifically to take advantage of thermoconductivity.

*Neutral* **SOLAR ENERGY**

Solar energy could be harvested on a dispersed, residential scale, but this future does not allocate areas for utility scale development.

# Issues Impacts Qualitative Evaluations

*Impairment* **AGRICULTURE**

The transfer of agricultural lands in the valley to non-agricultural open space could decrease total agricultural lands.

*Neutral* **BIODIVERSITY**

More land could be conserved as open space, but increased recreational impacts may diminish the habitat in these areas.

*Neutral* **POPULATION GROWTH**

Current housing densities would likely increase to accommodate projected growth in this future.

*Improvement* **AIR QUALITY**

Alternative transportation opportunities could reduce overall emissions. Also, the addition of non-agricultural open space could result in increased carbon sequestration.

*Improvement* **ECONOMY**

Total economic output could improve with the transition from an agriculture based economy to one based on recreation.

*Improvement* **RECREATION ACCESS**

Additional parkland, trails, etc could provide visitors and residents more areas to recreate.

*Neutral* **RECREATION IMPACTS**

Additional green belt recreation areas, if well-managed, could improve recreation impacts, but the addition of recreation areas could also increase the likelihood of impacts occurring.

*Improvement* **TRANSPORTATION**

Trails and bike share programs could provide alternative transportation options in this future.

*Neutral* **WATER QUANTITY**

While this future could preserve first order streams and reduce agricultural water use, increasing population and cultivated park landscapes in the green belts may increase overall water use.

*Neutral* **RURAL CHARACTER**

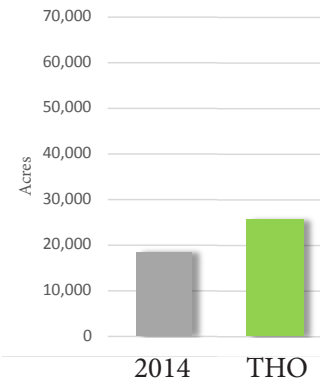
The green belts in this future would likely create a landscape character that is different from the one that exists today.

*Neutral* **WATER QUALITY**

Although riparian areas and first order watersheds could be conserved, recreation impacts and fertilizer runoff from parks could negatively affect water quality.

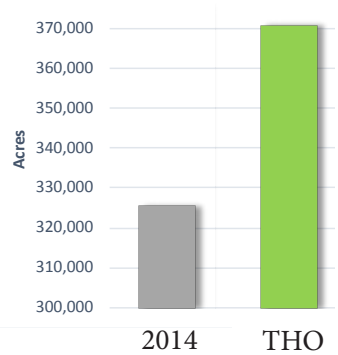
## Land Use Change Quantitative Evaluations

**DEVELOPMENT**



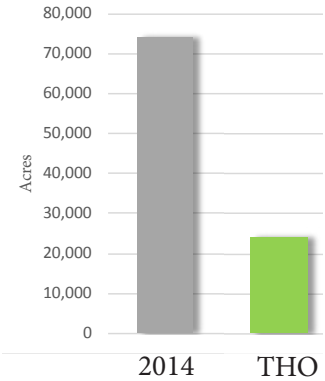

Development would likely increase overall, but at a higher overall density than currently exists.

**CONSERVATION**



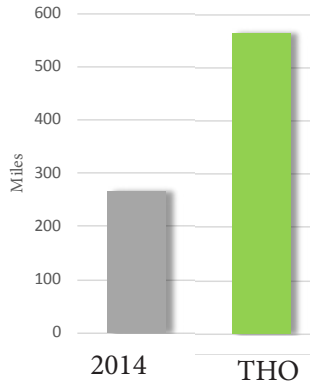

A large portion of the study area could be conserved for recreation and aesthetic purposes in the green belts around the town centers.

**AGRICULTURE**




Transitions to non-agriculture open space could result in a large net loss of agricultural lands.

**TRAILS**




The expansion of existing trail systems, as well as the development of entirely new systems, should take place this future.

*Figure 6.14.* Land Use Change graphs for Trailhead to the Outdoors (THO).

# CHAPTER 7: EVALUATIONS

Each of the four alternative futures represents a scenario for how the future of the Blacksmith Fork-Little Bear Watershed might change in the next twenty years.

This section provides comparisons of the four alternative futures, which are based on the three evaluation metrics used for each model, i.e., land use change, impacts on systems and impacts on issues. The comparisons are meant to indicate the strengths and weaknesses of each future relative to each other.

## Land Use Change Quantitative Evaluations

The land use change evaluation measures the amount of land lost or gained from 2014 to 2040 for the development, conservation, agriculture and trail land-use categories (see Figure 7.1).

Overall, the Business as Usual future provides the least restrictions on development. Both the Self Sustaining Cache and Trailhead to the Outdoors futures involve conserving large areas of land, thereby allotting them for multiple, non-permanent public uses (e.g., recreation and grazing). All of the alternative futures involve sharp declines in total area of agricultural land. However, the City-City, Country-Country future incorporates strategies to protect agricultural lands that are critical to the rural character of the study area. As a result, this future should preserve the greatest amount of agricultural land. Finally, all of the futures involve high degrees of trails expansion. However, the Business as Usual future would likely see less expansion overall, largely due to rights-of-way conflicts with future development.

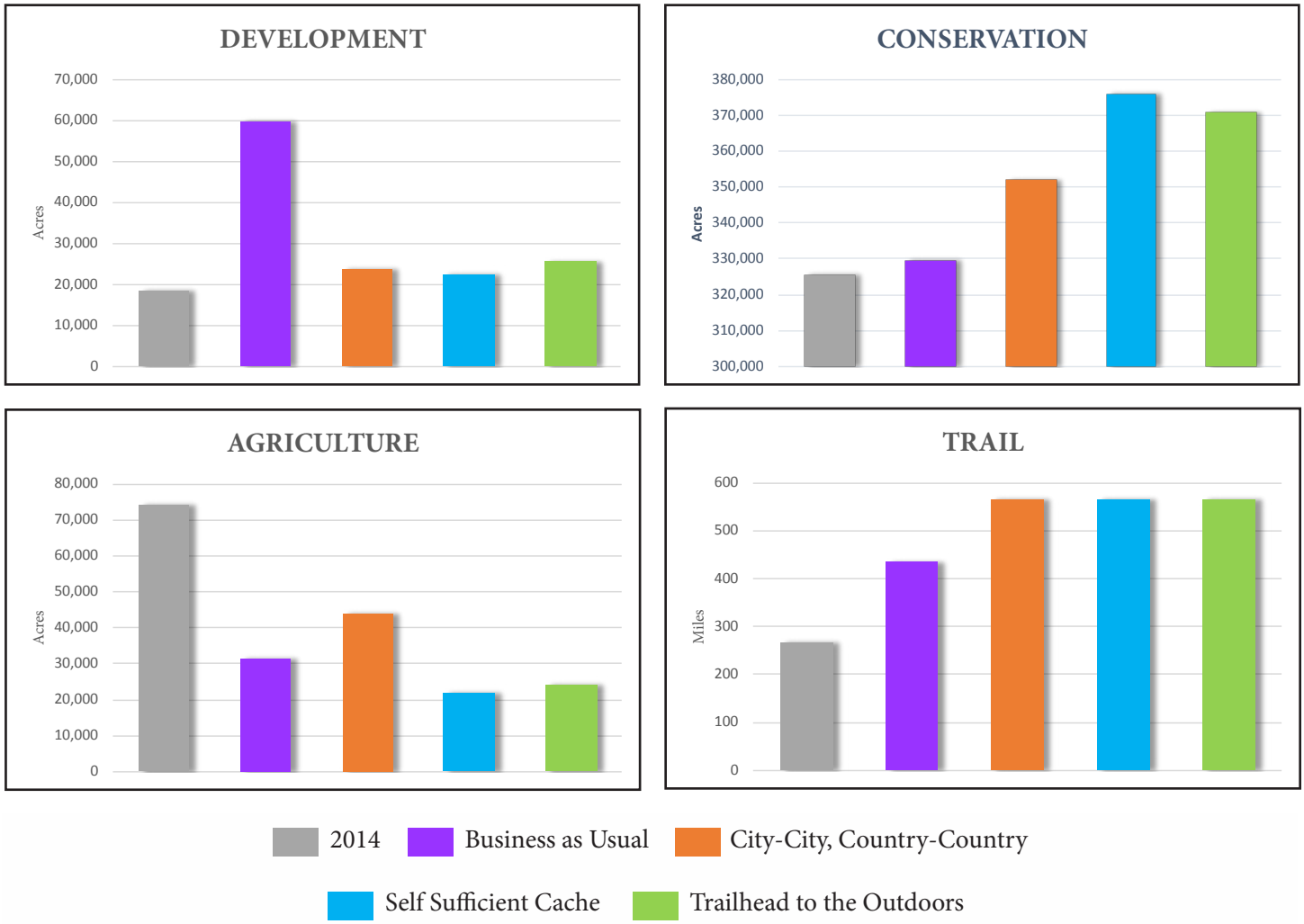



*Figure 7.1.* Land use change futures evaluations.

# System Evaluations Assessment Model Evaluations

In chapter 4, assessment models were created for the biophysical and cultural systems of the study area that were subject to vulnerability. These assessment models identified sensitive or critical areas for each system. These models were used to evaluate the impacts of the Alternative Futures on each of these systems, i.e. identify where the Alternative Futures impinged on critical areas (see Figure 7.2).

In order to compare the overall impact of the different Alternative Futures on the biophysical and cultural systems, the three categories of evaluation were assigned values: Impairment=3, neutral=2, improvement=1. The system impact values for each future are then totaled.

Overall, the Business as Usual future would impair most of the biological and physical systems, and would not considerably improve existing cultural systems. Business as Usual future would benefit specific groups, such as developers and crop producers, rather than the residents of the study area.

The Self Sufficient Cache future, by contrast, would improve most of the biological and physical systems. These improvements may produce goods, services and opportunities that would benefit the residents and crop producers of the study area.

The Trailhead to the Outdoors future would involve new regulations, which would be intended to transition the economy of the study area to a recreation base. This would have moderate impacts most systems, including water and wildlife systems due to increases in recreation.

Finally, the City-City, Country-Country future appears to provide improvements to most of the systems. As such, it may be the most desirable future in terms of overall impact to the critical systems that were identified by assessment models.

That being said, stakeholders will ultimately determine their own priorities for the future of their community, emphasizing particular systems over others. This analysis gives an overview of the general impact of the four different scenarios on important biophysical and cultural systems in the study area, and shows the opportunities and limitations of each of the Alternative Futures. However, decision makers can pick and choose the parts of each Future which they find most valuable.

| | BUSINESS AS USUAL | CITY-CITY, COUNTRY-COUNTRY | SELF SUFFICIENT CACHE | TRAILHEAD TO THE OUTDOORS |
|---|---|---|---|---|
| GROUNDWATER | 3 | 2 | 1 | 2 |
| SURFACE WATER | 3 | 3 | 1 | 2 |
| RIVER ECOSYSTEMS | 3 | 1 | 1 | 1 |
| SPECIES RICHNESS | 3 | 1 | 1 | 2 |
| AGRICULTURAL CROPS | 2 | 1 | 3 | 3 |
| AGRICULTURAL GRAZING | 3 | 1 | 2 | 2 |
| PUBLIC HEALTH & SAFETY | 2 | 1 | 2 | 2 |
| SOLAR ENERGY | 1 | 2 | 2 | 2 |
| GEOTHERMAL ENERGY | 2 | 2 | 2 | 2 |
| ***Systems Impact Total*** | ***22*** | ***14*** | ***15*** | ***18*** |

1 Impairment 2 Neutral 3 Improvement

*Figure 7.2.* Future impacts on systems

# Issues Evaluations Qualitative Evaluations

The intent of the Alternative Futures is to explore different solutions to the critical issues facing the watershed, which were identified in Chapter 2. For each Future, a qualitative assessment was made of how well it responded to each issue (see Figure 7.3). Similar to the previous systems evaluation, the assessment of how the Futures addressed the critical issues was made on a scale from 1:improvements to 3:impairments. Additionally, the aggregate score is used to compare the futures in terms of their overall effects on all of the critical issues.

The Business as Usual future would likely entail additional impairments for most current issues, especially as these issues relate to biophysical conditions. However, Business as Usual would likely be the most laissez-faire of any of the futures, and so would likely provide the fewest restrictions for population growth.

The Self Sufficient Cache and Trailhead to the Outdoors futures, by contrast, involve specific strategies to address issues relating to population growth and climate. The Self Sufficient Cache future aims to maximize ecological functions within the constraints of accommodating population growth, and the Trailhead to the Outdoors future aims to drastically alter the economy of the study area to a recreation base. The former would likely have the greatest positive impacts on biophysical issues, e.g. air, water quality and biodiversity; the latter could have unique strengths in regard to the cultural issues of recreation access and economic growth. The only impairment that these futures would likely involve regards agricultural lands, as these futures may significantly reduce agricultural crop lands.

The City-City, Country-Country future, on the other hand, is the only Future that is judged not to worsen the issues in the watershed. It aims to address both biophysical and cultural concerns, and would have strong benefits in both these categories, especially as relates to preserving the unique rural character of the study area.

Again, stakeholders may assess these impacts based on overall effect, or examine the issues that they perceive as the most important, in order to determine the opportunities and constraints of each alternative future.

| | BUSINESS AS USUAL | CITY-CITY, COUNTRY-COUNTRY | SELF SUFFICIENT CACHE | TRAILHEAD TO THE OUTDOORS |
|---|---|---|---|---|
| AIR QUALITY | 3 | 2 | 1 | 1 |
| RURAL CHARACTER | 3 | 1 | 2 | 2 |
| RECREATION ACCESS | 2 | 2 | 2 | 1 |
| RECREATION IMPACTS | 3 | 1 | 2 | 2 |
| WATER QUALITY | 3 | 2 | 1 | 2 |
| WATER QUANTITY | 3 | 2 | 1 | 2 |
| AGRICULTURE | 2 | 1 | 3 | 3 |
| ECONOMY | 2 | 1 | 2 | 1 |
| BIODIVERSITY | 3 | 2 | 1 | 2 |
| TRANSPORTATION | 3 | 1 | 2 | 1 |
| POPULATION GROWTH | 1 | 2 | 2 | 2 |
| ***Issues Impact Total*** | ***28*** | ***17*** | ***19*** | ***19*** |

3 Impairment 2 Neutral 1 Improvement

*Figure 7.3.* Future impacts on issues.

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**Self Sufficient Cache, Page 63**

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**Self Sufficient Cache, Page 64**

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**Trailhead to the Outdoors, Page 75**

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