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Commuter Rail and the Landscape: Alternative Futures for Planning in Southeastern Box Elder County

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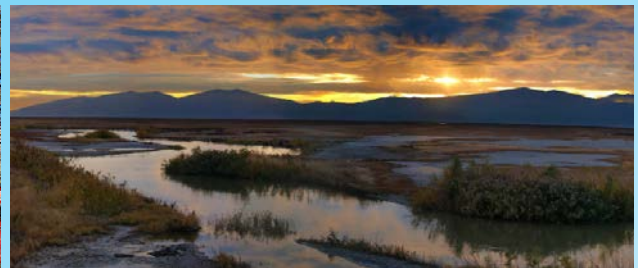
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COMMUTER RAIL AND THE LANDSCAPE

ALTERNATIVE FUTURES FOR PLANNING
IN SOUTHEASTERN BOX ELDER COUNTY



Plan B Project

C. Michael Gottfredson
M.S. Bioregional Planning

2016

BIOREGIONAL
PLANNING
PROGRAM



S.J. & JESSIE E. QUINNEY
COLLEGE of
NATURAL RESOURCES
UtahStateUniversity

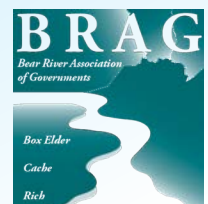


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COMMUTER-RAIL AND THE LANDSCAPE: ALTERNATIVE FUTURES FOR SOUTHEASTERN BOX ELDER COUNTY

EXECUTIVE SUMMARY

Context

Utah Transit Authority's (UTA) FrontRunner commuter-rail line was envisioned in the 1980's and 1990's to address the growing need in Utah for commuter transportation (UTA 2013). Issues such as the majority of Utah's population residing along the Wasatch Front, a growing population, and limited room for freeway expansion prompted Utah leaders to consider this alternative to the car. There were many roadblocks to the implementation of such a system, including cost and location. But with the acquisition of 175 miles of existing right of way from the Union Pacific Railroad in 2002, funding was granted from Federal and State governments, and construction began (UTA 2013). As of 2014, the FrontRunner commuter-rail system connects the greater Wasatch Front from Pleasant View to Provo. Connections to bus, light-rail, and car parks has increased FrontRunner's ridership to over 10,000 boardings per day (UTA 2014).

At the same time, southeastern Box Elder County (SEBEC), the area that encompasses Brigham City, Perry City, Willard City, and the surrounding county, has faced change and varying levels of growth. While the county has lost jobs from large corporations such as ATK and Laz Z Boy, population levels have risen, and employment is still strong when compared to the national average (BLS 2016). Couple this with the choice that local mayors made to join the Wasatch Front Metropolitan Planning Organization (MPO), a regional transportation planning body, the region is fastly becoming a focus of future planning and growth.

As the region continues to grow, UTA began preliminary investigations into bringing commuter-rail to Brigham City (Daily Herald 2009). The idea of bringing an alternative form of transportation to this rural region brings with it many questions and opportunities for analysis and study.



A view of southeastern Box Elder County from the Bear River Migratory Bird Refuge. Credits: Wikipedia

Southeastern Box Elder County is under increased development pressure as the Salt Lake metropolitan area expands.

The author, a student in Utah State University's Bioregional Planning Program, approached the local planners of SEBEC and proposed to do a study of the area to investigate the impacts FrontRunner would have on the environment and land-use. The planners, organized unofficially as the Box Elder Planners Association, agreed that such a study would be beneficial. Funded by Bear River Association of Governments (BRAG), the author began preliminary meetings in January 2014.

This report is the product of that study. However, this is not the only bioregional study that has been completed by Utah State University's professors or students that investigates this region. Landon Profaizer completed his thesis project in 2010, *Linking Communities in Box Elder County: Land Use Trends and Alternative Futures*. Profaizer's project was a review of the Box Elder County general plan, and analyzed historic, current and potential land uses in the county (Profaizer 2010). In regards to the potential to bring commuter-rail to Box Elder County, this study states the following:

"The eastern portion of the county is expected to grow significantly in the future given the likelihood of increased development pressure from the Wasatch Front. There are also improved public transit projects such as the I-15 expansion, construction of the northern portion of Legacy Highway, and the future addition of Commuter Rail to Brigham City." (Profaizer 2010).

His report also warns that "(w)ith increasing development pressure from the south, and the introduction of expected future highway and public transit projects, this area will be attractive to individuals or families looking for economic opportunities in urban areas, and more rural or affordable housing opportunities outside the cities they work in." (Profaizer 2010).

These development pressures produce at least one concrete conclusion: SEBEC is an area in transition. Several "trigger factors" have occurred, or will occur in the future, as a result of this pressure that will impact land-use, quality of life of the citizenry, and the environment. Specifically, these changes, or trigger factors, include the following:



The recent inclusion of the area into the Wasatch Front Metropolitan Planning Organization (MPO).



The advancement of mass-transit in the form of the Utah Transit Authority's FrontRunner train.



The development of the Bear River water allocations, placing constraints on the environmental services of the Bear River.

The FrontRunner coming to the “rural-urban fringe” that is SEBEC brings with it questions in regards to water quality, air quality, and environmental impact. Other questions include development patterns, the future of transit, and economic feasibility. This study will focus on the question: how will the coming of commuter-rail impact development in the area? It is the intent of this study to help local planners and decisionmakers address questions about future development in a logical, systematic way.

Objectives

The objectives of this study are as follows:

1. Provide the planning community in SEBEC with planning alternatives for commuter-rail. These alternatives, called alternative futures, show different visions for the form of land development in the future. These alternatives are to be amendable, meaning that they should be able to be adjusted, based on the values or vision the planners would like to pursue.
2. Provide the planning community with questions when considering planning and development in the region. These questions will be based on a bioregional analysis that would address the “triple bottom line” of economics, social/ cultural issues, and the environment.
3. Identify the issues that are most pressing to the people and elected officials of Box Elder County, and use these issues to direct how the bioregional analysis should move forward.
4. Create a digital document for the planners, elected officials, and public of SEBEC, that would be easily and publicly accessible.

These objectives provided the direction of the study. A customized method for the analysis of this region was developed based on bioregional planning precedent and case studies to accomplish these objectives. Figure 1 shows the methodology for this study. For more information on this methodology was developed, please see Appendix A in the full report.

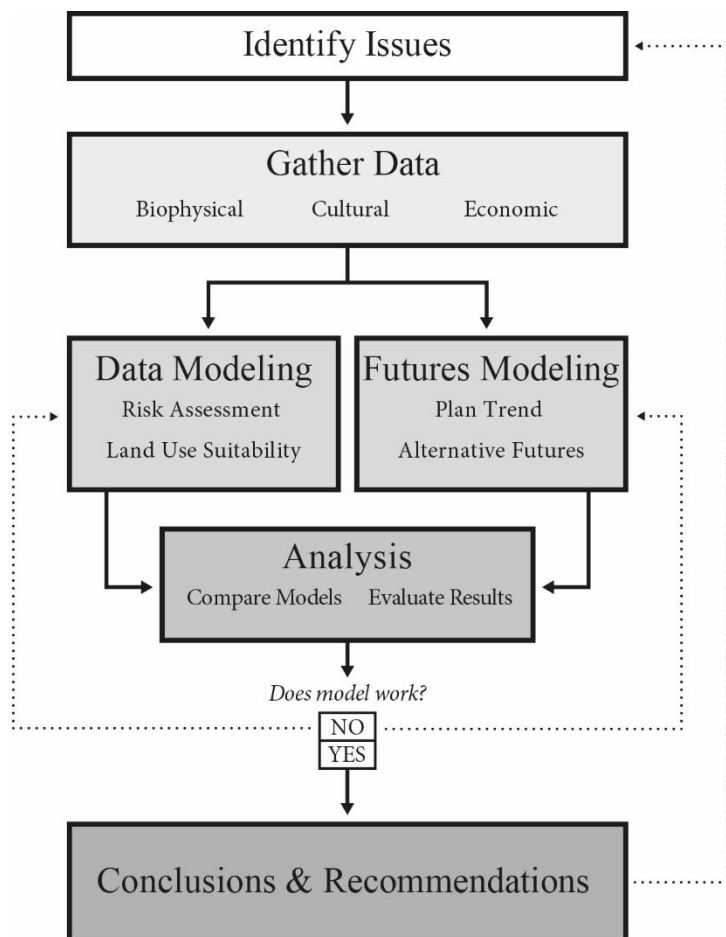


Figure 1: Study Methodology

Issues Identified

The author made multiple trips to the region to document it through photographs and observations. Places visited included South Willard, Willard, Willard Bay, Perry, Brigham City, Mantua, and the different proposed stop sites at Willard, Perry, and Brigham City. Face-to-face meetings were held with local community representatives and staff and planners from the Wasatch Front Regional Council. These stakeholder meetings took the form of informal interviews with local planners and elected officials between the fall of 2013 and the fall of 2014.

From the different trips to the region and stakeholder meetings, the following issues arose needing to be addressed when it comes to commuter-rail transit, development, and the environment:

1. There is discrepancy between municipalities as to the location of the proposed stops for the FrontRunner.
2. Currently, the factors that would fund the FrontRunner's operational cost would not be feasible.
3. Much of the land that the new rail line will pass through could be environmentally sensitive.
4. The air quality in eastern Box Elder County is far worse than the national average at certain times of the year.

Data Gathered

In order to evaluate the best future for the region in response to commuter-rail, a geographic information system (GIS) was used. This system was based on best available data found in local, state, and national data clearinghouses. By relying on these data clearinghouses, the process outlined in the Figure 1 can be replicated and updated as new data becomes available.

In this study, three aspects of the study area were reviewed: biophysical, economic and social/ cultural aspects (see Figure 2). These three aspects of the landscape are reviewed thoroughly in Chapter Three.

Biophysical: The study area is in southeastern Box Elder County, Utah. The study area encompasses a section of the northern Wasatch Range of mountains to the east, the lower Bear River Basin to the north, and the Great Salt Lake to the West. The Bear River flows into the Great Salt Lake from the north. The lowland areas are primarily marsh and wetland, surrounded by shrub-steppe, agricultural lands, foothills, and mountainous areas with steep slopes. The area resides in two ecoregions: the Central Basin and Range Ecoregion; and the Wasatch and Uintah Mountain Ecoregion (Bailey 1994).

Social/ Cultural: Five municipalities are encompassed within this area, Brigham City (also the County seat), Corinne City, Mantua Town, Perry City, and Willard City. Interstate 15 and multiple

Issues of concern for the region regarding commuter-rail include stop locations, the cost of service, and developing sensitive lands.

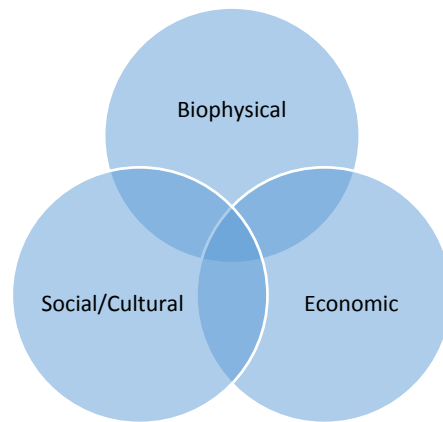


Figure 2: Aspects of the Landscape

The study area is on the rural-urban fringe, and includes the majority of Box Elder County's population, and has a growing economy.

utility corridors runs through the center of this area. Salt Lake City, Utah's capitol, is approximately 60 miles to the south. The area houses the majority of residents in Box Elder County, with an estimated population of 24,545 people in these five municipalities and more without in the county (ACS 2014). 91% of the people are white, with little other diversity (2010 Census). Land-use is varied, with the majority of lands categorized as agricultural and public lands. Residential and commercial lands make up the rest of the area. Of note, the area houses the largest Migratory Bird Refuge in the state, several large historic buildings and properties, and Willard Bay State Park.

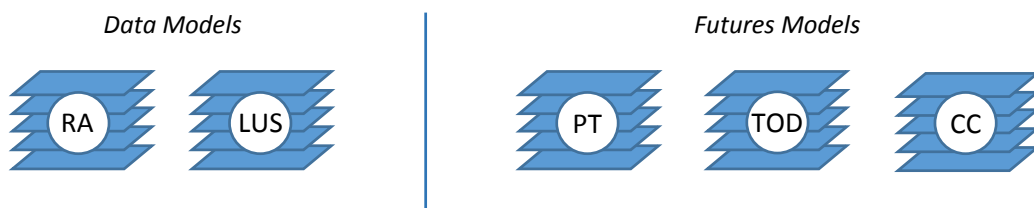
Economic: the primary economies of southeastern Box Elder County include manufacturing, commercial and agriculture. The total labor force of Box Elder County is 18,449 people, with an unemployment rate being 4.9%. Median household income is \$42,500. 83% of workforce have a high school education or higher, with 31% having the equivalent of a bachelor's degree or higher (Census 2010).

Looking at the biophysical, social/cultural, and economic aspects of the study area, we can conclude the following:

1. SEBEC is in the high mountain desert, with the associated resiliencies and sensitivities to change;
2. Most people in Box Elder County live in SEBEC;
3. The area is mostly rural, but is starting to develop into a more suburban environment; and
4. The economy in the region is strong and growing.

Create Models

The GIS models developed were created to evaluate how different types of development would impact the landscape, and how the landscape would impact development. These include *Data Models* and *Futures Models*.



Data Models: data: the two types of data models created were a risk-assessment model and a land-use suitability model.

The *risk-assessment model* focused on current landscape factors that have a positive value on public health, safety and welfare. This means that if development occurred in these areas, there would be a negative effect on overall public health, safety and welfare. Three tiers were developed for this model, with the Tier 1 having the least amount of sensitive land, and Tier 3 having the most amount of sensitive land. The basis of this model was founded on the *Critical Lands Toolkit*, developed by the Governor's Office of Planning and Budget (Utah GOPB 2005).

The *land-use suitability* model focused on aspects of the landscape that would lend themselves to the development of residential housing. The basis of this model was founded on the *Alternative Futures on the Little Bear River* study by the Bioregional Planning Studio (Toth et al, 2007).

Futures Models: three data models were developed to show three different future scenarios within the region: a plan trend future, a transit-oriented development future (TOD) alternative future, and a community center alternative future.

The *plan trend futures model* is based on current trend patterns. This analysis used historic GIS imagery and calculated the rate of change of development since 2006. Using this rate of change, the model projected development into the future until 2040, radiating out from current developed land. This future was used as the given future if no other future is considered.

The *TOD alternative futures* model is based on current plans for commuter-rail transit stops within the region. There are three sites: Willard, Perry, and Brigham City. These futures concentrate proposed future development to these stops and are based on future population projections.

The *community center alternative futures* model was based on focusing future commuter-rail transit stops closer to the community centers within the region. This means there would be more stops along the rail route. The sites would be in South Willard, Willard, Perry, and Brigham City. Because of the frequency of these stops, a diesel-car driven train would replace the current locomotive driven standard that is currently used by UTA’s FrontRunner.

Analysis

The Data Models and Futures Models were compared against each other in order to investigate how the Futures Models reacted to the Data Models. These models were compared using GIS calculations with the results shown in Tables 1 and 2:

Table 1: Comparison of Total Area of the Risk Assessment Model by the Futures Models

	Futures Models		
	<i>Plan Trend</i> Area (acres)	<i>TOD</i> Area (acres)	<i>Community Center</i> Area (acres)
<i>Risk Assessment Model</i>			
Tier 1	8,875.99	6,734.55	6,718.98
Tier 2	8,971.62	7,029.67	7,001.87
Tier 3	12,694.72	9,607.44	9,594.10

Table 2: Comparison of Total Area of the Land-use Suitability Model by the Futures Models

	Futures Models		
	<i>Plan Trend</i> Area (acres)	<i>TOD</i> Area (acres)	<i>Community Center</i> Area (acres)
<i>Land-use Suitability Model</i>			
Residential	4,518.39	3,320.80	3,311.68

From these results the Community Center Alternative Futures model impacts the least amount of land according to the Risk Assessment Model. The Community Center Alternative Futures Model also impacts the least amount of land in the Residential Land-use Suitability Model. This means more land can be used for future development.

Conclusions

Based on the comparison of the Data Models and the Futures Models, the Community Center Alternative Futures model impacts the least amount of land. This means concentrated rail-development around these community centers would address the proposed development needs while impacting the least amount of critical lands and lands most suitable for residential development. It should be mentioned that these results only reflect the values representing concentrated residential development. Other types of future residential development, such as the single-family housing, is not taken into account. Alternative futures taking into account single-family housing development, along with other types of housing, can be developed following the study methodology outline in Figure 1.

The Community Center Alternative Futures model conserved the most sensitive and most suitable lands for residential development.

Recommendations

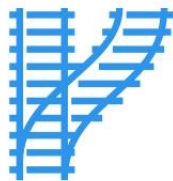
Based on the conclusions from the study, five recommendations became apparent:

- (1) *Conduct a community survey gauging the development preferences of the public.* This survey would serve as a basis for the development of future plans for development, and localities could cite this survey as in developing future land-use policy.
- (2) *Identify the rail corridor for commuter-rail.* By identifying the rail corridor, the localities and Box Elder County could then work with state and federal funders to begin to pursue the purchase of right-of-ways for future rail development.
- (3) *Continue to perform advanced modeling of proposed future development in the region.* This advanced modeling would build on the plan trend futures models developed by Landon Profaiser in 2010, and the plan trend futures models developed in this study. These models would take into account different data sets not available to the author, and provide a more robust idea of where development will occur.
- (4) *Pursue more information regarding a diesel-powered commuter-rail option to southeastern Box Elder County.* Having more information regarding this option would assist the localities in the region, Box Elder County, and the Utah Transit Authority in assessing the feasibility of providing this service in the region.

1. Conduct Community Survey



2. Identify Rail Corridor



3. Continue Advanced Modeling



4. Pursue Diesel Information



Summary

<u>Study Objective</u>	<u>Proposed Solution</u>
<i>Provide alternatives for commuter-rail</i>	Concentrated development around community centers in South Willard, Willard, Perry, and Brigham City, all serviced by diesel-driven cars as a commuter-rail service, meets future residential development needs while impacting the least amount of critical lands. Other alternatives are found within this document.
<i>Provide the community with questions to answer when addressing development</i>	<ul style="list-style-type: none">• What are the community’s critical lands for health safety and welfare? How can these be protected?• Where are the lands that are most suitable for residential development?• How can suitable residential lands be developed with the least amount of impact on the critical lands of the community?• How can commuter-rail address the growing needs of the region?
<i>Identify the issues most pressing by the community</i>	<p>(1) There is discrepancy between municipalities as to the location of the proposed stops for the FrontRunner.</p> <p>(2) Currently, the factors that would fund the FrontRunner’s operational cost would not be feasible.</p> <p>(3) Much of the land that the new rail line will pass through could be environmentally sensitive.</p> <p>(4) The air quality in eastern Box Elder County is far worse than the national average at certain times of the year.</p>
<i>Create a digital document</i>	This document is provided to the localities and communities of southeastern Box Elder County as a digital copy, and is available through Utah State University’s Bioregional Planning Program website.

About the Author

C. Michael Gottfredson is a Master of Science in Bioregional Planning candidate at Utah State University. Mr. Gottfredson has a Bachelor of Landscape Architecture from Utah State University, and was employed as a regional planning intern at the Bear River Association of Governments, in Logan, Utah, from 2012-2015. Mr. Gottfredson is currently employed as a regional planner for the New River Valley Regional Commission, in Radford, Virginia.

This executive summary report was developed in November 2016. It is based on a Master of Science Plan B project by the author, titled *Commuter-rail and the Landscape: Alternative Futures for Southeastern Box Elder County* (2016). For a digital copy of the full report, please contact Bear River Association of Governments at 435-752-7242, or at zacc@brag.utah.gov.

ACKNOWLEDGEMENTS

I would like to thank the following: Bear River Association of Governments, who provided financial support to this project in the form of a part-time internship, data support, and general knowledge. From Bear River Association of Governments, special thanks to Zac Covington and Brian Carver for their patience and support- not only in this project, but for the experience working for their outstanding organization.

Thanks to members of the Box Elder Planners Association, including Bryce Wheelwright, Scott Lyons, Sam Heiner, Mark Bradley, Paul Larsen, and Shawn Warnke. Special thanks to Box Elder County Commissioner Stan Summers and Mayor Karen Cronin of Perry City. Thanks to Jon Cluff and Kent Jorgensen at Utah Transit Authority for their expertise.

Thanks to my outstanding thesis committee from Utah State University. Special thanks to Dr. Barty Warren-Kretzschmar, whose close examinations helped the logic and flow of the study. Thanks to Professor David Evans, whose encouragement in this project, and reminder of how well I did in Construction Documents, will forever be on my mind.

My most special thanks go to family, Emily, Daniel, and Grace, whose support and encouragement I could not do without. Thank you for your sacrifices in helping me complete this project. I couldn't have done it without you.

And a special thanks to my major professor, Professor Richard E. Toth, whose guidance, leadership, and theory influenced me to enter the field of bioregional planning. His influence will be with me for the rest of my professional and personal life, and I am indebted to him.



Professor Richard E. Toth, 1937-2018

PREFACE

Utah Transit Authority's (UTA) FrontRunner commuter-rail line was envisioned in the 1980's and 1990's to address the growing need in Utah for commuter transportation (Utah Transit Authority, 2013). Issues such as the majority of Utah's population residing along the Wasatch Front, a growing population, and limited room for freeway expansion prompted Utah leaders to consider this alternative to the car. There were many roadblocks to the implementation of such a system, including cost and location. But with the acquisition of 175 miles of existing right of way from the Union Pacific Railroad in 2002, funding was granted from Federal and State governments, and construction began (Utah Transit Authority, 2013). As of 2014, the FrontRunner commuter-rail system connects the greater Wasatch Front from Pleasant View to Provo. Connections to bus, light-rail, and car parks has increased FrontRunner's ridership to 19,800 boardings per day, with an estimated increase of 34,100 boardings by 2040 (Utah Transit Authority, 2013).



FrontRunner train (Source: UTA)



View of Southeastern Box Elder County (Source: U.S. Fish and Wildlife Service)

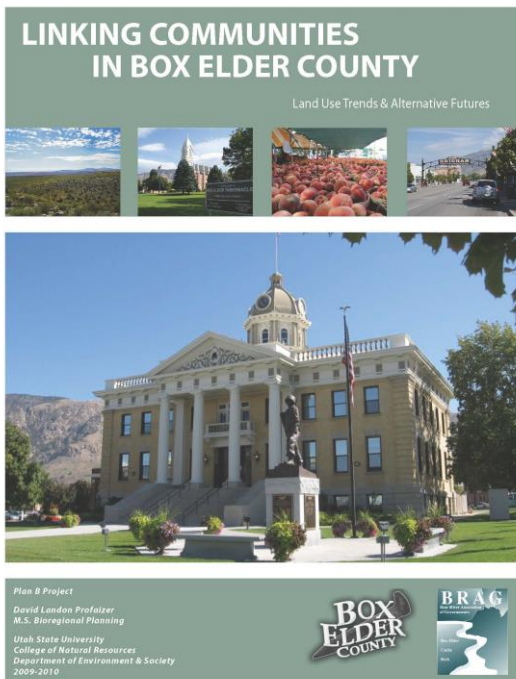
At the same time, southeastern Box Elder County (SEBEC), the area that encompasses Brigham City, Perry City, Willard City, and the surrounding county, has faced change and varying levels of growth. While the county has lost jobs from large corporations such as ATK and Laz Z Boy, population levels have risen, and employment is still strong when compared to the national average (Utah Department of Workforce Services, 2016)(Bureau of Labor Statistics, 2016). Couple this with the choice that local mayors made to join the Wasatch Front Metropolitan Planning Organization (MPO), a regional transportation planning body, the region is fastly becoming a focus of future planning and growth.

As the region continues to grow, UTA began preliminary investigations into bringing commuter-rail to Brigham City (Stryker, 2009). The idea of bringing an alternative form of transportation to this rural region brings with it many questions and opportunities for analysis and study.

CONTEXT

The author, a student in Utah State University's Bioregional Planning Program, approached the local planners of SEBEC and proposed to do a study of the area to investigate the impacts the FrontRunner commuter-rail service would have on the environment and land-use. The planners, organized unofficially as the Box Elder Planners Association, agreed such a study would be beneficial. Funded by Bear River Association of Governments (BRAG), the author began preliminary meetings in January 2014. Map 1 shows the context map of the study area.

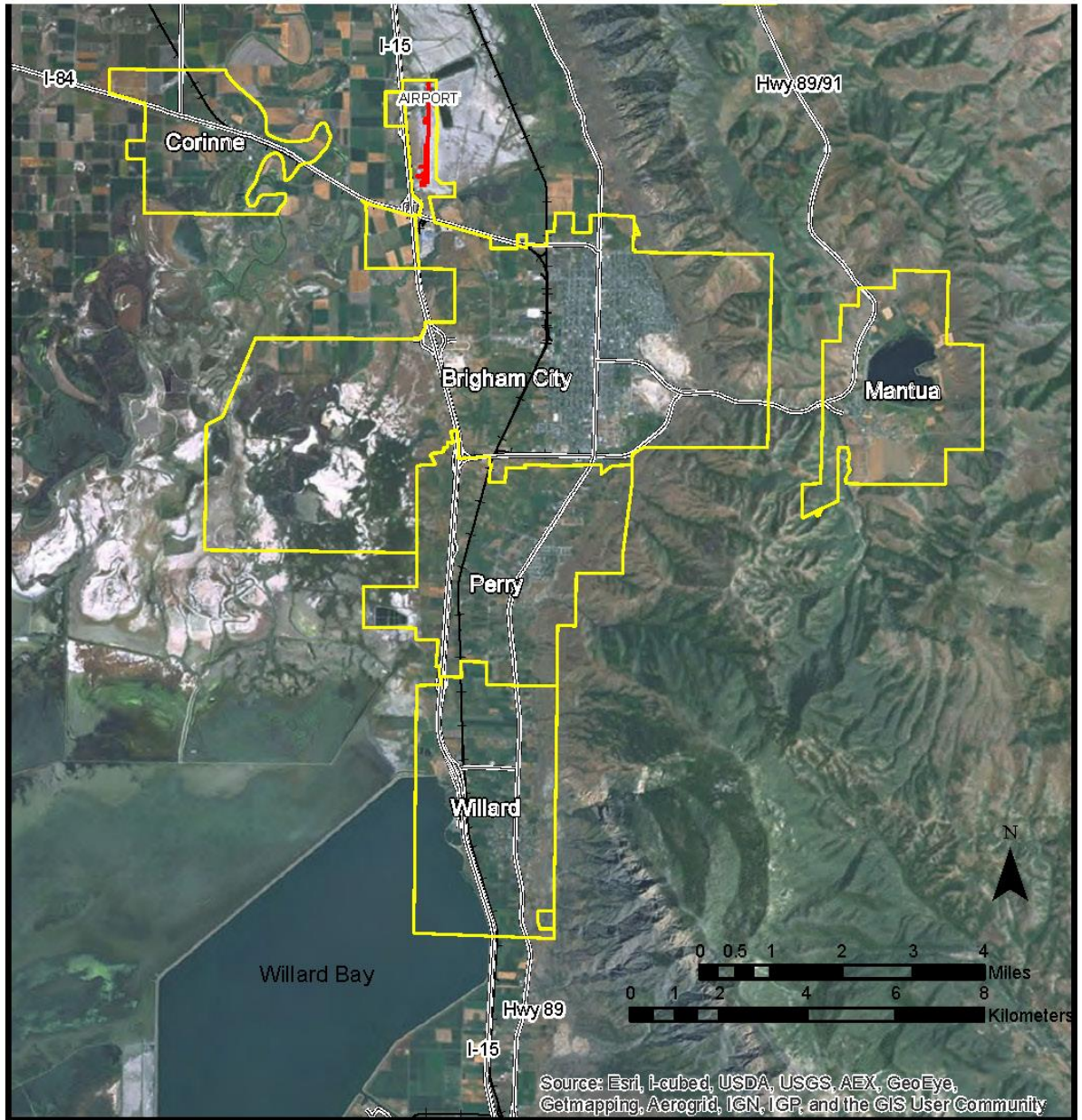
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“The eastern portion of the county is expected to grow significantly in the future given the likelihood of increased development pressure from the Wasatch Front. There are also improved public transit projects such as the I-15 expansion, construction of the northern portion of Legacy Highway, and the future addition of Commuter Rail to Brigham City.” (Profaizer, 2010).

His report also warns that “(w)ith increasing development pressure from the

Context Map



Legend

-  Airports
-  Major Roads
-  Railroads
-  Municipalities



Parcel for sale in Brigham City. (Source: Author)

south, and the introduction of expected future highway and public transit projects, this area will be attractive to individuals or families looking for economic opportunities in urban areas, and more rural or affordable housing opportunities outside the cities they work in.” (Profaizer, 2010).

These development pressures produce at least one concrete conclusion: SEBEC is an area in transition. Several “trigger factors” have occurred, or will occur in the future, as a result of this pressure. These trigger factors will impact land-use, quality of life of the citizenry, and the environment. Specifically, these changes, or trigger factors, include the recent inclusion of the area into the Wasatch Front Metropolitan Planning Organization (MPO); the advancement of mass-transit in the form of the Utah Transit Authority’s FrontRunner train services; and the development of the Bear River water allocations, placing constraints on the environmental services of the Bear River.

Trigger Factors for the Region



The recent inclusion of the study area into the Wasatch Front Metropolitan Planning Organization (MPO).



The advancement of mass-transit in the form of the Utah Transit Authority's FrontRunner train.



The development of the Bear River water allocations, placing constraints on the environmental services of the Bear River.

The FrontRunner coming to the “rural-urban fringe” that is SEBEC brings with it questions in regards to water quality, air quality, and environmental impact. Other questions include development patterns, the future of transit, and economic feasibility. This study will focus on the question: how will the coming of commuter-rail impact development in the area? It is the intent of this study to help local planners and decisionmakers address questions about future development in a logical, systematic way.

OBJECTIVES

The objectives of this study are as follows, and provide the direction of the study:

- 1. Provide the planning community in SEBEC with planning alternatives for commuter-rail.** These alternatives, called alternative futures, show different visions for the form of land development in the future. These alternatives are to be amendable, meaning that they should be able to be adjusted, based on the values or vision the planners would like to pursue.
- 2. Provide the planning community with questions when considering planning and development in the region.** These questions will be based on a bioregional analysis that would address the “triple bottom line” of economics, social/ cultural issues, and the environment.
- 3. Identify the issues that are most pressing to the people and elected officials of Box Elder County,** and use these issues to direct how the bioregional analysis should move forward.
- 4. Create a digital document for the planners, elected officials, and public of SEBEC,** that would be easily and publicly accessible.

A customized method for the analysis of this region was developed based on bioregional planning precedent and case studies to accomplish these objectives. Figure 1 shows the methodology for this study. For more information on this methodology was developed, please see Appendix A in the full report.

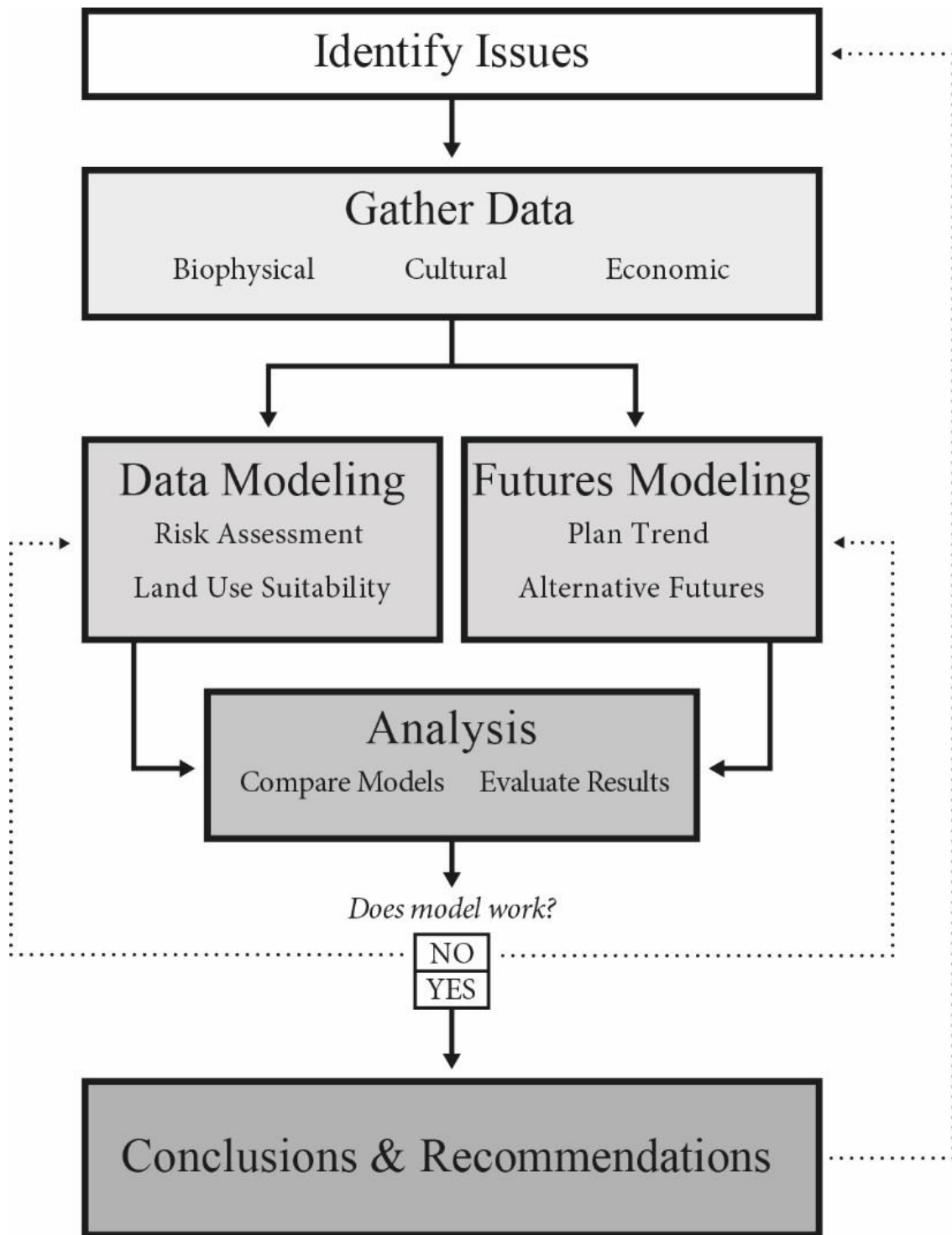


Figure 1: Study Methodology

ISSUES IDENTIFIED

The author made multiple trips to the region to document it through photographs and observations. Places visited included South Willard, Willard, Willard Bay, Perry, Brigham City, Corinne, Mantua, and the different proposed stop sites at Willard, Perry, and Brigham City. Face-to-face meetings were held with local community representatives and staff and planners from the Wasatch Front Regional Council. These stakeholder meetings took the form of informal interviews with local planners and elected officials between the fall of 2013 and the fall of 2014. Appendix B includes a list of the meetings held.



South Willard, Utah. (Source: Author)



Willard Canyon, Utah. (Source: Author)



Willard Bay, Utah. (Source: Author)



Perry, Utah. (Source: Author)



Brigham City, Utah. (Source: Author)



Corinne, Utah. (Source: Author)



Mantua, Utah. (Source: Author)

From the different trips to the region and stakeholder meetings, the following issues identified relating to commuter-rail transit, development, and the environment:

1. **There is discrepancy between municipalities regarding the location of proposed stops for the FrontRunner.** While there is a general desire for the FrontRunner to be extended into the region, the different localities desire a stop in each of their areas. Due of the proximity of the localities, the type of locomotive used for the FrontRunner, and the length of the cars associated with the FrontRunner, a stop in each locality would violate UTA policy. UTA's policy must change, the local governments must agree with UTA on only a few designated spots, or an alternative to the current mass-transit train must be considered for this issue to be resolved
2. **Funding the FrontRunner's operational cost is not feasible.** Commuter-rail must have a transportation tax designated for mass-transit and revenue from ridership to qualify an area for expansion. Current estimates show region would not have enough riders nor the tax base to adequately fund extending the FrontRunner. For this issue to be resolved, operational funding must increase, or be expected to increase in the near future.
3. **Much of the land that the new rail line will pass through could be environmentally sensitive.** Due to the history of development in the region, much of the land along the existing rail corridor is marsh or wetland. Mitigating for the development of wetland is time-consuming, highly impactful, and expensive. For a new mass-transit corridor to be feasible, environmental considerations must be addressed.
4. **The air quality in eastern Box Elder County is worse than the national average at certain times of the year.** While this issue does not pose a problem for commuter-rail, this is an issue of concern for local leaders when planning for new development, and should be noted. Much of the local economy depends upon commuting, and increased development could lead to more exhaust emissions from cars.

DATA GATHERED

In order to evaluate the best future for the region in response to commuter-rail, a geographic information system (GIS) was used. This system was based on best available data found in local, state, and national data clearinghouses. By relying on these data clearinghouses, the process outlined in the Figure 1 can be replicated and updated as new data becomes available.

The data and information for this study is collected around how the landscape functions and how it is structured. “Function” and “structure” means “how a system works, its patterns, and the relationship of its parts.” (Toth, 1972). The function and structure of the landscape of southeastern Box Elder County can be broken down into three aspects: biophysical, social/ cultural, and economics. By focusing on these three aspects of the landscape, it will be easier to organize the different information and data gathered (see Figure 2).

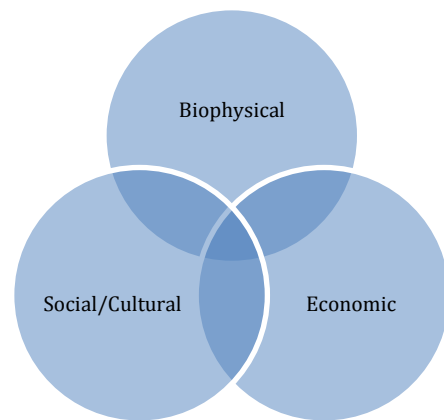


Figure 2: Aspects of the Landscape

This chapter will investigate the different data factors of each landscape aspect. By inventorying and studying each factor, cause and effect relationships can be identified, and these relationships will help form the justification for modeling in the Data and Futures Modeling phase of the project.

It should be clarified that the factors of each of the three aspects of the landscape are based on the “major data subjects” that are described by Professor Ian McHarg in *Design with Nature* (McHarg, 1969). McHarg describes the reasoning behind the selection of these subjects through the cipher of place: “any place is the sum of historical, physical, and biological process, ... these are dynamic, (and) they constitute social values...” (McHarg, 1969). In other words, in order to understand this study area, we must understand the different factors that make up the landscape.

Biophysical Aspect of the Landscape

The biophysical factors for this study are: geology, soils, hydrology, climate, vegetation, and wildlife. These will be reviewed individually.

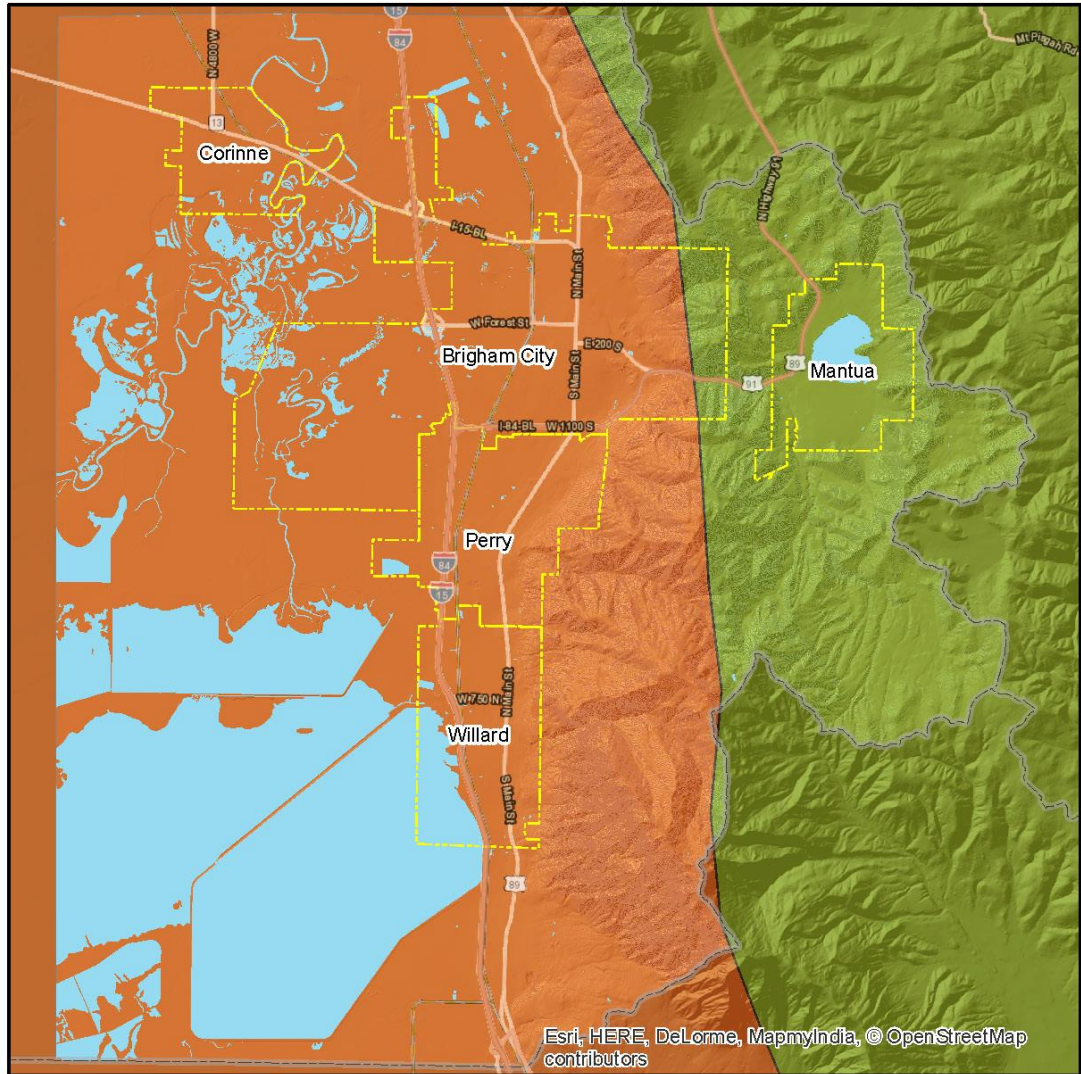
Geology

Geology is “the study of the planet earth- the materials it is made of, the processes that act on these materials, the products formed, and the history of the planet and its life forms since its origin.” (Neuendorf, Mehl, Jr., & Jackson, 2005). Some of these products that are formed are useful to humanity. Some of them are detrimental. The same can be said for the materials and processes of geology. The history of these things also has an impact on human development and settlement pattern, and can inform where to develop next.





This is no different in southeastern Box Elder County. The study of geology is relevant to not only ascertain what areas are best suited for future development, but also to identify which areas are most at risk from geologic processes.

The study area is unique in its geology for several reasons. First, it straddles the border between two physiographic divisions, the *Intermontane Plateaus division* to the west, and the *Rocky Mountain System division* to the east (Fenneman & Johnson, 1946). A physiographic division is part of the U.S. Geologic Survey’s three-tiered classification system of organization to describe the geologic landscape of the United States. In addition to divisions, the other tiers are provinces and sections (United States Geological Survey, 2003). The divisions in the study area can be most apparent in the rising Wellsville and Wasatch Mountains to the east, and the wide basin valley that runs west to the Promontory Mountains across Bear River Valley (see Map ###). While these divisions can describe large-scale processes and trends, this study will need to examine the second tier (provinces) to better understand the geology of the area.

GEOLOGY



Legend

- | | |
|--|---|
| Physiographic Subdivisions |  Towns |
|  Basin and Range |  Water |
|  Middle Rocky Mountains | |

Each division within the study area contains one province respectively. These two provinces are the *Middle Rocky Mountains province* in the Rocky Mountain System division, and the *Basin and Range province* in the Intermontane Plateaus division. The following are descriptions of each province from the Utah Geologic Survey.

Middle Rocky Mountains Province: The Middle Rocky Mountains province in northeastern Utah consists of mountainous terrain, stream valleys, and alluvial basins. It includes the north-south trending Wasatch Range, comprised mainly of pre-Cenozoic sedimentary and Cenozoic silicic plutonic rocks, and the east-west trending Uintah Mountains, comprised mainly of Precambrian sedimentary and metamorphic rocks (Utah Geological Survey, 2013).



Willard Basin. (Source: Jim Olsen)



Wasatch Mountains near South Willard, Utah. (Source: Author)

Basin and Range Province: The Basin and Range Province is noted for numerous north-south oriented, fault-tilted mountain ranges separated by intervening, broad, sediment filled basins. The mountain ranges are typically 20-50 km (12-31 mmi) apart, 45-80 km (28-50 mi) long and are bounded on one, or sometimes two sides by high-angle, commonly listric, normal faults. Typical mountain ranges are asymmetric in cross section, having a steep slope on one side and a gentle slope on the other. The steep slope reflects an erosion-modified fault scarp and the range is a tilted fault block. Rocks within the Basin and Range vary widely in age and composition. Older rocks consist mostly of a variety of Mesozoic and Paleozoic sedimentary units and their metamorphic equivalents. Proterozoic-age rocks have limed exposures in the region. Cenozoic volcanic rocks and valley-fill units generally overlie the sedimentary and metamorphic rocks. Valley-fill deposits consist mostly of late Cenozoic lakebeds and alluvium as much as 3,000 m (10,000 ft) thick (Utah Geological Survey, 2013).

These two provinces have different characteristics that should be noted in discussing past, current, and future land-use. The geologic uplift in the Middle Rocky Mountain Province gives a broad western solar aspect and elevation that has been traditionally used for fruit agriculture. These higher elevations have been used in the past as pasture and timberland. Because of its steep slopes and high elevation, it has not been suitable for other types of development. Currently, most of this land is managed by the U.S. Forest Service, and extraction or change of the local geography falls within the service's management schemes. The Basin and Range Province has served as the main development area since the establishment of the current communities. Relatively flat lowlands and access to water have made this area more ideal for agriculture and settlement. However, because the study area is wider at the base of the Wasatch Mountain Range or sloping towards the trough of the basin, the area is awash in valley-fill rocks and alluvium from Box Elder Canyon, amongst others. This material poses some development issues,



An orchard near Perry, Utah. (Source: Author)



A gravel pit near Perry, Utah. (Source: Author)

especially along fault lines. But as the material could be an impediment or constraint for residential, commercial, or other types of built development, it is a boon as an extractive resource. The area is rich in gravel and rock fill, and several gravel extraction companies exist in the region because of it.

The current land of the Basin and range Province is privately owned, except for some state land at Willard Bay and federally owned land to the north at the Bear River Migratory Bird refuge. Because the management of most of the land is private, the ability to change the geology of the area falls under local government's regulations and the land owner's discretion.

Soil

Closely linked to the geology of the area is soil. Soil has influenced the landscape and settlement just as much as the physical form. Soils are “the unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants.” (Soil Science Society of America, 2008). Soils are made up of sand, silt, and clay derived from the bedrock, organic matter from plants and animals, and water (Billings, 1978). To better understand how the area has developed and how it can best develop in the future, the biophysical factor of soils is critical. A few key points about soils will be discussed.

Soils are classified by their size, or texture (Soil Science Society of America, 2008). Textures range from fine to coarse. Texture is comprised of the soil separates: *silt*, *sand*, and *clay* (Soil Science Society of America, 2008). To be considered a separate, the mineral particle of the soils must be <2mm. (Soil Science Society of America, 2008). Another common description of a mixture of these separates in soil is described as *loam*.

These separates can be combined together or combined with rocks to describe certain textures (ex. *Stony silt loam* or *very fine sand*).

Figure 3 and Table 1 (page 23) shows the difference between the soil separates.

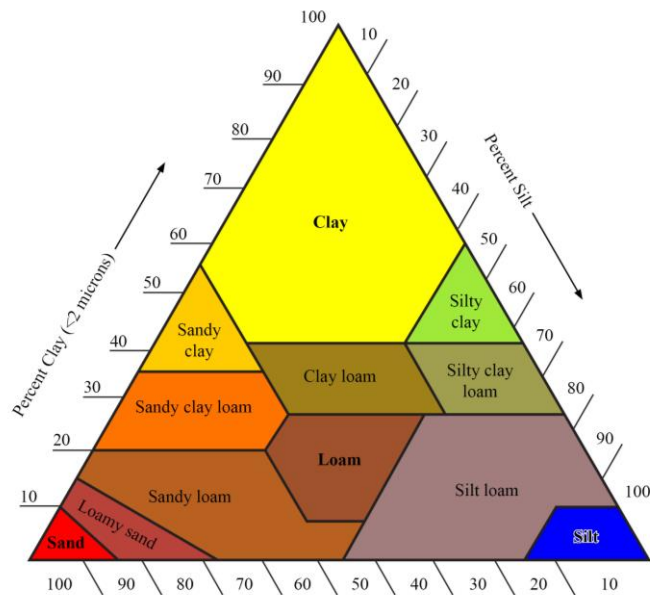


Figure 3: Relationship of Soil Separates

<i>Soil Separate/ Class</i>	<i>Size</i>
Sand	2 – 0.05 mm
Silt	0.05 – 0.002 mm
Clay	< 0.002 mm
Loam	7-27% clay, 28-50% silt, and < 52% sand
Source: (Soil Science Society of America, 2008)	

Soil affects development in many ways. Skousen classifies nine critical soil and site factors that determine development suitability and limitations (Skousen, 2013). These factors are:

1. *surface texture*, the amount of sand, silt, and clay in the soil;
2. *permeability*, the rate at which water enters and passes through the soil;
3. *depth of soil to bedrock*, including both topsoil and subsoil;
4. *slope*, steepness and length of the slope;
5. *erosion hazard*, the amount of topsoil currently on the site and the potential for future losses;
6. *surface runoff*, the rate at which water flows off the site based on slope, drainage, and texture;
7. *shrink-swell of the soil*, which involves changes in volume based on soil wetness;
8. *water table*, the depth at which water occurs in the soil both seasonally or permanently; and
9. *flood hazards*, the frequency that water from storm runoff inundates the site. (Skousen, 2013)

Some of these factors can only feasibly be determined at the site scale, or must be discussed broadly to apply to the scale of this study. These factors could include depth of soil to bedrock, erosion hazard, surface runoff rates, and shrink-swell of soils. The information for these factors was not available for the study area at large. Factors that

will be discussed are surface texture and permeability. Water table and flood hazards will be discussed in the next section, Hydrology.

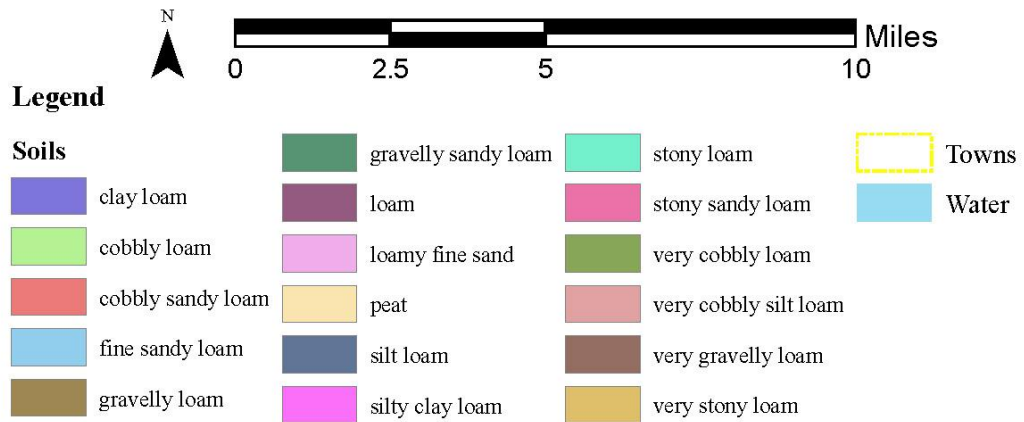
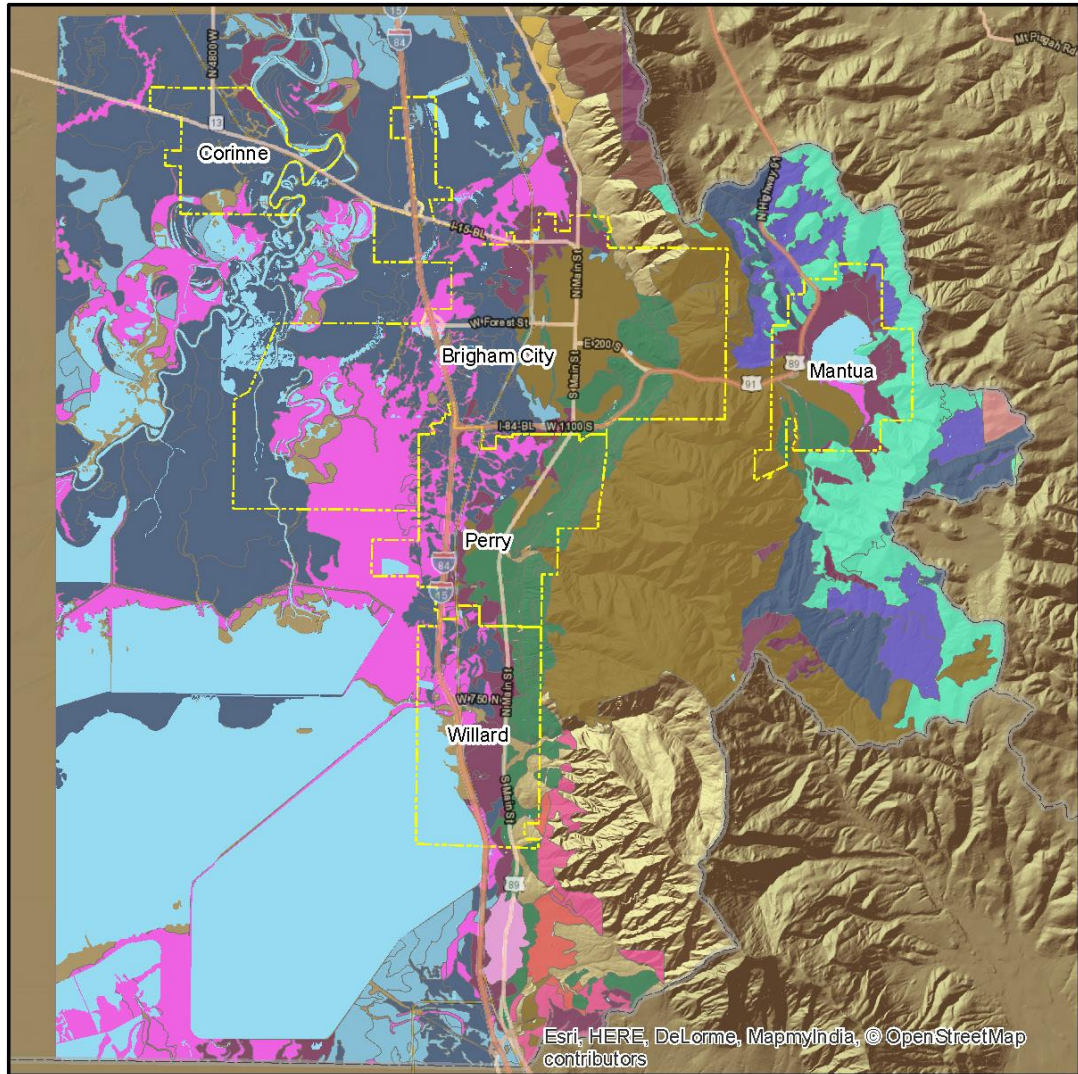
The map of page 25 shows the study area with the different types of soil. Most the soils in the study area are silt loam, gravelly loam, and silty clay loam (Natural Resources Conservation Service, 2008). While gravelly loam is suitable for many applications, silt loam and silty clay loam is less desirable for development. These soil types area susceptible to earthquake and liquefaction, and will need to be either mediated or avoided for development.

Another issue is percolation. *Percolation* is the downward movement of water through soil (Soil Science Society of America, 2008). Percolation rates affect foundation settling, septic draining, and flooding (Anderson & Halsey, 1990). Percolation rates for silt loam is 45-90 minutes per inch, gravelly loam is 10-45 minutes per inch, and silty clay loam is greater than 45 minutes per inch (Anderson & Halsey, 1990).

Past development of the area can also be traced to soil type. The denser, saturated soils in the western part of the study area were either developed as agricultural pasture, or left alone. These areas still reflect this land-use, and are the majority of undeveloped private lands in the study area. Areas with coarser soils have been developed for other uses.



SOIL



Hydrology

While one biological factor cannot be placed over another in its inherent value, it is hard to argue against water being critical to all processes of the landscape. This is especially true of human development and settlement (Pastore, et al., 2010). Water shapes earth, refining it over time, and provides life. It has been, and continues to be, integral to all living things on this planet. It is no different in southeastern Box Elder County.

The study of the behavior water as it occurs on the landscape, whether it be in air, on the land, or in the ground, is called *hydrology* (American Society of Civil Engineers, 1949).

Hydrology is best understood in the context of a *watershed*. A watershed “is an area of land that drains all the streams and rainfall to a common outlet, such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel.” (United States



Bear River near Corinne, Utah. (Source: Author)

Geological Survey, 2016). Watersheds vary in scale and size. The U.S. Geologic Survey delineated six different scales of watersheds into a hierarchy of hydrologic units. These are: Region, Sub-region, Basin, Sub-basin, Watershed, and Sub-watershed (Seaber, Kapinos, & Knapp, 1987) (Natural Resource Conservation Service, 2007).

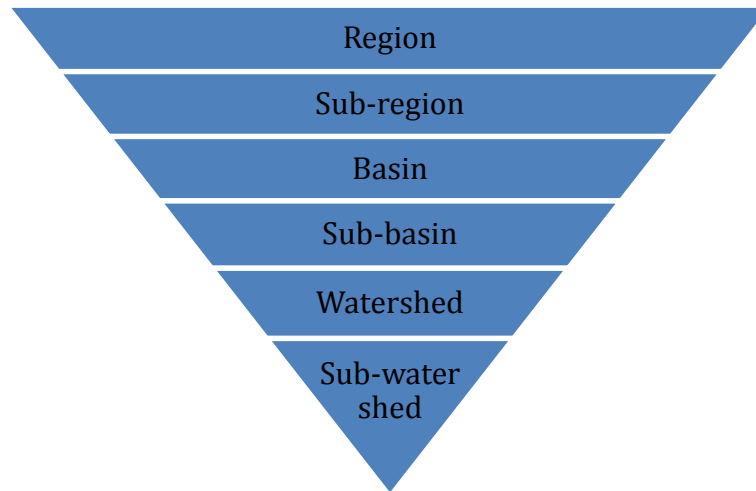


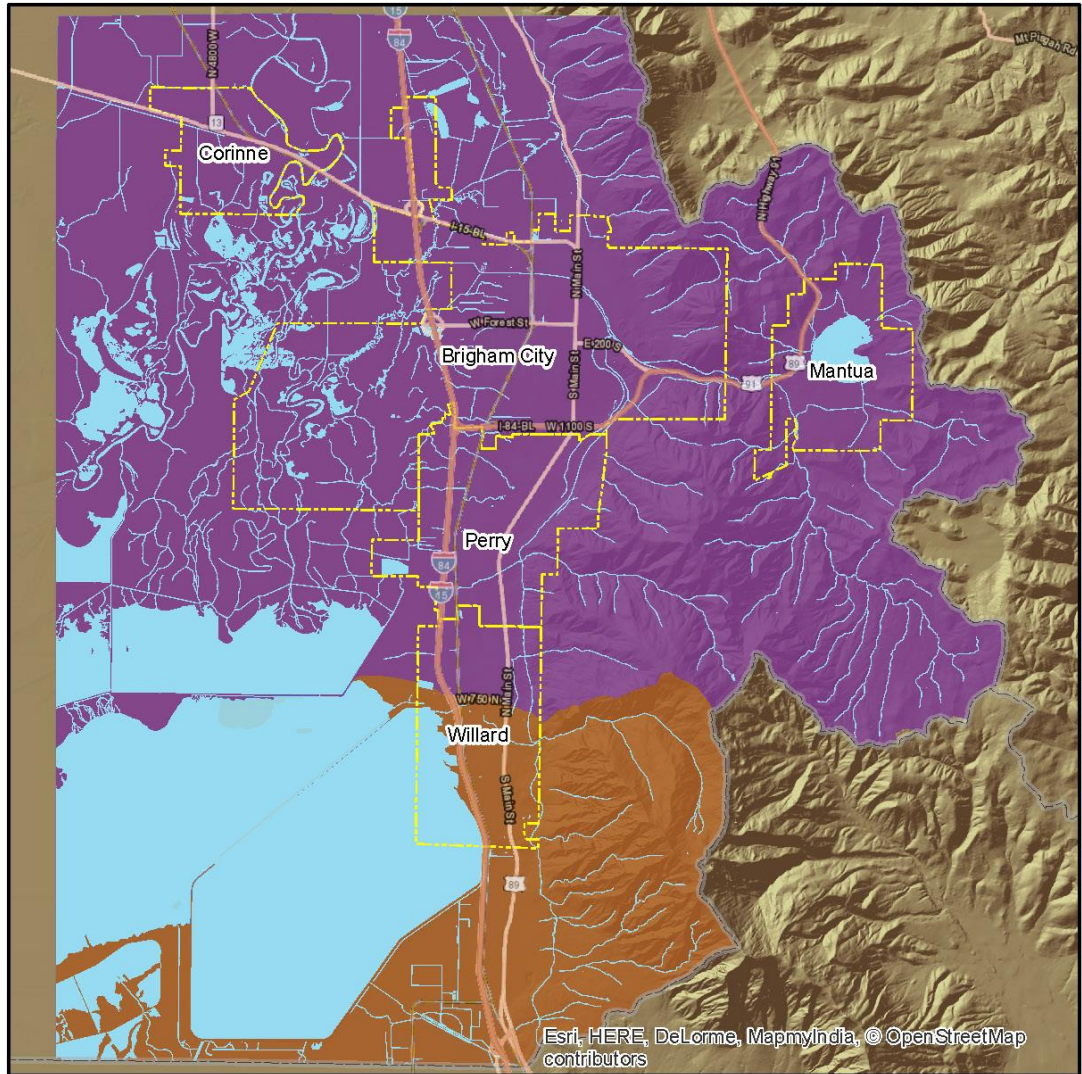
Figure 4: Hierarchy of Hydrologic Units

The scale of these hydrologic units starts with the largest being the Region hydrologic unit, and working down to the smallest, the Sub-watershed hydrologic unit. It should be noted that even though the hydrologic units “Watershed” and “Sub-watershed” are assigned names of these hydrologic units, they should be carefully distinguished from the general term of *watershed* as defined above. Table 2 (page 28) lists the watersheds that both fall within or encompass the study area.

For the scale of this study, the Sub-basin hydrologic units will be used to describe the hydrology of the study area. These include the confluence of four watersheds: the Little Bear to Logan, the Lower Bear to Malad, the Great Salt Lake, and the Lower Weber.






Table 2: Watersheds of Southeastern Box Elder County	
<i>Hydrologic unit</i>	<i>Name</i>
Region	Great Basin
Sub-region	Bear River Basin Great Salt Lake Basin (excluding BRB)
Basin	Lower Bear River Basin Weber River Basin Great Salt Lake Basin
Sub-basin	Little Bear to Logan Lower Bear to Malad Great Salt Lake Lower Weber
Watershed	Great Salt Lake Box Elder Creek-Bear River Outlet Little Bear River Headwaters Little Bear River Outlet Ogden River Third Salt Creek Fourmile Creek-Weber River
Sub-watershed	Great Salt Lake Outlet Bear River Wellsville Canyon Box Elder Creek-Black Slough Hyrum Reservoir-Little Bear River Mantua Reservoir-Box Elder Creek South Fork Little Bear River Cutler Creek-North Fork Ogden River First Salt Creek-Willard Bay Reservoir Second Salt Creek Fourmile Creek
Source: (Natural Resource Conservation Service, 2007)	

HYDROLOGY



Legend

Watersheds

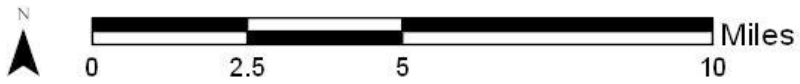
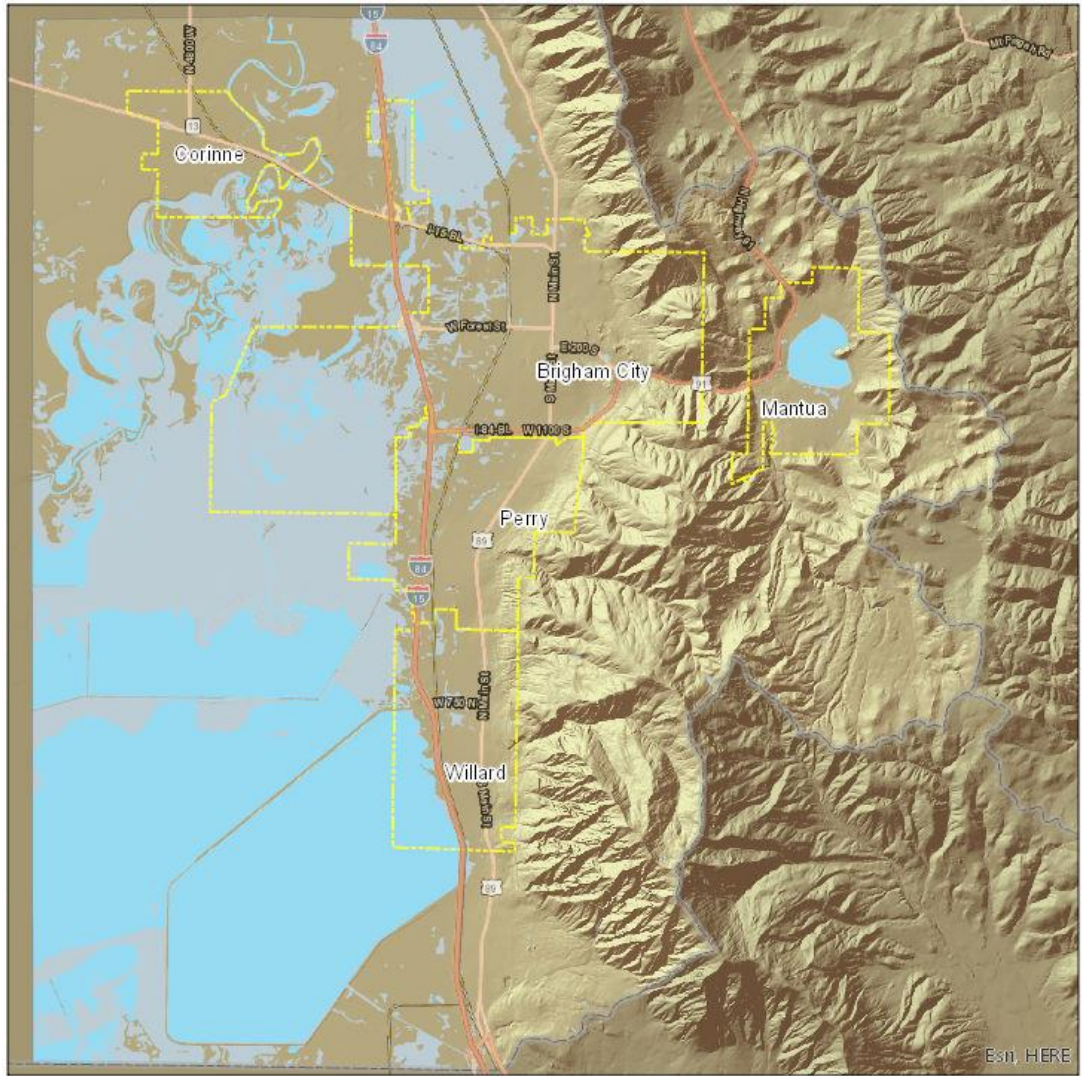
-  Box Elder Creek-Bear River
-  Great Salt Lake
-  Third Salt Creek
-  Towns
-  Water

Other components of hydrology include ground water, surface water, and water in the atmosphere. *Ground water* is “Water which is not exposed to the atmosphere- it is located underground and is generally accessed via wells.” (Toth, et al., 2005). *Surface water* is “water which is exposed to atmosphere- e.g. lakes and streams.” (Toth, et al., 2005). Water in the atmosphere can be described through a discussion on climate, and will be discussed in a later section.




Ground water: water flows through, or is stored in, the ground in aquifers. An aquifer is a rock formation that can bear enough water to be extracted by wells and springs (Lohman, 1972). This rock formation could be made up of many types of rock material. In this study area, the principal aquifer is primary recharge areas along the Wasatch and Wellsville Mountains, or in the secondary recharge areas at the mouth of Box Elder Canyon. Water exits the aquifer at discharge areas in valley bottom, or at springs along fault fractures in the mountainous areas (Bartolino & Cunningham, 2003).

Surface water: water that is exposed to the atmosphere can come in many forms. Streams, rivers, lakes, wetlands, and other large bodies of water, are all surface water. In southeastern Box Elder County, surface water is the primary source of water for irrigation, as well as a source for culinary use and recreation (Toth, et al., 2005). One project states that “the rivers and lakes of the Bear River Watershed are considered to have plenty of water to support both current and projected populations in the watershed, the seasonal fluctuations present a constant need to maintain and develop ways to contain and distribute water so that it is available during dry periods” (Toth, et al., 2005). As part of the Bear River Watershed, the same statement is true for southeastern Box Elder County.

HYDROLOGY-WETLANDS



Legend

-  Towns
-  Water
-  Wetlands

Major Water Features and Sources

The major water features within the study area are portions of the Great Salt Lake, Willard Bay Reservoir, and the Lower Bear River. Tributaries to these amount to smaller streams and canals. In addition to these water bodies, there are many interspersed wetlands throughout the study area, serving critical ecological functions for the landscape (Toth, Edwards, Jr., Perschon, & White, 2010).

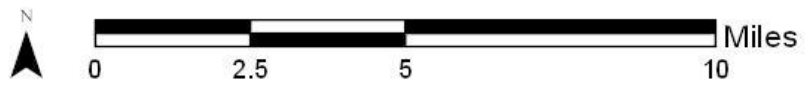
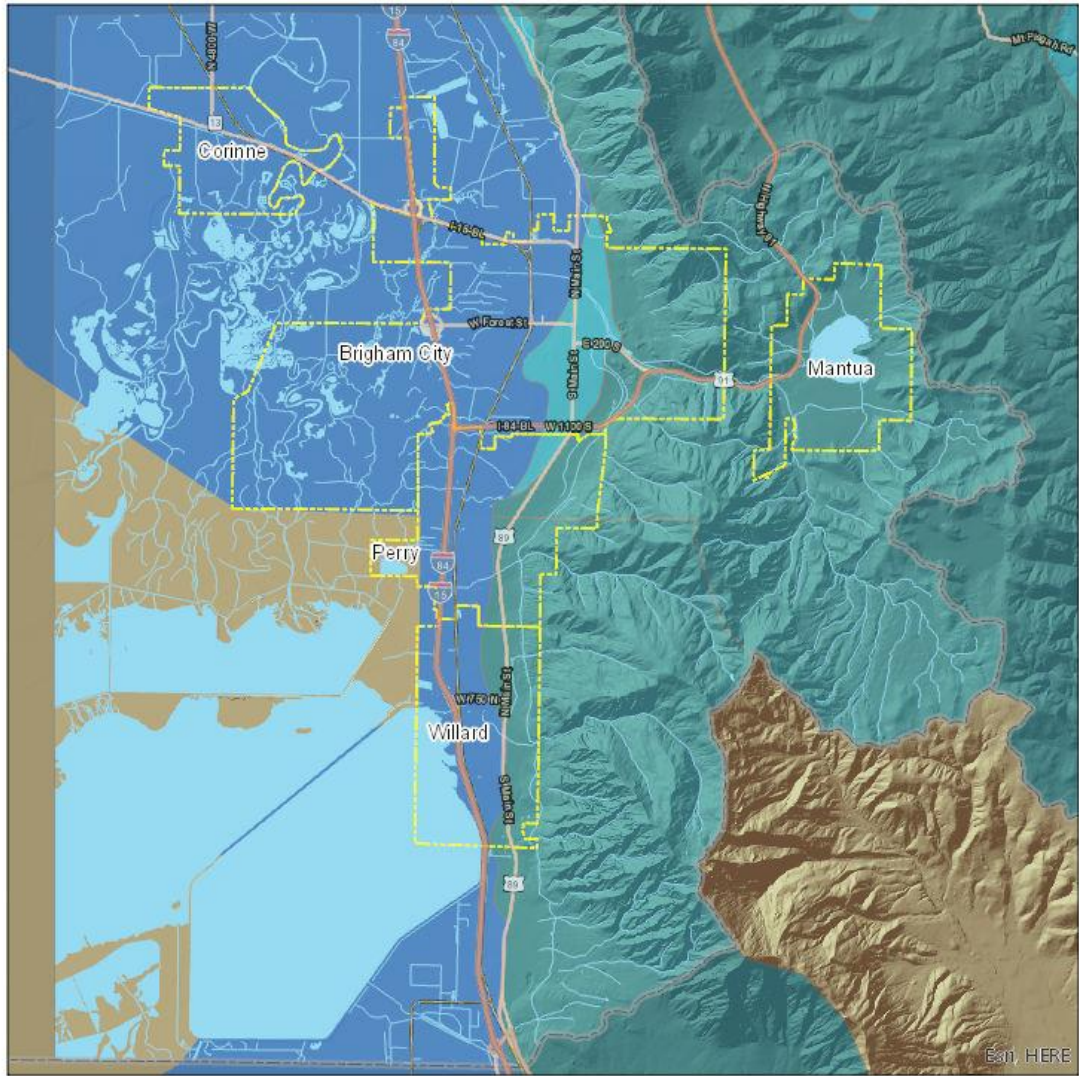
Because this area is high mountain desert, water is limited. Protection of water to support both human and environmental systems is paramount. There are limited areas of water sources within the study area, which include both reservoirs in the surrounding Wasatch and Wellsville mountains, and wells (Toth, Edwards, Jr., Perschon, & White, 2010)

Aquifers play a large role in the water source and supply within the study area. Although aquifer data is not readily available, aquifer discharge and recharge areas have been identified see (Map on page 33). Any development along the aquifer recharge or discharge areas could imperil the integrity of local aquifer as a whole (Winter, Harvey, Franke, & Alley, 1998).









Bear River near Brigham City, Utah. (Source: US Fish and Wildlife Service)

HYDROLOGY-AQUIFER



Legend

- | | |
|---|--|
|  Towns |  Primary Recharge |
|  Water |  Secondary Recharge |
| ZONE_ |  <all other values> |
|  Discharge | |

Water Quantity

Understanding how much water flows on and through the study area is critical to understand how proposed changes (such as commuter-rail) will affect human development and the environment (Winter, Harvey, Franke, & Alley, 1998). Water flowing into the Great Salt Lake in the study area vary due to seasonal and annual changes (Bear River Watershed Information System, 2007). However, because the Bear River is the largest tributary in the area, it delivers over half of the total surface water every year (Bear River Watershed Information System, 2007). Major diversions include canals and the Bear River Migratory Bird Refuge. Although irrigation is the current most intensive use of water in the area, it is expected that the Bear River will be developed to draw water to the greater Wasatch Front (Division of Water Resources, 2000) (Stewart, 2015), altering the amount of water is put into the Great Salt Lake by the river.



Canal near Corinne, Utah. (Source: Author)



Box Elder Creek near Mantua, Utah. (Source: Author)

Water Quality

Like water quantity, the quality of the water is critical when discussing change. Water quality is the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose (United States Geological Survey, 2017). The study area's water quality varies depending on what is being considered. The source water for human consumption is considered good (Toth, Edwards, Jr., Perschon, & White, 2010), but the water in the Lower Bear River is considered poor due to drainage of "dissolved solids (salts), sediments and phosphorus." (Bear River Watershed Information System, 2007). The Lower Bear River is designated as an impaired water body due to agriculture, urban runoff, erosion, and point source pollutants. Wetlands in the area mitigates against such pollution, and their role as a natural buffer against water quality impairment should be preserved or enhanced (Toth, Edwards, Jr., Perschon, & White, 2010).

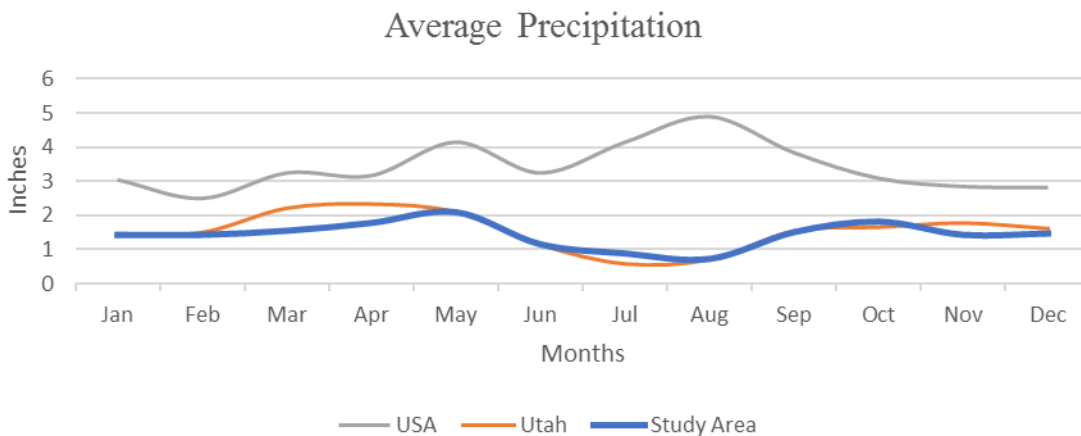
Climate

Climate influences where and how the built environment is developed. Likewise, climate also influences how an ecosystem is constructed over time. The resilience of a community of people, plants, or animals on the landscape is often determined by climate. Climate is the composite or generally prevailing weather conditions of a region, throughout the year, averaged over a series of years (National Oceanic and Atmospheric Administration, 2009).

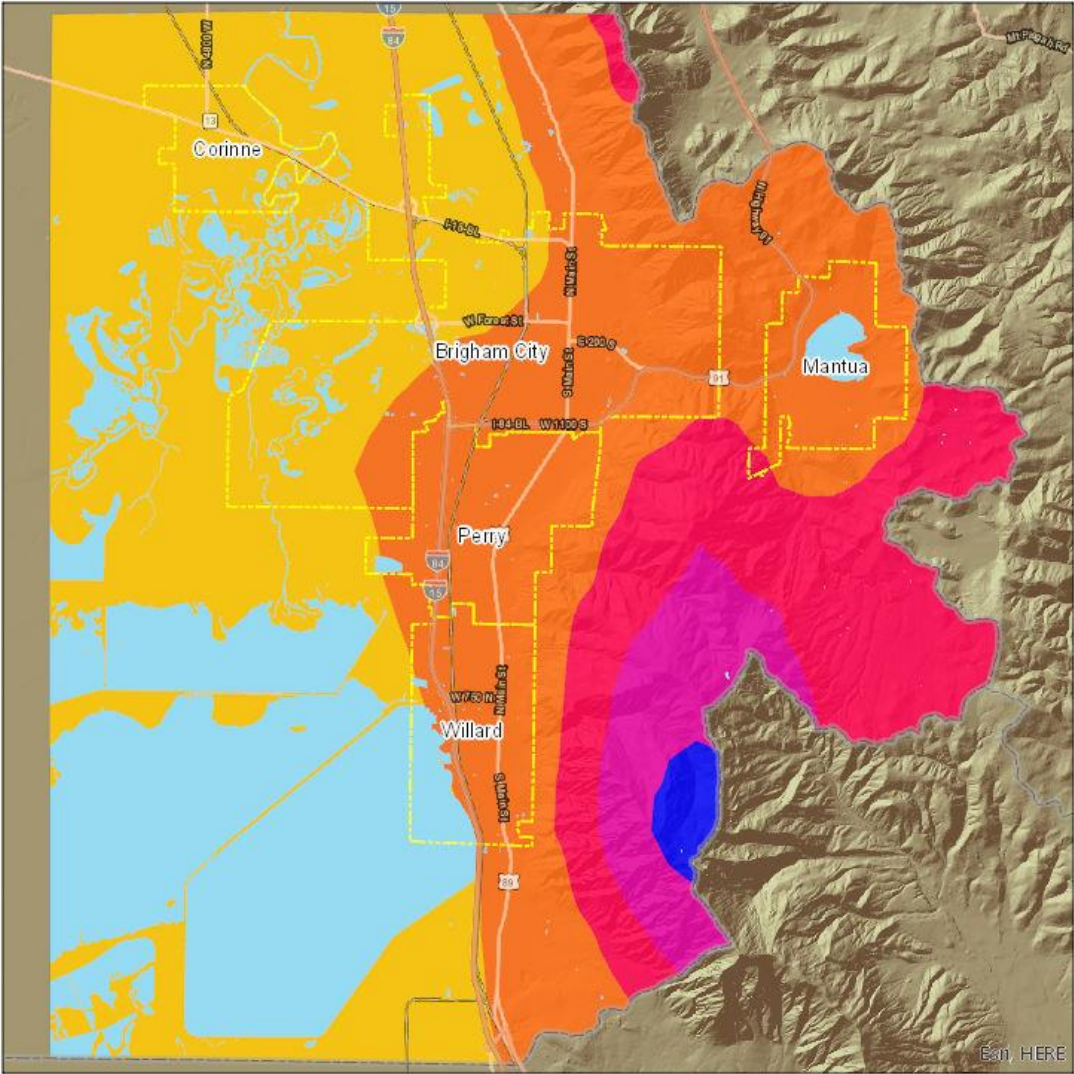
The study area is split between the North Central and Northern Mountains climate divisions in Utah (Gillies & Ramsey, 2009). The climate of the study area is reviewed as annual precipitation and annual average temperature.

Annual precipitation

The winter months bring most precipitation to the study area. Broadly, the average annual precipitation in Box Elder County ranges from 4 inches in the Western (desert) region to over 30 inches in the higher mountains to the East. (Natural Resources Conservation Service, 2005). The average annual precipitation of the area is 11.78 inches, which is in line with other semiarid, or steppe, regions (Gillies & Ramsey, 2009).



CLIMATE

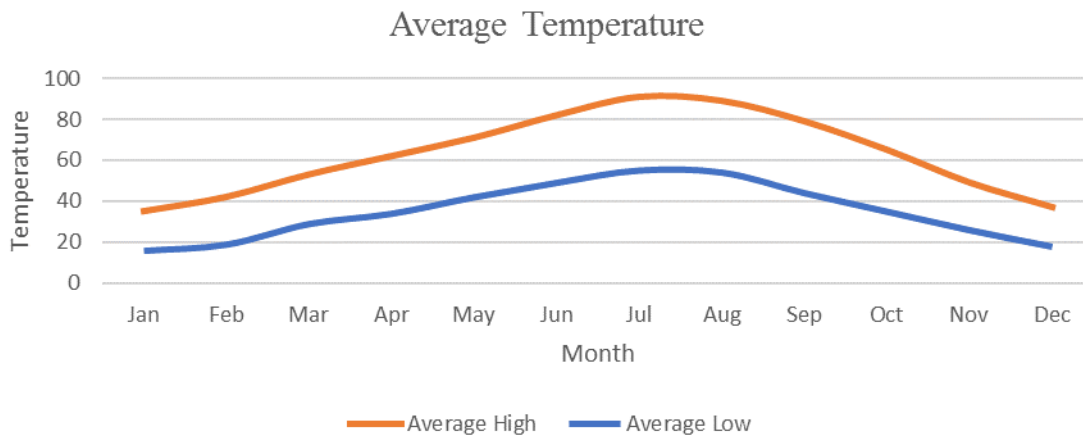


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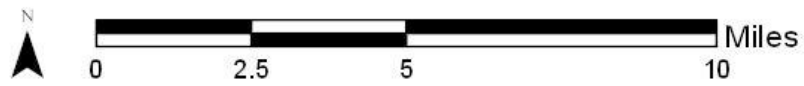
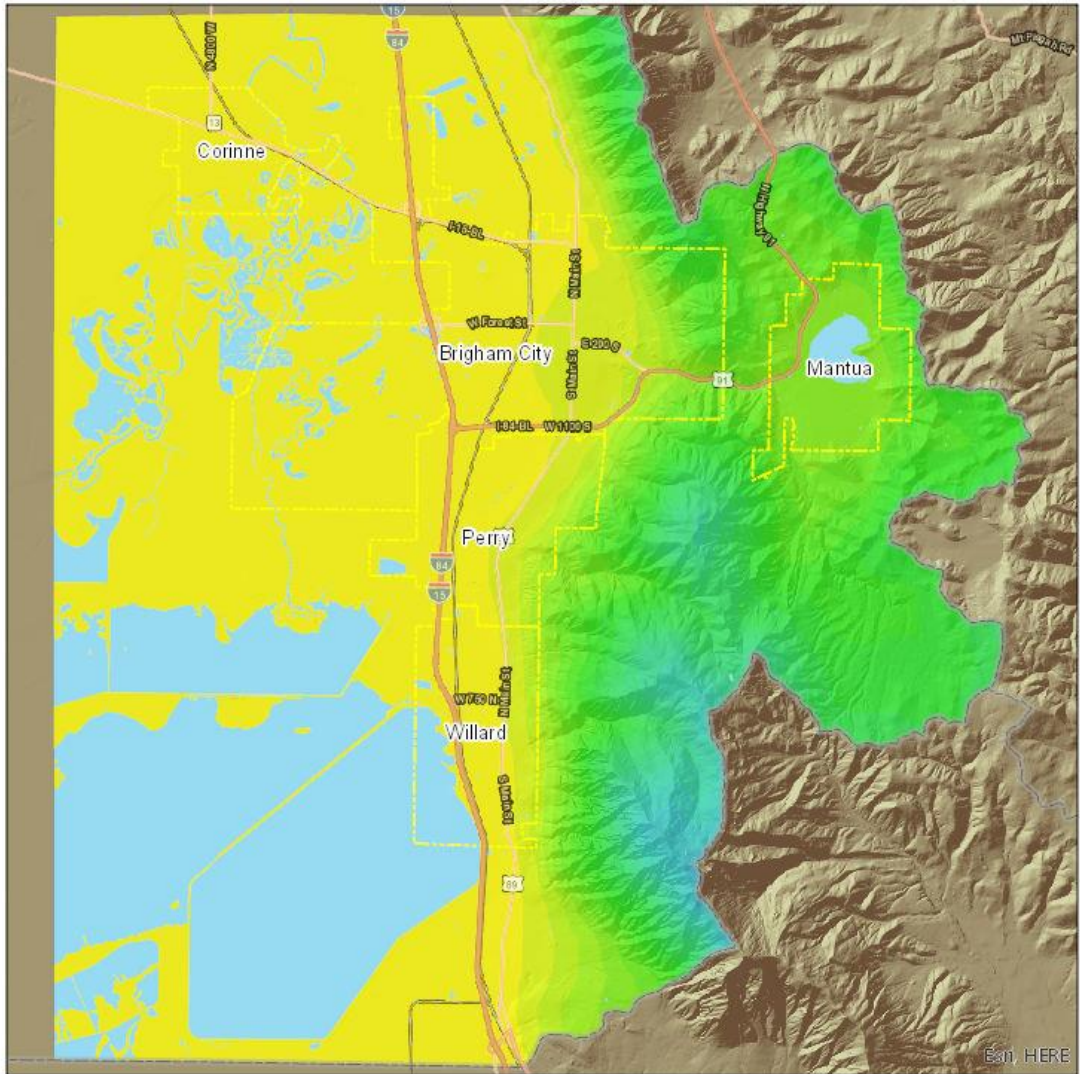
Annual Precipitation	49-63
15-18	64-67
19-33	Towns
34-48	Water

Annual Average Temperature

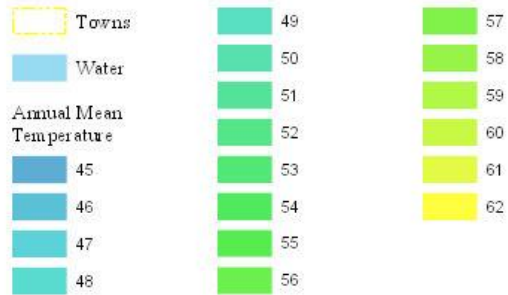
The annual temperatures for the study area is 49.2 degrees (National Centers for Environmental Information, 2016). The mean maximum temperature is 59.89 degrees F. The mean minimum temperature is 33.36 degrees F (National Centers for Environmental Information, 2016). The average July high is 90 degrees Fahrenheit, with the average January low being 15.3 degrees F.



TEMPERATURE



Legend



Vegetation

Understanding the ecosystem of the region is key to understanding its vegetation. The study area falls within the Great Salt Lake Area and Wasatch and Uinta Mountain Major Land Resource Areas (MLRA) (R. Douglas Ramsey, Neil E. West. "Vegetation of Utah." From Rangeland Resources of Utah, 2009. Utah State University Cooperative Extension). This means the study area's vegetation is generally made up of desert shrub, shrub-grass, and woodland vegetation in the Great Salt Lake Area, and conifer, aspen, grass, mountain shrub, and sagebrush-grass vegetation in the Wasatch and Uinta Mountain Major Land Use Areas (USDA, 2006. "Land resource regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin." Natural Resources Conservation Service, USDA Agricultural Handbook 296)

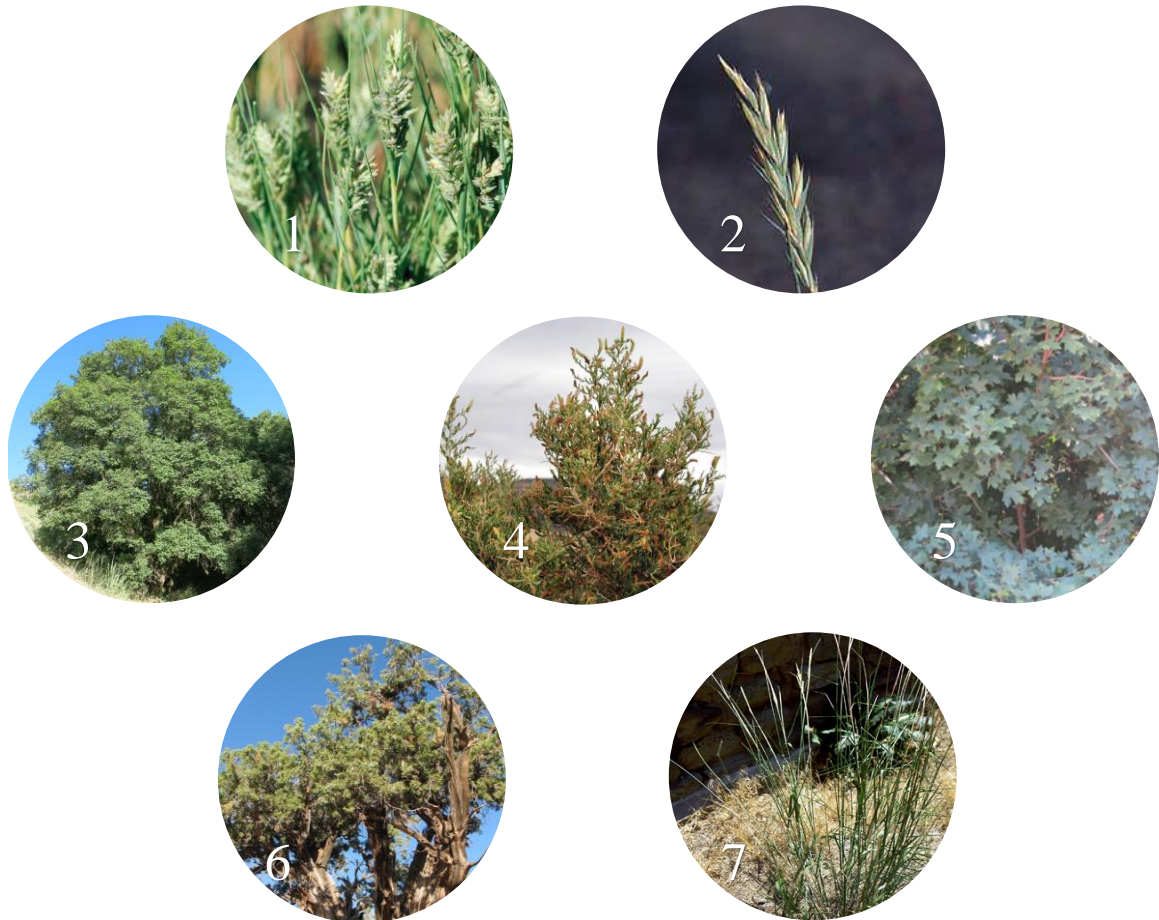
Vegetation for the study area is broken down into five parts: dominant vegetation; crops and pasture; rangeland and forestland; endangered species; and noxious and invasive species.

Dominant Vegetation

The Utah Division of Wildlife Resources maintains a database of dominant vegetation for the State. Table 3 lists the dominant vegetation in the region.

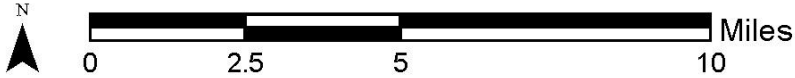
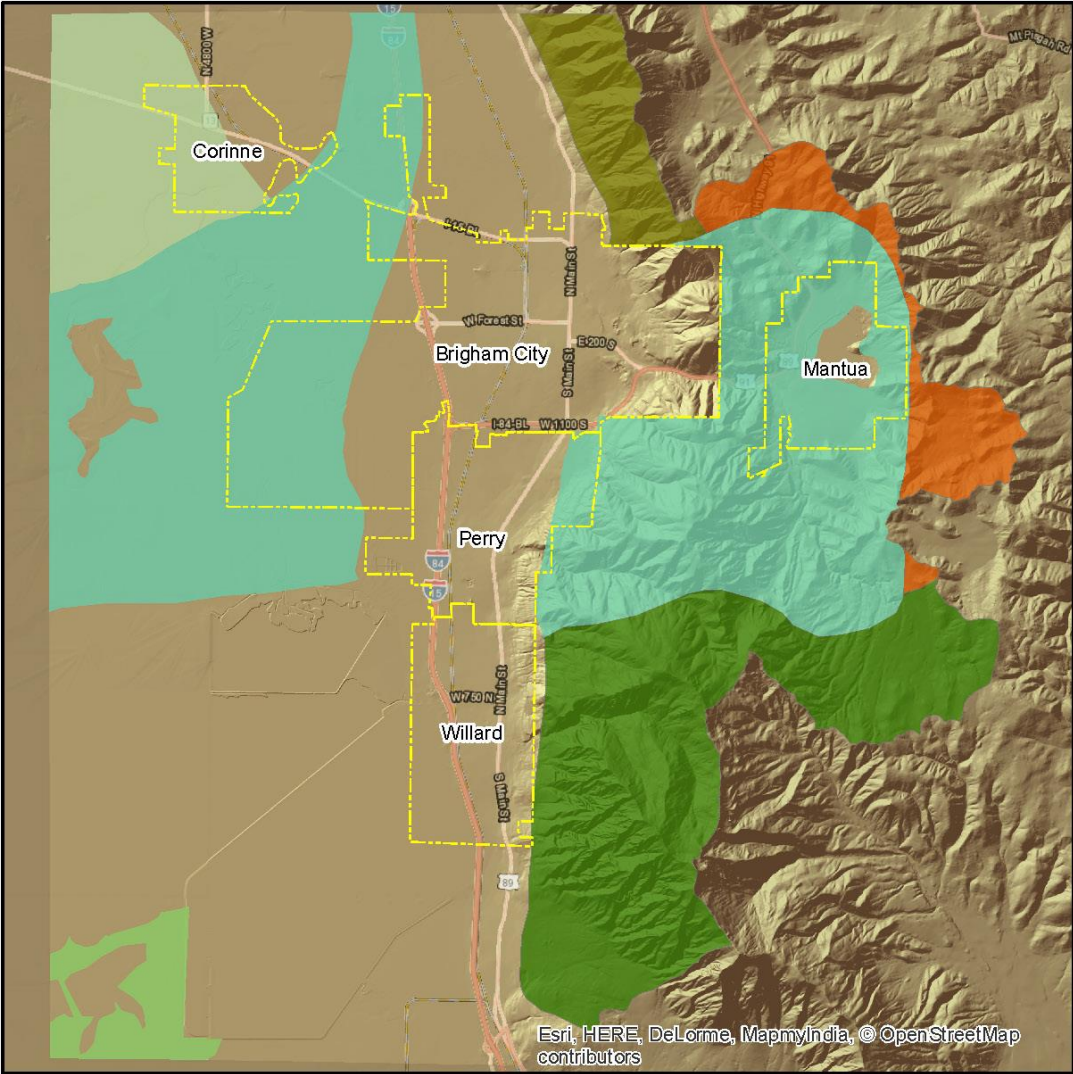
Species Common Name	Species Scientific Name	Area (acres)	Percent of Study Area	Picture Number
Saltgrass	<i>Distichlis spicata</i>	20,798.60	29.8%	1
Wheatgrass	<i>Pascopyrum smithii</i>	17,001.00	24.4%	2
Oak	<i>Quercus gambelii</i>	16,032.70	23.0%	3
Greasewood	<i>Sarcobatus vermiculatus</i>	6,890.60	9.9%	4
Maple	<i>Acer grandidentatum</i>	3,697.00	5.3%	5
Utah Juniper	<i>Juniperus osteosperma</i>	3,053.50	4.4%	6
Dropseed	<i>Sporobolus cryptandrus</i>	2,228.00	3.2%	7

Table 3: Dominant plant species. Source: UDWR 2009



Dominant vegetation of study area. (Source: 1. William Skaradek; 2. Robert Mohlenbrock; 3. Author; 4. Cory Maylett; 5. Author; 6. National Park Service; 7. Robert Soreng)

DOMINANT VEGETATION



Legend

Dominant Vegetation	 Oak	 Towns
 Dropseed	 Saltgrass	
 Greasewood	 Utah Juniper	
 Maple	 Wheatgrass	

Crops and Pasture

As part of the State Water Plan, the Utah Department of Natural Resources maintains a list of the types of crops and pasture for different parts of the State (UDNR, 2015. “Water Related Land Use” GIS data from gis.utah.gov). Table 4 lists the prominent crops and pasture in the study area.

<i>Crop/pasture</i>	<i>Area (acres)</i>
Pasture-sub-irrigated	11,123.57
Alfalfa	9,486.47
Pasture	8,459.48
Corn	5,851.16
Grain	5,844.84
Grass hay	4,435.11
Orchard	1,361.69
Dry alfalfa	857.52
Dry grain	806.35
Onions	291.58
Other Vegetables	159.84
Oats	107.39
Melon/Pumpkin/Squash	46.36
Safflower	14.59
Tomatoes	12.41
Berries	9.35
Beans	2.75

Table 4: Crops and Pasture in the Study Area. Source: UDNR 2015.



Corn field near Corinne, Utah. (Source: Author)



Pine tree near Box Elder Creek, Utah. (Source: Author)

Rangeland and Forestland

The study area includes both rangeland and farmland. Box Elder County data shows 1,485,000 acres or 70% of the total land acreage within the County is rangeland. This includes perennial grasses, forbs, juniper, and pinyon pine. “Rocky ridges have stands of curl-leaf mountain mahogany. The higher mountainous areas support coniferous trees on north and northeast aspects and aspen thickets in depressions where snow accumulates. Numerous small, wet meadow sites are in the mountain areas.” (USDA 2005. “Box Elder County, Utah Resource Assessment.” 8/1/2005). Forestland make up 100,000 acres.

Endangered Species

Ute Ladies'-Tresses Orchid: The orchid occurs along riparian edges, gravel bars, old oxbows, high flow channels, and moist to wet meadows along perennial streams. It typically occurs in stable wetland and seepy areas associated with old landscape features within historical floodplains of major rivers. It also is found in wetland and seepy areas near freshwater lakes or springs (USFWS May 7 2010 <http://www.fws.gov/mountain-prairie/species/plants/uteladiestress/>)



Ute Ladies'-Tresses Orchid. (Source: Teresa Prendusi)



Medusahead rye near Perry, Utah. (Source: Author)

Noxious and Invasive Species

Noxious weeds are plants identified by the State of Utah as especially injurious to public health, crops, livestock, land, or other property. (Utah Code 4-17-2(4)) Box Elder County is home to over 206 invasive species (UGA 2015. “Status of Invasive Plants in Utah.” Center for Invasive Species and Ecosystem Health EDDMaps Technology and Data report). The noxious and invasive species in this study area include the following:

Medusahead rye, cheatgrass, Russian knapweed, Hoary cress, Rush skeletonweed, and Yellow starthistle (NRCS 2005) These species come from different regions of the world, and have proven to be problematic to the health and vitality of the region’s ecology. Localities have plans in place for the eradication and management of these species.

Wildlife

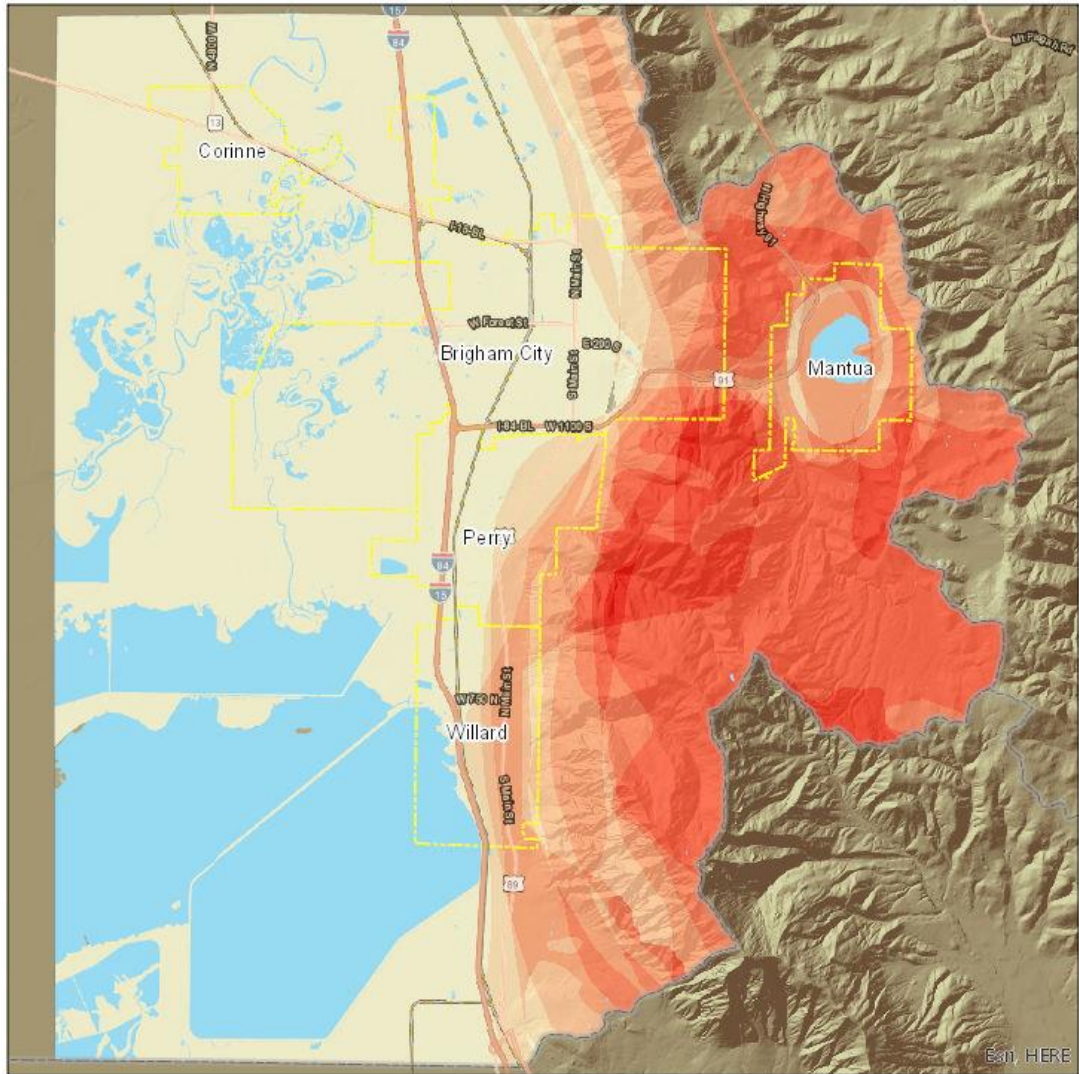
The study area includes a myriad of wildlife that both supports and enhances the landscape. Wildlife behavior and lifecycles influences how the landscape functions, and the human perception of the region. In fact, the study area hosts the Bear River Migratory Bird Refuge, run by the U.S. Fish and Wildlife Service. This Refuge was established to provide critical habitat to migratory birds and other wildlife in the region. Other habitat includes the U.S. Forest Service land, and state lands held in the surrounding Wasatch and Wellsville Mountains.

Major Wildlife

The Utah Department of Wildlife Resources maintains a database of the habitat of major wildlife for the State. The following are the major wildlife species found within the study area: black bear, blue grouse, California quail, chukar, Hungarian partridge, moose, mule deer, ring-necked pheasant, Rocky Mountain elk, ruffed grouse, sharp-tailed grouse, and the snowshoe hare (UDWR 2006).



MAJOR HABITAT



Note: More Overlays = More Species

Endangered Species

While there have not been sightings of the three listed endangered species within the study area, the elements to make up the habitat for these species are present. The three wildlife species in the study area listed as endangered include the yellow-billed cuckoo, gray wolf, and the Canada lynx.

Yellow-billed cuckoo: Nesting habitat is classified as dense lowland riparian characterized by a dense subcanopy or shrub layer (regenerating canopy trees, willows, or other riparian shrubs) within 100 meters of water. Over story in these habitats may be either large, gallery forming trees (1027 meters) or developing trees (310 meters), usually cottonwoods. Nesting habitats are found at low to midelevations (7,501,820 meters) in Utah. Cuckoos may require large tracts (100,200 acres) of contiguous riparian nesting habitat; however, cuckoos are not strongly territorial and home ranges may overlap during the breeding season. Nests are usually 1.22.4 meters above the ground on the horizontal limb of a deciduous tree or shrub, but nest heights may range from 16 meters and higher. (Text modified from: Parrish, J. R., F. P. Howe, and R. E. Norvell. 1999. Utah Partners in Flight draft conservation strategy. UDWR publication number 9940. Utah Partners in Flight Program, Utah Division of Wildlife Resources, Salt Lake City.)

Gray wolf (recovery): Gray wolves require large home ranges and move long distances. They do not need any other habitat requirements outside of water and prey (UDWR 2005). Factors that influence wolf habitat include availability and density of prey, snow conditions, availability of protected and public lands, density of domestic livestock, road density, human presence, and topography. The study area falls within a managements area where the gray wolf has been delisted as endangered (UDWR 2005).

However, in 2010, the Utah Legislature directed the Division of Wildlife Resources (DWR) to prevent any packs of wolves from establishing in the area (UDWR 2012).

DWR has a management plan in place to manage wolf populations, and has the personnel to manage wolf populations statewide.

Canada lynx (threatened): Canada lynx typically are found in the boreal forests of North America. However, the range of lynx populations have extended to the south to the classic boreal forest zone in the subalpine forest of the western U.S. (FWS 2016). Canada lynx prefer areas with deep snow and have high-density populations of snowshoe hares.



Social/Cultural Aspect of the Landscape

History

Prehistoric

While the exact length of human habitation is unknown, there are several archaeological sites in the county that help provide evidence of the generations of human use of this landscape dating back over 12,000 years ago (Profaizer, 2010).

Native American

Native American artifacts have been found throughout the study area, but are prevalent around Willow Creek, near present day Willard. A major living area for the Shoshone people was known to be around Willard Bay. They also occupied the Mantua Valley. The Northwestern Band of Shoshone is a branch of the larger group of Shoshone people that cover Utah, Idaho, Wyoming, and Nevada. When whites began encroaching on the area that is now Utah in the 1840s, three different groups of Northwestern Shoshones lived there: the Weber Utes, the Pocatello Shoshones, and the *kammitakka*, or “jackrabbit-eaters” in Cache Valley along the Bear River. (nwshoshone.org 2015)



Pioneer Settlement

Mormon settlement came to the region in 1851 (Profaizer, 2010). Having established a main settlement in Salt Lake City to the south in 1847, settlers began to expand into outward territory in the ensuing years. Led by Brigham Young, a system of small communities were set up throughout the territory. Settlers were sent to a settlement, and uniformly developed communities around the “plat of Zion.” This concept is based on Mormon founder Joseph Smith’s vision of city development, which includes the overall plat being 1 mile square, with the center being maintained for places of worship and civic buildings, outlying blocks being 10 acres each, and the entirety supporting 15,000 to 20,000 people (Smith, 1833 “An Explanation of the Plat of the City of Zion.” Letter, June 25, 1833. Retrieved from <http://urbanplanning.library.cornell.edu/DOCS/smith.htm> on 11 January 2016.). With the exception of Corinne, all other towns and cities in the study area were formed after this model.

Willard: Willard was first settled as North Willow Creek in 1851. A fort was built, and the settlement was surveyed in that same year. The settlement was named Willard in 1859, and was incorporated in 1870. Industries developed during this time include a brickyard, a grist mill, molasses mills, along with other agricultural pursuits. Electricity came in the early 1900’s, with a water system being completed in 1912, the water being taken from Willard Canyon. Willard had a station on the main line of the Utah-Idaho Central Railroad. Fruit crops were its major product. A major flood occurred in 1923, due to overgrazing in Willard Canyon, destroying many homes and taking many lives. Because of this, a flood dike and spillway was constructed along Willard Creek in

the 1930's.

Mantua: Mantua was first known as “Little Valley” by Mormon settlers, and was settled in 1863. Originally sent to grow hemp flax and hemp for clothing, Little Valley was named Flaxville, before finally being named Mantua, after the Mantua Township in eastern Ohio. The settlement was platted in 1864, and functioned as a part of Brigham City until its incorporation in 1911. Outside of flax, hemp, and other agriculture, other industries developed were a lime from a kiln on the northern part of the town, mining, a saw mill, and a fish hatchery. Water comes from surrounding springs, and a reservoir was developed in the middle of the valley to supply water to Brigham City (<http://www.boxeldercounty.org/mantua-history.htm>; 11 January 2015).

Corinne: Corinne was founded as a railroad town in 1869 by Union Pacific railroad officials. Having completed the the Transcontinental Railroad in 1869, railroad officials hoped to capitalize on the rail line with a settlement around its changing station in Box Elder County. Officials even lobbied for the City to be the territories capital. With the railroad's backing, industry was established, including blacksmith shops, livery stables, boarding houses, hotels, an opera house, newspapers, banks, warehouses, cigar factory, a saw mill, gambling halls and saloons. Irrigation systems were set up, but crop agriculture struggled due to the salinated soils. With the advent of the Utah-Northern Railroad in the 1870's, the routing of the rail system changed, and the City went into decline (<http://www.boxeldercounty.org/corinne-history.htm>; 11 Jan. 2016).

Perry: First settlement came around 1851, but settlers did not arrive until 1853. Early name for the Town was Three Mile Creek. Water prevented widespread settlement, and flooding from water development efforts caused flooding of the area in 1896 and

1923. The railroad passed through the area in 1868-69. The name of the settlement changed from Three Mile Creek to Perry in 1898. Culinary water came in 191, and was developed through canals, mountain springs, and wells. The settlement remained agricultural based, with dairies, cattle, and fruit orchards as the leading industries. As the canals further developed, so did orchards and row crops. Demographics changed in the 1950's, with agricultural land giving way to housing. Perry began to become a bedroom community to surrounding areas, such as Ogden, Brigham City, and other areas of employment. (<http://www.boxeldercounty.org/perry-history.htm>; Jan. 11, 2016)

Brigham City: Settlement from Mormon settlers first came in 1851 in Reeder Grove. In 1855, a townsite was surveyed, and city lots were divided amongst the families present. In 1856, with the designation of Box Elder County, Brigham City was named as the county seat. A cooperative movement began in 1863, and lasted in the City until 1896 (<http://www.boxeldercounty.org/brigham-city-history.htm>; Jan. 11, 2016). A cooperative enterprise is system of industries that are linked together to form a self-sufficient economy. Mormon settlers established over 150 cooperative mercantile and manufacturing enterprises during this time period, Brigham City's being one of the most notable because of it's success (Israelson, L. Dwight. "Encyclopedia of Mormonism," pg. 149; 1992.; retrieved Jan. 11, 2016 from Harold B. Lee Library Collection, Brigham Young University.<http://contentdm.lib.byu.edu/cdm/fullbrowser/collection/EoM/id/4298/rv/com-poundobject/cpd/4391>) Industries that were established in the City at this time included a hotel, a general store, a tannery, a shoe and harness shop, woolen mills, and a dairy. The City was formally incorporated in 1867. In 1871, the Utah and Northern Railroad

was built through Box Elder County, and began running from Ogden to Idaho in 1874. Electric lights and culinary water works were developed in 1892. The Union Pacific railroad Depot was built on Forest Street in 1907, and streetcars came to the City in 1910. (<http://www.boxeldercounty.org/brigham-city-history.htm>; Jan. 11, 2016). Peach Days began as a harvest celebration in 1904. Bushnell Military Hospital was created in 1942, and operated until 1946. It later became the Intermountain Indian School, and operated from 1949 until the mid 1980's. During the 1950's, Thiokol Chemical Corporation opened a facility west of Brigham City, and many City residents became employed at the facility. Other industries came into Box Elder County that City residents commuted to for work. (<http://www.benewsjournal.com/bc.html>; 11 Jan. 2016).

Golden Spike

The most noted historical event in the county took place on May 10, 1869. On this date, the driving of the Golden Spike marked the completion of the Transcontinental Railroad when the Central Pacific and Union Pacific Railroads were joined. (Profaizer, "Linking Communities", pg. 9; 2010; Utah State University.)

Demographics

Population

Due to the rural character of the study area, this report relied on the 2010 census data to maintain accuracy. Current population totals show the majority of the population of Box Elder County living within the study area (27,135 people, or 54.3% in 2010). Population projections show an increase in this area, with the population in the study area to grow to 37,924 in 2040, or 58.6% of the population at that time. This is an increase in population of 39.8% over 30 years, with Perry City growing the fastest (see Table 6).

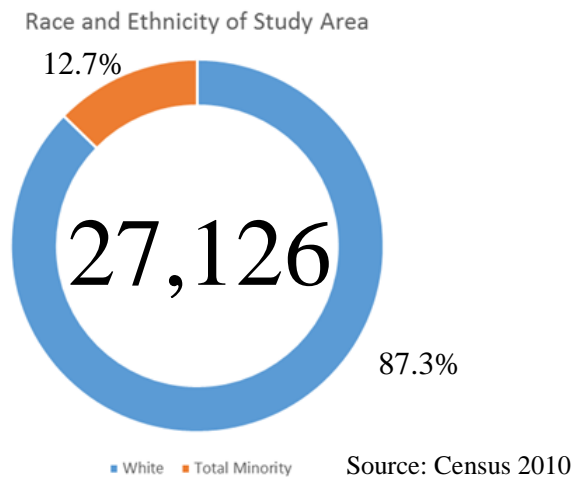
Table 6: Population Projections

Population	Actual			Projection		
	1990	2000	2010	2020	2030	2040
Brigham City	15678	17477	17908	19100	21397	22970
Corinne	639	623	685	764	892	1035
Mantua	705	791	687	709	773	841
Perry	1219	2418	4512	6538	7764	8531
South Willard	-	586	1571	1836	2100	2365
Willard	1301	1625	1772	1945	2036	2182
Box Elder County	36568	42872	49975	54571	59437	64704
	U.S. Census					
	Governors Office of Management and Budget 2012;					
	Computation based on 2015 Census data					
	Population base + births-deaths+migration=population estimate					

Race

The study area is mostly white, with the total minority population being 3,449 of 27,126 persons in 2010, or 12.7% of the population (see Figure 5).

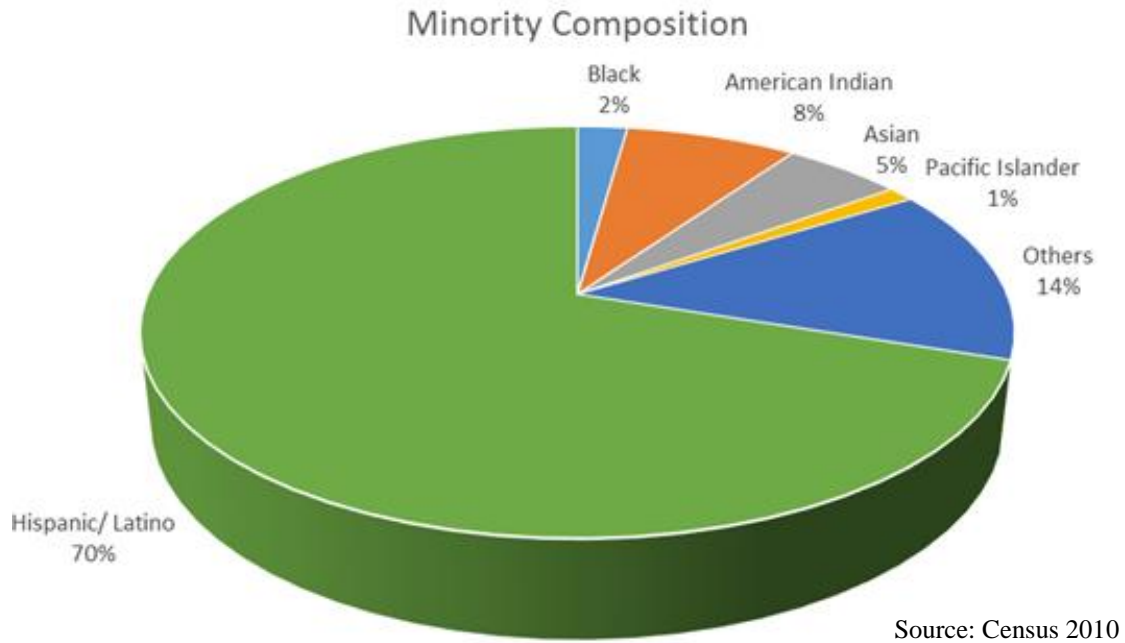
Figure 5: Race and Ethnicity of Study Area.



Most of those who are a minority are Hispanic or Latino, or identify as “others”

(see Figure 6)

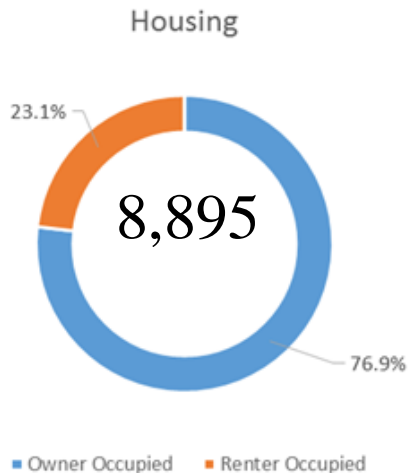
Figure 6: Minority Composition in the Study Area.



Housing

76.9% of homes within the study area are owner-occupied, with 23.1% being renter occupied (see Figure 7).

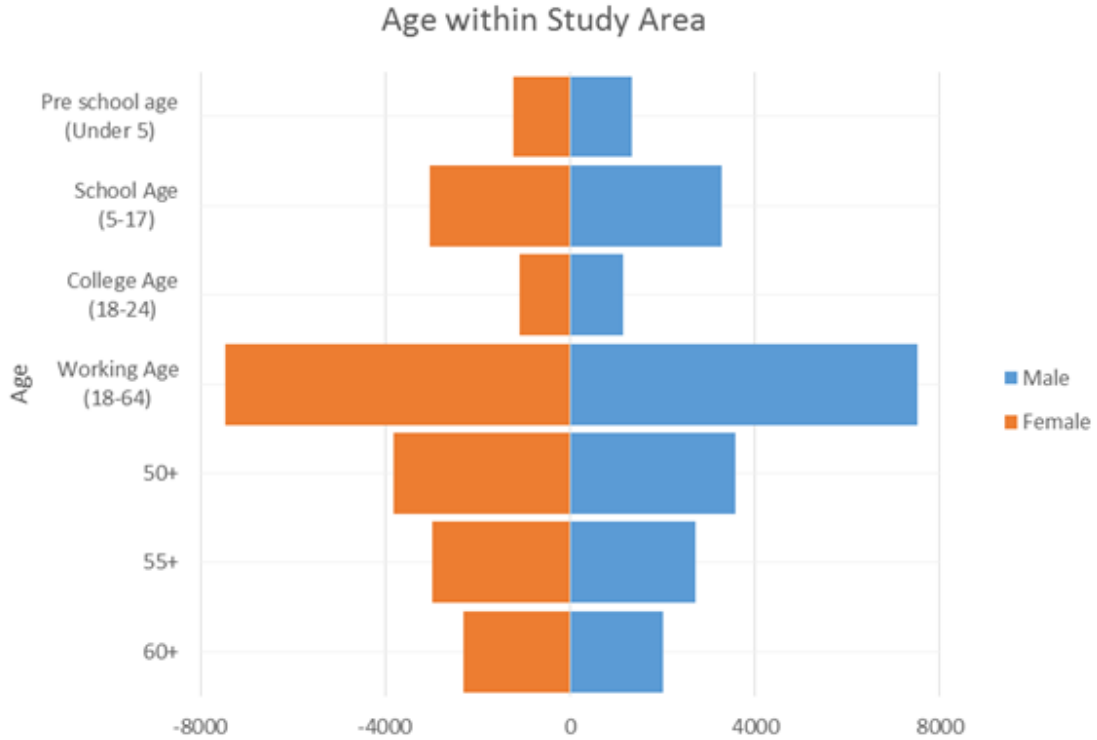
Figure 7: Housing within the Study Area



Age

Figure 8 and Table 7 show the age characteristics of the study area.

Figure 8: Graph of Age Characteristics in Study Area.



Source: Census 2010

Table 7: Age Characteristics of Study Area

Age	Total	
	Male	Female
2010 Census		
Pre school age (Under 5)	1331	1223
School Age (5-17)	3294	3033
College Age (18-24)	1146	1099
Working Age (18-64)	7521	7471
50+	3569	3822
55+	2716	2986
60+	2007	2301

Source: Census 2010

Income

Table 8 shows the median household, family, and per capita incomes for this area.

Table 8: Median Household, Family, and Per Capita Incomes for the Study Area

Income	
2014	Average
Median household incomes	\$ 65,919.33
Median family income	\$ 72,762.67
Per capita income	\$ 23,474.83

Land Use

Source: Census 2010

Land use of the study area has traditionally been agriculture, manufacturing and commercial industry (Profazer 2010, pg. 11) Table 9 shows current land ownership of the study area.

Table 9: Current Land Ownership		
Owner	Area (acres)	Area (%)
Private	36,353.80	27.47%
Federal	72,073.14	54.45%
State	23,929.64	18.08%
Total	132,356.58	100.00%

Development Trends

Agricultural lands are diminishing in order to provide for new residential and commercial uses. Lands are being developed at an increasing rate (Profazer 15-22).

Economic Aspects of the Landscape

The best available economic data was not available at the scale of the study area. For this review of the economic aspects of the landscape, data at the county level will be used.

Box Elder County has many types of industry, with the majority of jobs being in the Service Production (11,842), Goods Production (6,683), and Government (2,513) (UDWS 2015).

Employers

Table 10 shows the different employers within Box Elder County.

Table 10: Employers within Box Elder County.

<i>Company Name</i>	<i>Employees</i>
Autoliv	1000-1500
Orbital ATK	500-999
Nucor Corporation	500-999
Walmart	500-999
WestLinerty Foods, LLC	250-499
Associated Brigham Contractors, Inc.	250-499
Vulcraft	250-499
Bear River Valley Hospital	100-249
Workforce Services	100-249
Kents Foods	100-249
Maddox Ranch House, Inc	100-249
Malt O Meal Company	100-249
Smiths Food and Drug	100-249
SOS Staffing Services, Inc	100-249
Storm Products, Inc	100-249
Thayn and Cari Tagge's Famous Fruit	100-249
Proctor & Gamble Paper Products	100-249
Whitaker Construction Co., Inc	100-249
Source: Utah DWS	

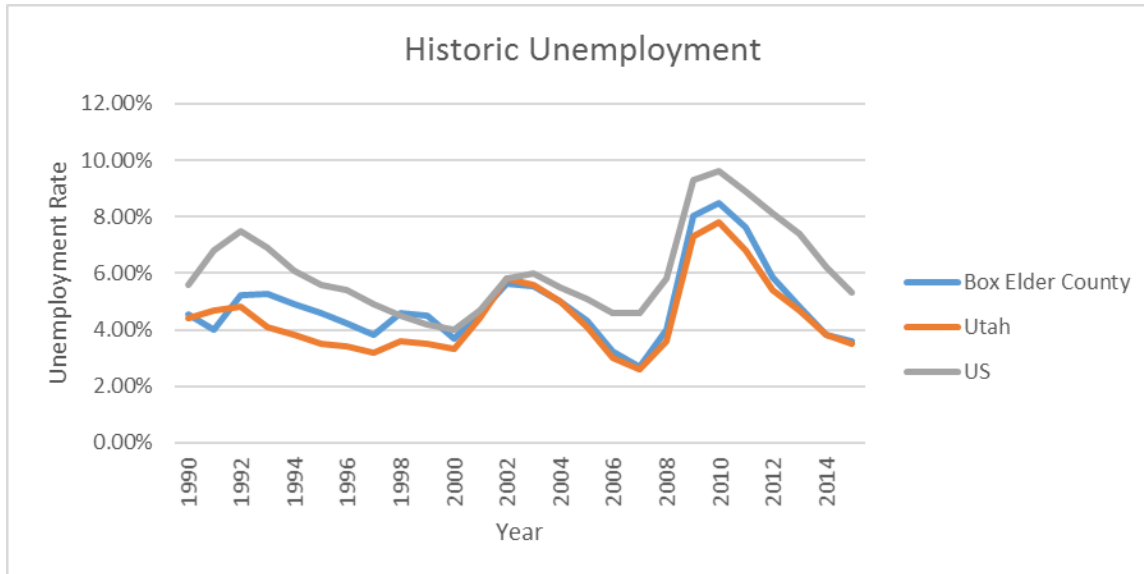
Source: UDWS 2015

Employment

The unemployment rate for the study area was 3.6% in 2014 (UDWS 2014).

Figure 9 shows the historic unemployment rate in Box Elder County, Utah, and the United States from 1990 to 2015.

Figure 9: Historic Unemployment Rate for Box Elder County, Utah, and the U.S., 1990-2015



Source UDWS 2016; DLS 2016.

From this data, it is inferred that the County has held a higher unemployment rate than that of the Utah since 1990, but has stayed below the national average.

Wages

Total wages for Box Elder County in 2012 was \$133,407,667. This was down from the all-time high of \$219,290,498 in 2008. Figure 10 shows historic total wages in Box Elder County from 1990 to 2012.

Figure 10: Total Wages in Box Elder County from 1990 to 2012.

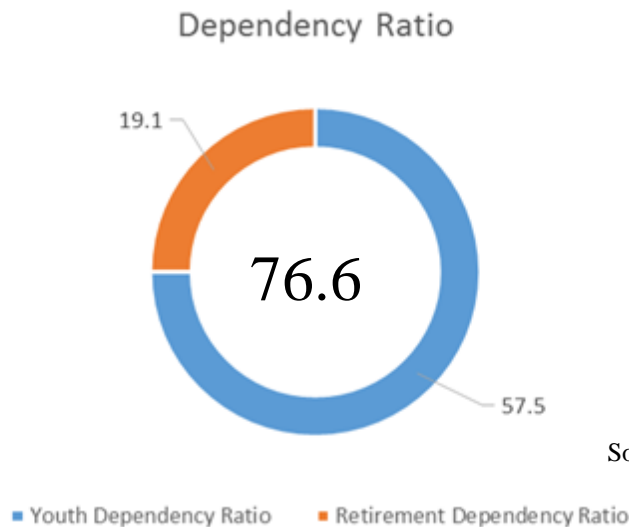


Source: UDWS 2014.

Other statistics

Dependency Ratio: The Total Dependency Ratio for Box Elder County was 76.6 in 2010. (see Figure 11). The youth dependency ratio is the number of persons under 18 per 100 working-age persons. Similarly, the retirement dependency ratio is the number of persons 65 and older per 100 working-age persons. The total dependency ratio is the sum of the two.

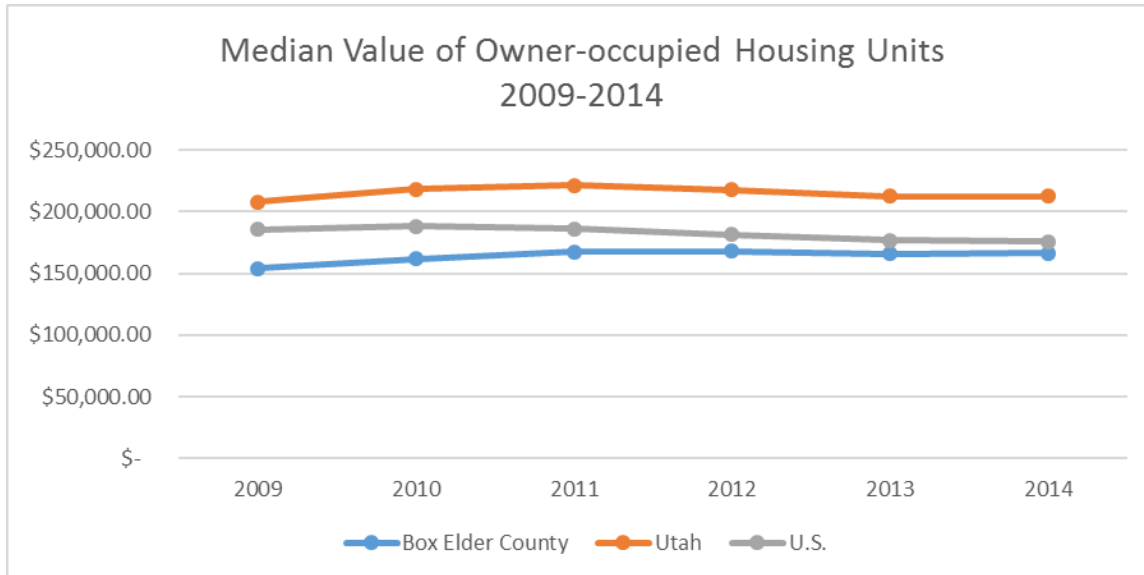
Figure 11: Dependency Ratio in Box Elder County.



Source: Census 2010

From 2009 to 2014, the median value of owner-occupied homes in Box Elder County has been below both the national and state average (see Figure 12). However, while Utah’s median value has remained the same, and the national average has decreased, Box Elder County has increased in median value of owner-occupied homes during this period.

Figure 12: Median Value of Owner-occupied Housing Units.



Source: ACS 5-Year 2009-2014.



Single-family home in Brigham City, Utah. (Source: Author)

MODEL CREATION

The data gathered and inventoried were used to develop a structured geographic information system (GIS) analysis. GIS was used because of its utility in being able to rapidly compare geographic data. These structured GIS analyses are called models, and are constructed to best represent a set of landscape attributes through spatial representation. For this study, the models developed were categorized as *data models* and *futures models*.

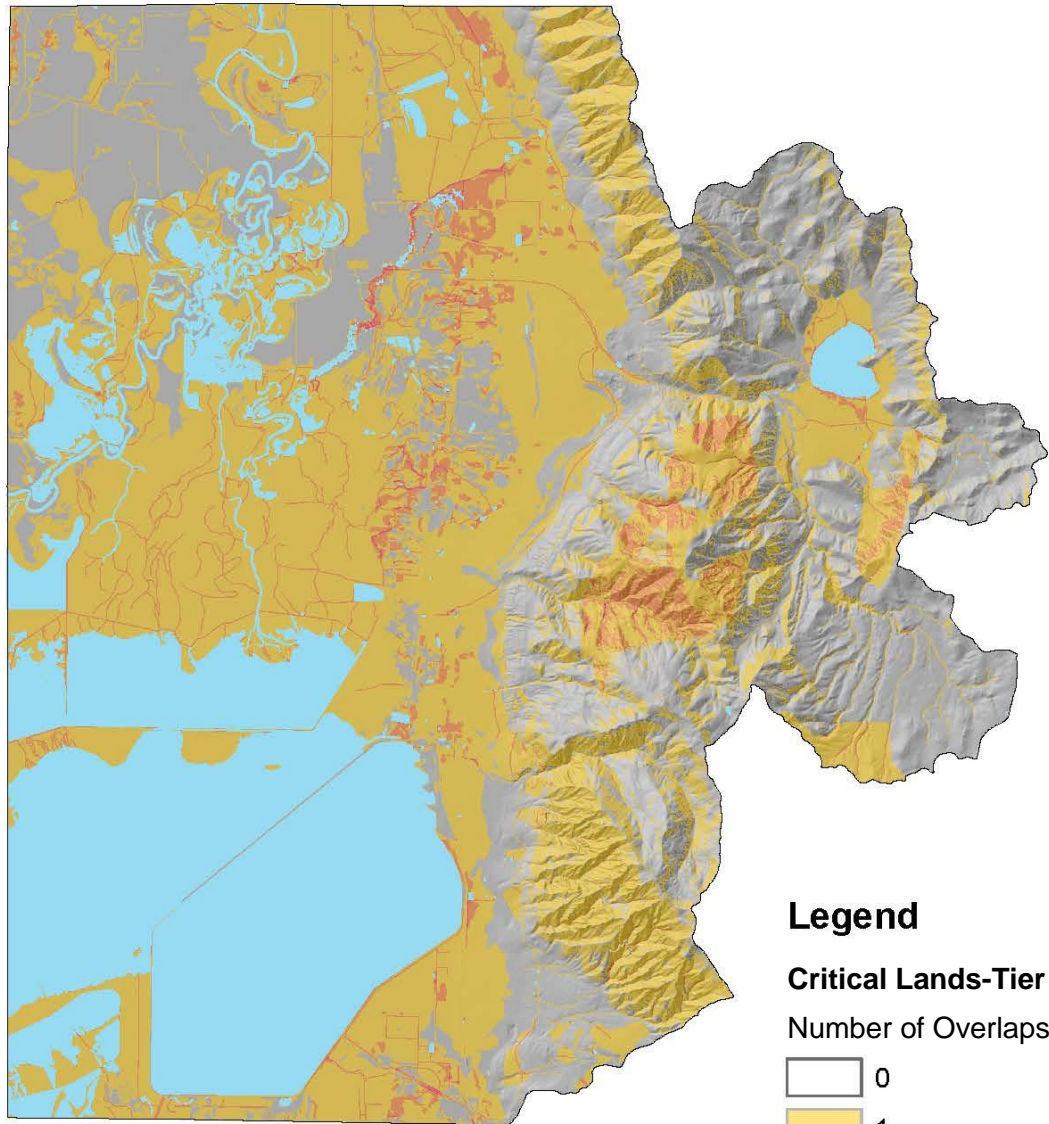
Data Models

Data models reflect significant regional attributes and land-use suitability. The significant regional attributes were organized as a *risk-assessment model*, and represents the attributes of the landscape that are critical to the health, safety, and welfare of both human settlement, and the function and structure of the landscape itself. This model was created with the intent to assess how futures models would impact the critical attributes of the landscape. The basis of this model was founded on the *Critical Lands Planning Toolkit* for the State of Utah, developed by the Governor's Office of Planning and Budget (GOPB 2005). The process of the toolkit focused on several attributes of the landscape, broken down into three tiers in order to represent varying levels of conservation. These attributes are summarized in Table 11, along with their description, and data source.

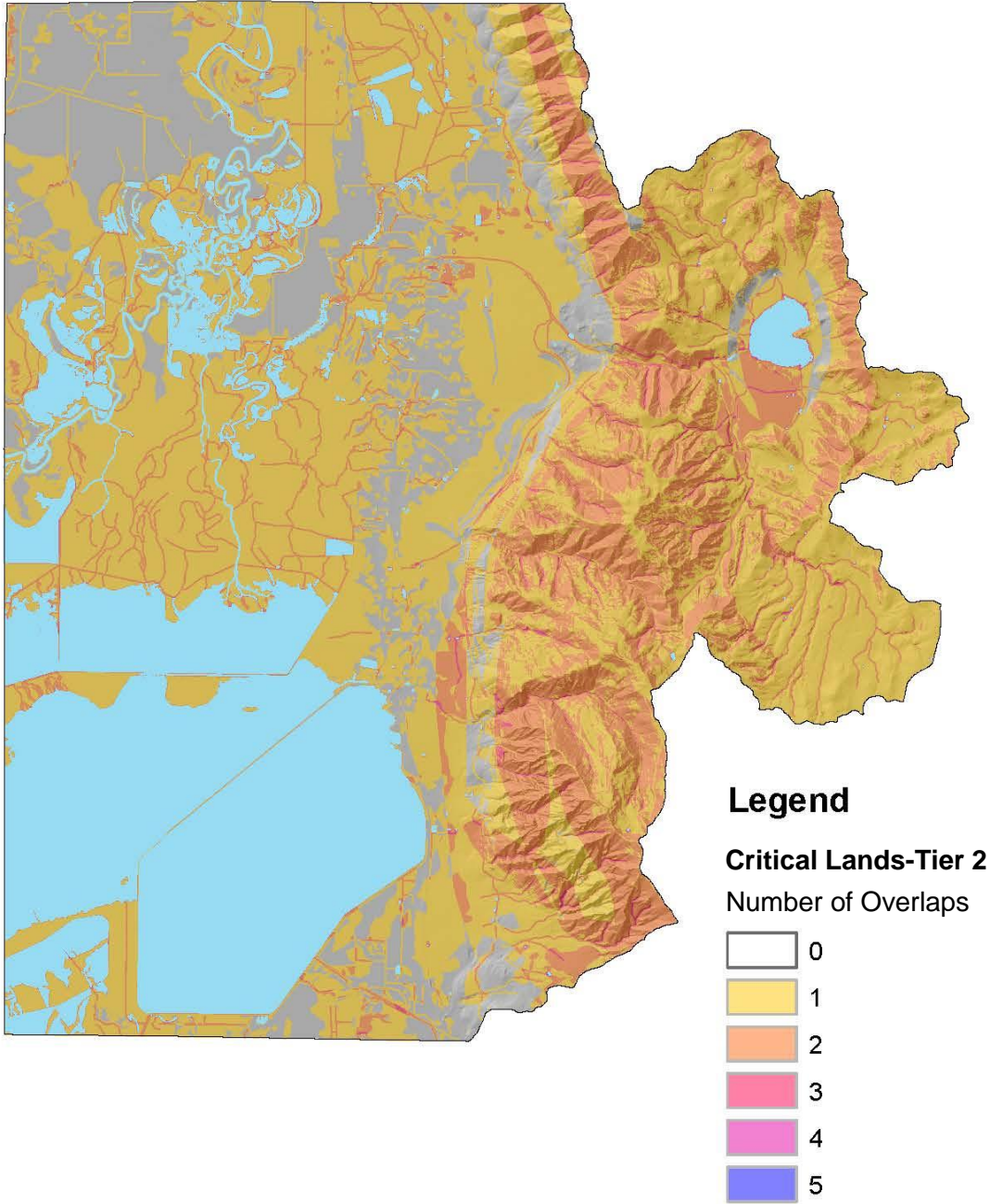
Table 11: Landscape Attributes of the Risk-Assessment Data Model		
<i>Landscape Attribute</i>	<i>Description</i>	<i>Data Source</i>
Steep slopes	Tier 1: 30% or greater Tier 2: 25% or greater Tier 3: 15% or greater	Digital Elevation Model (DEM)
Prime agricultural land	Tier1: Prime ag land Tier2: Prime + Unique ag land Tier 3:Prime+Unique+ ag land of statewide importance	Natural Resource Conservation Service (NRCS)
Wildlife habitat	Tier 1: 6-8 overlaps of species habitat Tier2: 4-6 overlaps of species habitat Tier 3: 1-3 overlaps of species habitat	Utah Division of Wildlife Resources (UDWR)
Streams, lakes, and wetlands	Tier 1: 15 meter buffer Tier 2: 25 meter buffer Tier 3: 50 meter buffer	National Hydrography Dataset (NHD), from the U.S. Geological Survey (USGS); U.S. Fish and Wildlife Service (FWS)

These attributes were combined together spatially through GIS processes by each corresponding tier. So, all Tier 1 attributes were combined into a Critical Lands-Tier 1 risk-assessment model, a Critical Lands-Tier 2 risk assessment model, and a Critical Lands-Tier 3 risk-assessment model.

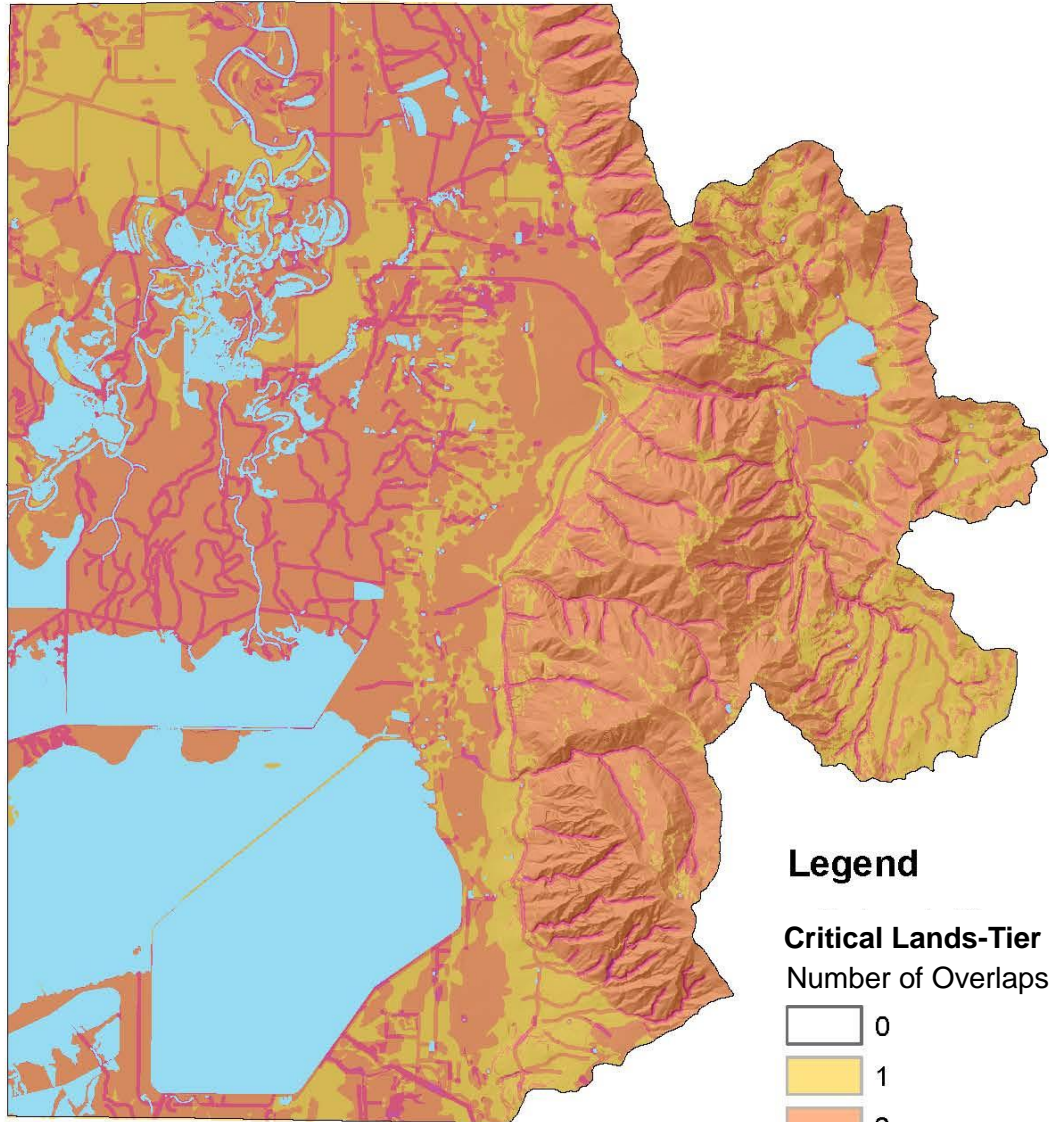
Critical Lands-Tier1



Critical Lands-Tier 2

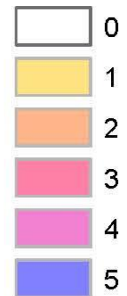


Critical Lands-Tier 3



Legend

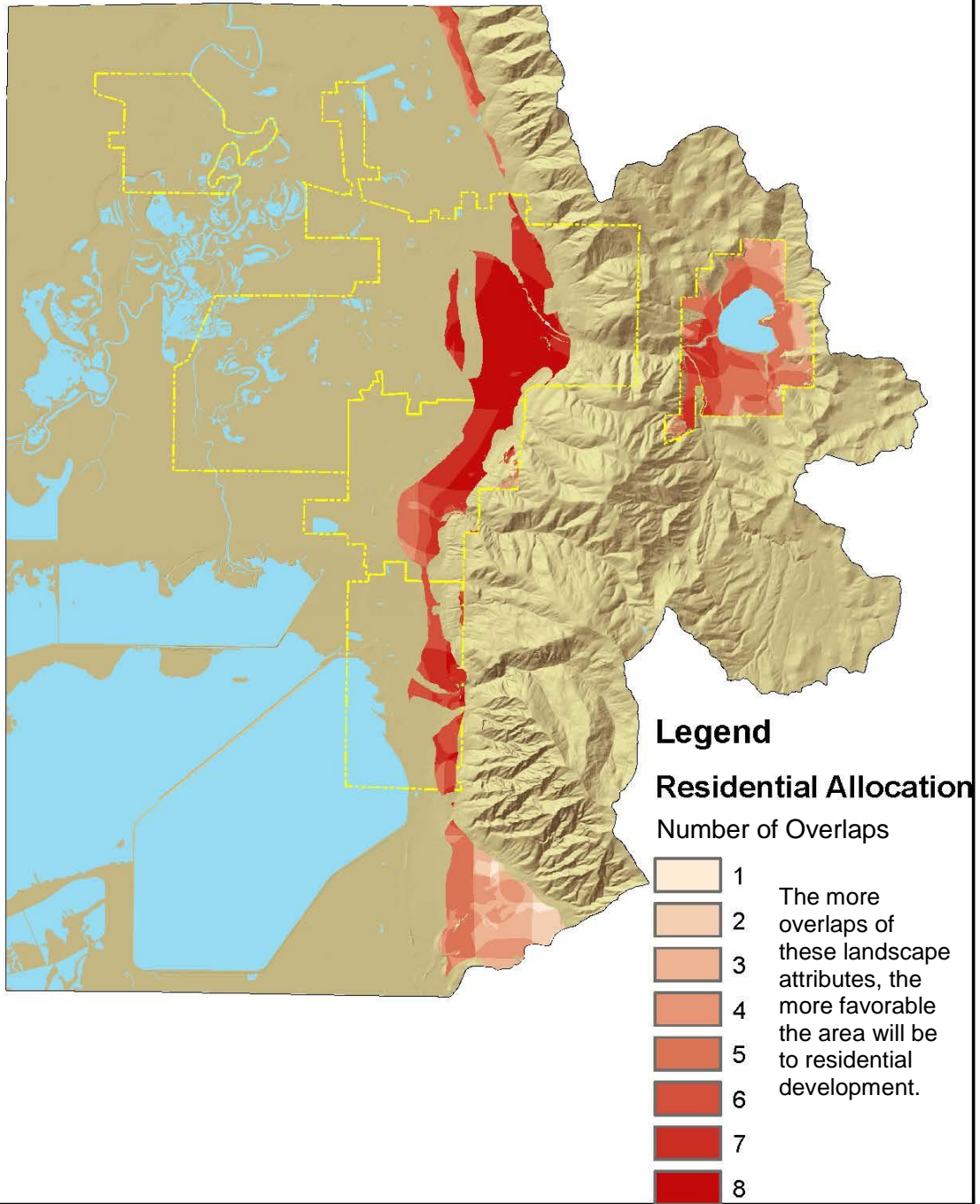
Critical Lands-Tier 3
Number of Overlaps



The second data model was developed into a *land-use suitability* model. This model was organized from those attributes of the landscape that would lend themselves to a particular type of land-use or activity. In this case, attributes that would lend themselves to residential development were compiled. Just like the risk-assessment model, the land-use suitability model was created with the intent to assess how the future models would impact landscape attributes ideal for residential development. This model was based on the residential model developed in the *Alternative Futures Study: Little Bear River Watershed* (Toth et al 2007). Table 12 summarizes the attributes of the landscape that were compiled spatially to create this model, along with a description, and data source.

<i>Landscape Attribute</i>	<i>Description</i>	<i>Data Source</i>
Roads	Within ¼ mile	Utah Department of Transportaion (UDOT)
Slope	Less than 25%	Digital elevation model (DEM)
Flood plain	Outside	Digital Flood Insurance Rate Map (DFIRM) Database
Soil	Well-drained	National Resources Conservation Service (NRCS)
Industrial areas	Outside	Box Elder County
Other residential areas	Within ¼ mile	Box Elder County
Aquifer recharge	Within recharge areas	Utah Department of Environmental Quality, Division of Drinking Water (DEQ-DDW)
Seismic fault zones	Outside	Utah Geologic Survey (UGS)
Landslide/liquefaction	Outside	Utah Geologic Survey (UGS)
Schools	Within 1 mile	Utah Automated Geographic Reference Center (AGRC)
Recreational facilities	Within ¼ mile (walking distance)	Utah Automated Geographic Reference Center (AGRC); Bear River Association of Governments (BRAG)
Shopping Centers	Within 7 miles (17 min. @ 25 mph)	GIS analysis; The Architects' Handbook
Hospitals	Within 2 miles (5 min. @ 25 mph)	Utah Department of Health (UDH); Wilde 2009

Land-use Allocation Model: Residential



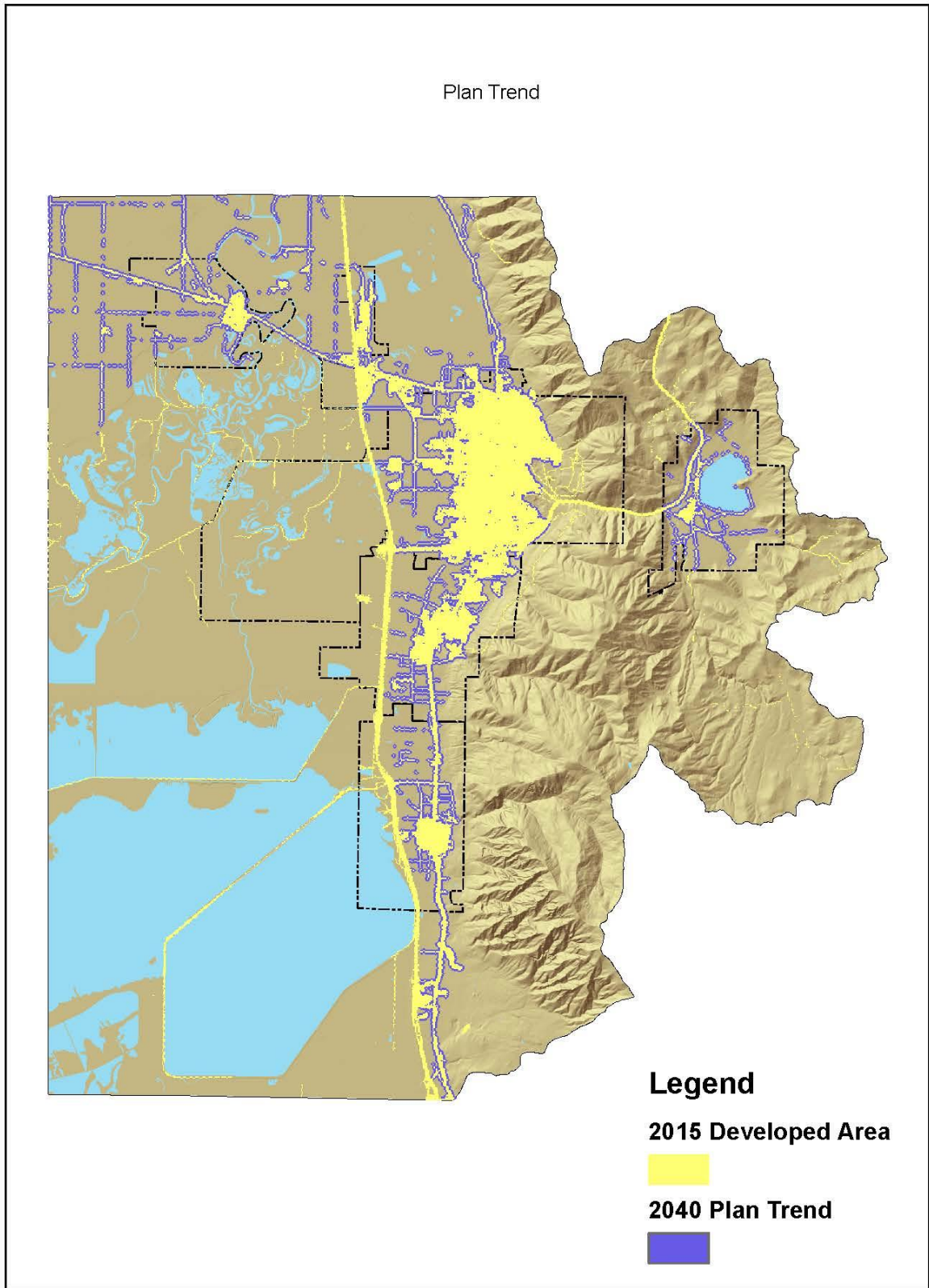
Futures Models

Futures models are based on data supporting a specific “storylines” or “scenario.” They respond to any different possibility for development in the future. For example, this study investigates how commuter-rail could influence development in this region. Many types of future development could occur. It could develop around future stop sites already identified by the study area’s localities, or it could develop in another arbitrary spot preferred by UTA. It may not develop at all. Using GIS, any future model can be conceived, created, and tested, and corrected in a rapid manner. They are amendable and can be updated over time. This study considered three different futures models: a plan trend futures model, a transit-oriented development (TOD) futures model, and a community center futures model.

Plan Trend Futures Model

The plan trend futures model is based on the current development trends in the study area. Development change was measured using the National Agricultural Statistics Service land maps from 2010-2015. Over these six years, land developed at a rate of 312 acres per year. Using this measure, development was projected forward until 2040, culminating into 7,811.6 acres of future land to be developed. In order to spatially represent where this would be, a GIS analysis occurred using the raster calculator feature in ArcGIS 10.3. To spatially represent the increased 7,811.6 acres, the radius between the 2015 developed land and the 2040 developed land was determined through subtracting the 2015 developed land from the 2040 developed land and using basic circle trigonometry ($\text{area}=\pi\cdot\text{radius}^2$). By solving for the radius, the linear measurement of 48.49 meters was found. The 2015 developed area was then buffered by 48.49 meters to

represent the 2040 plan trend developed area.



Transit-oriented Development (TOD) Alternative Futures Model

The TOD futures model is referred to as an alternative, because it is a futures model outside of the current development trajectory. Transit-oriented development is a development of high-intensity, mixed-use land use patterns with pedestrian-friendly design at strategic points along regional transit systems. (Envision Utah 2002). The basic components of TOD are compact development, a diversity and mix of uses, and pedestrian-friendly design (Envision Utah 2002). This study will focus on the residential land-use component of TOD in order to address the growing population within the study area by 2040.

Through conversations and interviews with the local planners through the Box Elder Planners Association, and through preliminary studies by Brigham City and Box Elder County (InterPlan 2004, 2007), three sites within the study area were identified as possible future FrontRunner commuter-rail stops: one at 800 West and 200 South in Brigham City; one at a proposed development in Perry, off of Highway 91 and 900 West; and a stop at 750 North and 550 West in Willard.

For the purposes of this study, TOD were explored around these sites. In order to determine the appropriate development footprint for these sites, several factors and data were reviewed.

1. *Population per acre for 2040 was calculated.* This came about through identifying the increase of persons in the study area by that time, which is 10,789 additional persons. For the purposes of this study, the entire anticipated population will be taken into account in these TOD's. With 132,356.6 acres in the study area, this brings the 2010 population per acre of 0.21 to .29 persons per acre

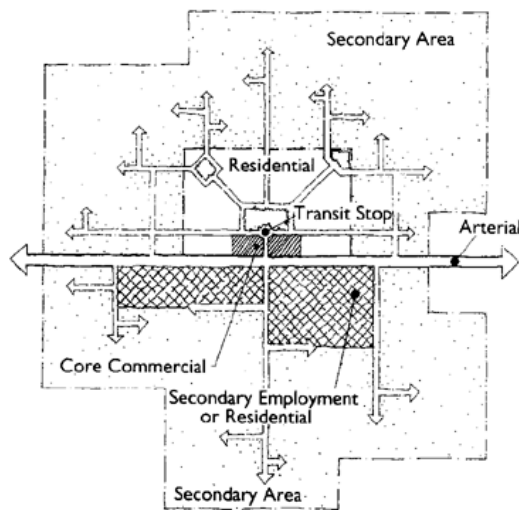
in 2040.

2. *Population was distributed to each transit stop.* Within the study area, the Brigham City stop would serve itself, Corinne, and Mantua; the Perry stop would serve itself; and the Willard stop would serve Willard and South Willard. Due to its position along Highway 91, and due to the anticipated rapid population growth over the next 25 years, the Perry stop was ranked as the same as the Brigham stop, with the Willard stop anticipated to be a smaller development. The Brigham City stop and the Perry stop would then get 44% of the anticipated population growth each, and the Willard stop would get 12%. With 10,789 anticipated persons in 2040, this means the Brigham City and Perry TOD's would have 4,747 people each, and the Willard TOD would have 1,295.
3. *TOD Residential units were determined.* Based on the *Transit-Oriented Development (TOD) Design Guidelines* from UDOT (UDOT 2014), there are different minimum residential units per acre depending upon the TOD center type. The Brigham City and Perry City TOD's were determined to be Town Centers, and the Willard TOD was determined as a Station Community center type. Town Centers are associated with 30 units/acre, and the Station Community center type are associated with 25 units per acre.
4. *Identified total acreage of each site.* Based on the preliminary studies, conversations, and site visits, each site's acreage was determined. The Brigham City TOD would impact 45.13 acres, the Perry TOD would impact 72.21 acres, and the Willard TOD would impact 34.02 acres. Based on the *Florida Department of Transportation Transit Oriented Development Design Guidelines*

(FDOT 2005), TOD's with 5 to 30 units per acre have a minimum lot coverage of 80%. Therefore, the final total acreage for each TOD has the Brigham City TOD at 36.1 acres, the Perry TOD at 57.77 acres, and the Willard TOD at 27.22 acres.

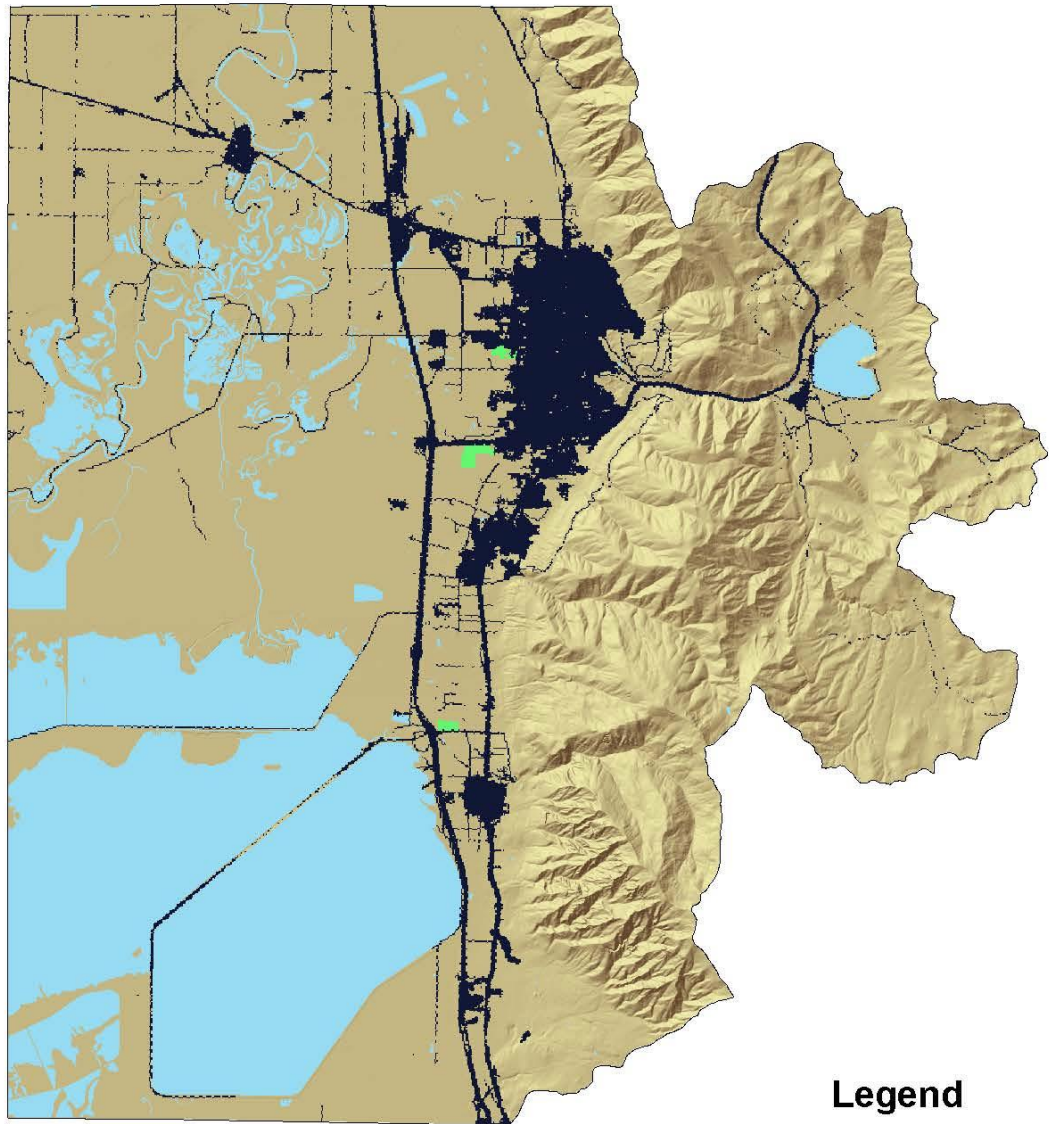
5. *Converted units per acre:* Using each TOD's density and net acres, units per acre was determined. This means the Brigham City TOD had 1,083 units per acre, the Perry TOD has 1,733 units per acre, and the Willard TOD has 680 units per acre.
6. *Determine population of each TOD.* Using the 2010 Census average person per household for the study area (3.09 person per household), the Brigham City TOD would have 3,347 persons, the Perry TOD would have 5,356 people, and the Willard TOD would have 2103 people. All totaled, these TOD's would house 10,806 people, or just 16 more people than the estimated population increase by 2040.

Using the total acreage determined through this process, the areas identified as TOD's were combined with current developed areas using the raster calculator function in ArcGIS 10.3.



TRANSIT-ORIENTED DEVELOPMENT

TOD 2040



Legend

2015 Developed



TOD 2040



Community Center Alternative Futures Model

The Community Center Alternative Futures model is similar to the TOD Alternative Future, but with some differences. With the FrontRunner model of a locomotive-driven commuter-rail service, UTA regulations requires a seven-mile interval between stops. This would mean the TOD Alternative Futures model wouldn't be feasible. However, if a designated diesel-driven car, or set of cars, were set up for exclusive service between the current Pleasant View stop in North Ogden and Brigham City, the required interval between stops would not be enforced. Also, the ability to stop more frequently could open up the opportunity for commuter-rail stops closer to the community centers of the localities within the study area.

The stops for this alternative future would start in South Willard, at 8700 South, between Highway 89 and I-15; the Willard stop would be at 900 South and 200 West; the Perry stop would be at 2950 South and 1500 West; a stop would straddle Brigham City and Perry at 1150 South and 1200 West (Brigham City); the final stop would be on a new rail line that would run along 1200 West in Brigham City, terminating at Forrest Street.

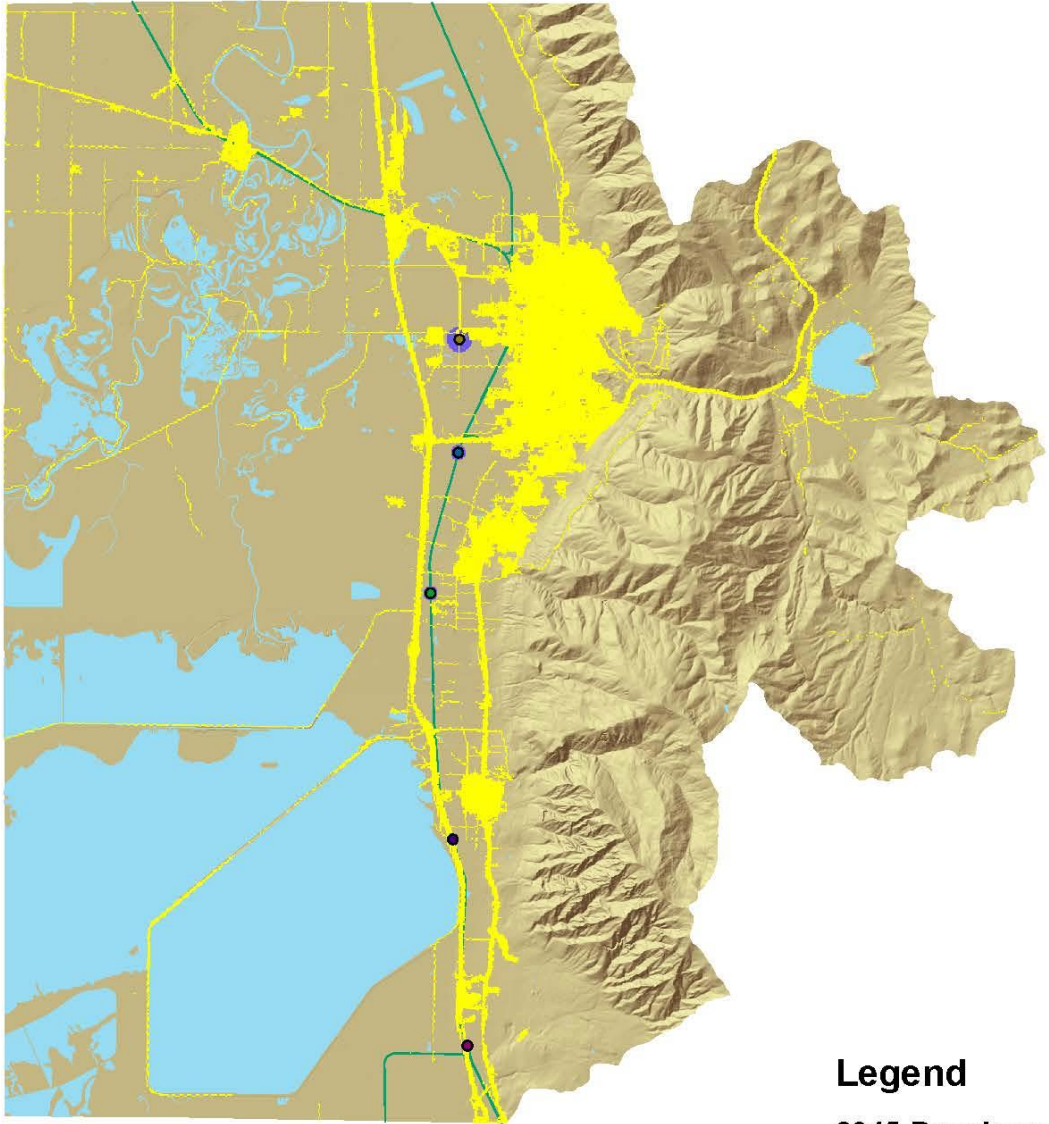
Following the process referred to in the TOD Alternative Future, and based on UTA TOD guidelines (UTA 2014), the TOD's for this alternative future will each have a density of 25 dwelling units per acre. Using each locality's population projections and average density, the total acres for each site was calculated. Using the raster calculator tool in ArcGIS 10.3, the Community Center TOD's were added to the current developed area (2015) in order represent population projections in 2040. Please see Table 12 for more details.

Table 12: Density, Population Increase, and Acres per Stop for the Community Center Alternative Futures Data Model.			
<i>Stop</i>	<i>Average Density (persons/household)</i>	<i>Population Increase 2040</i>	<i>Acres per Stop</i>
Brigham City	2.94	5,412	73.63
Brigham/Perry	3.29	2,164	26.31
Perry	3.29	2,009	24.43
Willard	2.96	410	5.54
South Willard	3.62	794	8.77



Home converted from train station in Willard, Utah. (Source: Author)

Community Center



Legend

2015 Developed



Nodal 2040



ANALYSIS

The Data Models and Futures Models were compared against each other in order to investigate how the Futures Models reacted to the Data Models. These models were compared using GIS calculations with the results shown in Tables 13 and 14.

Table 13: Comparison of Total Area of the Risk Assessment Model Impacted by the Futures Models

	Futures Models		
	<i>Plan Trend</i>	<i>TOD</i>	<i>Community Center</i>
	Area (acres)	Area (acres)	Area (acres)
<i>Risk Assessment Model</i>			
Tier 1	8,875.99	6,734.55	6,718.98
Tier 2	8,971.62	7,029.67	7,001.87
Tier 3	12,694.72	9,607.44	9,594.10

Table 14: Comparison of Total Area of the Residential Land-use Suitability Model Impacted by the Futures Models

	Futures Models		
	<i>Plan Trend</i>	<i>TOD</i>	<i>Community Center</i>
	Area (acres)	Area (acres)	Area (acres)
<i>Land-use Suitability Model</i>			
Residential	4,518.39	3,320.80	3,311.68

From these results the Community Center Alternative Futures model impacts the least amount of land according to the Risk-Assessment Model. However, by comparison, both the TOD and Community Center Alternative Futures are minimally different over the entire project area.

The Community Center Alternative Futures Model also impacts the least amount of land in the Residential Land-use Suitability Model. However, just like in the comparison with the Risk-Assessment Model, both the Community Center and the TOD Alternative Futures are minimally different.

What is clear from both comparisons of Alternative Futures and the Risk-Assessment and Residential Land-use Suitability Models is that the Plan Trend Future Model impacts more land.

Limitations

Some items to observe as limitations in the development of these models include the projection of where future roads will be built. While prime areas of development have been identified generally, unless there are specific future developments taken into account, these models connect project more concentrated impacts within the project area. However, if a locality would like to see the impact of a future development, they may include the proposed new roads within the Residential Land-use Allocation Model and get more specific results.

Another item pertains to the Residential Land-use Model. Does higher impact (i.e. more land displaced) by the Plan Trend or Alternative Future Models equate to a more favorable outcome? Or, like the Risk-Assessment Model, does less impact (i.e. fewer acres displaced) equate to a more favorable outcome? These questions are important and

go back to the values of the region. If the priority of the region is to preserve a sense of place, perhaps a limited residential impact would be more favorable. If the priority is to be a draw for families and people into the region, a higher residential impact would be more favorable. Regardless, this model can be adapted to address these questions.

CONCLUSIONS

Based on the comparison of the Data Models and the Futures Models, and with the object of having the least impact on the land to maintain a sense of place, the Community Center Alternative Futures model impacts the least amount of land. This means concentrated rail-development around these community centers would address the proposed development needs while impacting the least amount of critical lands and lands most suitable for residential development. It should be mentioned that these results only reflect the values representing concentrated residential development. Other types of future residential development, such as the single-family housing, is not taken into account. Alternative futures taking into account single-family housing development, along with other types of housing, can be developed following the study methodology outline in Figure 1.

RECOMMENDATIONS

From on the conclusions from the study, five recommendations became apparent:

- (1) *Conduct a community survey gauging the development preferences of the public.* This survey would serve as a basis for the development of future plans for development, and localities could cite this survey as in developing future land-use policy.

(2) *Identify the rail corridor for commuter-rail.* By identifying the rail corridor, the localities and Box Elder County could then work with state and federal funders to begin to pursue the purchase of right-of-ways for future rail development.

(3) *Continue to perform advanced modeling of proposed future development in the region.* This advanced modeling would build on the plan trend futures models developed by Landon Profaiser in 2010, and the plan trend futures models developed in this study. These models would consider different data sets, (such as current or proposed developments, zoning and comprehensive planning information, higher-quality floodplain or environmental data, etc.) not available to the author and provide a more robust idea of where development will occur.

(4) *Pursue more information regarding a diesel-powered commuter-rail option to southeastern Box Elder County.* Having more information regarding this option would assist the localities in the region, Box Elder County, and the Utah Transit Authority in assessing the feasibility of providing this service in the region. This review would also include a review of the merits and drawbacks of a diesel-powered car versus an electric-powered car.

VERIFICATION

In fall 2016, the author created an executive summary of this study and sent it to the members of the Box Elder Planners Association for review. The intent was to have the planners evaluate the methodology, logic, and conclusions of the study, and to verify if the solutions would be feasible. The author would then request comments and include them in the study.

BIBLIOGRAPHY

- American Society of Civil Engineers. (1949). *Hydrology Handbook*. Reston: American Society of Civil Engineers.
- Anderson, J. L., & Halsey, C. F. (1990). *Housing Technology: Evaluating Soil Texture for House Sites*. St. Paul: University of Minnesota Extension.
- Bartolino, J. R., & Cunningham, W. L. (2003, November). *Ground-Water Depletion Across the Nation*. Retrieved from United States Geological Survey: <https://pubs.usgs.gov/fs/fs-103-03/#pdf>
- Bear River Watershed Information System. (2007, July 11). *Bear River Watershed Fact Sheets-Lower*. Retrieved from Bear River Watershed Information System: <http://bearriverinfo.org/files/uploads/narrative7SI.pdf>
- Billings, W. D. (1978). *Plants, Man, and the Ecosystem*. Wadsworth Publishing.
- Bureau of Labor Statistics. (2016, April 10). *Labor Force Statistics from the Current Population Survey*. Retrieved from Bureau of Labor Statistics: <https://stats.bls.gov/cps/cpsaat01.htm>
- Division of Water Resources. (2000). *Bear River Development*. Salt Lake City: Division of Water Resources.
- Fenneman, N. M., & Johnson, D. W. (1946, January 1). Physiographic Division of the Conterminous United States. Washington, D.C.: United States Geological Survey.
- Gillies, R. R., & Ramsey, R. D. (2009). Climate of Utah. In R. E. Banner, B. D. Baldwin, & E. I. Leydsman McGinty, *Rangeland Resources of Utah* (pp. 39-45). Logan: Utah State University Cooperative Extension.
- Lohman, S. W. (1972). *Glossary of Hydrologic Terms*. Retrieved from United States Geological Survey: https://or.water.usgs.gov/projs_dir/willgw/glossary.html
- McHarg, I. (1969). *Design with Nature*. Garden City: John Wiley & Sons, Inc. .
- National Centers for Environmental Information. (2016, December 31). *Climate Data Online*:

- Dataset Discovery*. Retrieved from National Oceanic and Atmospheric Administration:
<https://www.ncdc.noaa.gov/cdo-web/datasets#GSOM>
- National Oceanic and Atmospheric Administration. (2009, June 25). *National Weather Service Glossary*. Retrieved from National Weather Service:
<http://w1.weather.gov/glossary/index.php?letter=c>
- Natural Resource Conservation Service. (2007, June 18). *Watersheds, Hydrologic Units, Hydrologic Unit Codes, Watershed Approach, and Rapid Watershed Assessments*. Retrieved from Natural Resource Conservation Service:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1042207.pdf
- Natural Resource Conservation Service. (2014, October 9). *Web Soil Survey*. Retrieved from Natural Resource Conservation Service:
<https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>
- Natural Resources Conservation Service. (2005, August 1). *Box Elder County Resource Assessment*. Retrieved from Natural Resources Conservation Service:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ut/technical/dma/nri/?cid=nrcs141p2_034106
- Natural Resources Conservation Service. (2008, February 12). *Soils (SGID93 Geoscience)*. Retrieved from Automated Geographic Reference Center:
ftp://ftp.agrc.utah.gov/SGID93_Vector/NAD83/MetadataHTML/SGID93_GEOSCIENCE_Soils.html
- Neuendorf, K. K., Mehl, Jr., J. P., & Jackson, J. A. (2005). Glossary of Geology. In K. K. Neuendorf, *Glossary of Geology* (p. 267). Alexandria: American Geological Institute.
- Pastore, C. L., Green, M. B., Bain, D. J., Munoz-Hernandez, A., Vorosmarty, C. J., Arrigo, J., . . . Zalzal, K. (2010). Tapping Environmental History to Recreate America's Colonial Hydrology. *Environmental Science & Technology*, 44.

- Profzaizer, D. L. (2010). *Linking Communities in Box Elder County: Land Use Trends & Alternative Futures*. Logan: Utah State University.
- Seaber, P. R., Kapinos, F. P., & Knapp, G. L. (1987). *Hydrologic Unit Maps*. Denver: United States Geological Survey.
- Seaber, P. R., Kapinos, F. P., & Knapp, G. L. (1987). *Hydrologic Unit Maps*. Denver: United States Geological Survey.
- Skousen, J. (2013). *Before You Build Your Home: Conduct a Soil/Site Review*. Morgantown: WVU Extension Service Agriculture and Natural Resources.
- Soil Science Society of America. (2008). *Glossary of Soil Science Terms*. Madison: Soil Science Society of America. Retrieved from Soil Science Society of America:
<https://www.soils.org/publications/soils-glossary/#>
- Stewart, L. (2015, January 16). Water experts discuss impacts, benefits of Northern Utah dam proposals. *Herald Journal*. Herald Journal.
- Stryker, A. (2009, January 14). Utah County FrontRunner expansion on track. *Herald Extra*, pp. http://www.heraldextra.com/news/local/utah-county-frontrunner-expansion-on-track/article_2bfca76b-4c96-58e5-a548-4d3aa6009166.html.
- Toth, R. E. (1972, June). An Approach to Principles of Land Planning and Design. *Harvard Graduate School of Design*, p. 5.
- Toth, R. E., Baker, J. B., Bryner, C. L., Evans, J., Hinman, K. E., Kilpatrick, K. R., & Seegmiller, K. (2005). *Alternative Futures for the Bear River Watershed*. Logan: Utah State University.
- Toth, R. E., Edwards, Jr., T. J., Perschon, A. L., & White, D. C. (2010). *Bear River Watershed: It's Role in Maintaining the Bear River Migratory Bird Refuge*. Logan: Utah State University.
- United States Geological Survey. (2003, January 1). *Physiographic Divisions of the*

- Conterminous U. S.* Retrieved from United States Geological Survey:
<https://water.usgs.gov/GIS/metadata/usgswrd/XML/physio.xml>
- United States Geological Survey. (2016, December 9). *What is a Watershed?* Retrieved from United States Geological Survey: <http://water.usgs.gov/edu/watershed.html>
- United States Geological Survey. (2017, April 19). *Water Science Glossary of Terms.* Retrieved from United States Geological Survey: <https://water.usgs.gov/edu/dictionary.html#W>
- Utah Department of Workforce Services. (2016, April 10). *Utah Economic Data Viewer: Labor Force Data.* Retrieved from Utah Department of Workforce Services:
<http://jobs.utah.gov/jsp/wi/utalmis/countyhistdata.do>
- Utah Geological Survey. (2013, January 1). *Physiographic Provinces.* Retrieved from Utah Geological Survey: <http://geology.utah.gov/popular/general-geology/utah-landforms/physiographic-provinces/>
- Utah Transit Authority. (2013, April 25). *Five Years of Frontrunner.* Retrieved from Utah Transit Authority: <http://www.rideuta.com/news/2013/04/five-years-of-frontrunner/>
- Utah Transit Authority. (2013). *UTA Network Study: Next Tier Program Final Report.* Salt Lake City: Lochner.
- Winter, T. C., Harvey, J. W., Franke, O. L., & Alley, W. M. (1998). *Ground Water and Surface Water: A Single Resource-U.S. Geological Survey Circular 1139.* Denver: United States Geological Survey.

METHODOLOGY

What is a “methodology?”

The dynamics of planning and the landscape are in a state of constant flux. Time, economy, ecology, and human impact all affect how the landscape is changed and perceived. In order to be deemed as a viable solution to the issues presented in the introduction, the approach of this study must be able to be dynamic and systematic. It must be independent of time, scale, content, location, and technology (Toth 1968). That way, even though there will be solutions offered in this report, the approach can be replicated in the future to reflect inevitable change.

A methodology is “a set of methods, rules, or ideas that are important in a science or art, and is a particular procedure or set of procedures.” (Merriam-Webster 2014). The methodology for this study will follow the framework outlined by Professor Richard Toth in *A Planning and Design Methodology* (Toth 1974). This framework has been the foundation of the Bioregional Planning Studio at Utah State University, and has been used in both studio projects and student projects (Toth, Edwards, Lilieholm, and Hunter 2000), (Toth, Edwards, Lilieholm 2004), (Toth et al 2004), (Toth et al, 2006), (Toth et al, 2008), (Toth, Edwards, Perschon, and White 2010), (Covington 2008), (Hurst 2009), (Profaizer 2011), (White 2011). The framework is dynamic and follows a systems approach to landscape planning. It has a logic and flow that can be altered and manipulated as criteria changes. Importantly, it is self-correcting, as the flow of the process is cyclical and not just linear in function.

Case Studies and Literature Research

This phase was guided by many literary sources. Case studies in large-scale environmental planning, were reviewed to establish a foundation of scholarly work and best practices in land planning. These works were used to identify potential strategies and methodologies that could be used as a template in this project. These case studies included *Design with Nature*, by Ian McHarg; *A Planning and Design Methodology*, by Richard E. Toth; and *A Framework for Theory*, and *A Framework for Geodesign*, by Carl Steinitz. Each of these works presents not only a framework, or template, for how to move forward in the land planning process, but also sets the language that can best describe this process.

Design with Nature: Professor Ian McHarg’s seminal work, *Design with Nature*, is one of the most successful books in describing landscape planning that is sensitive to ecology. Professor McHarg’s approach is based on the idea that each feature of the landscape has “intrinsic suitability” (McHarg, 1969). Sometimes these features and suitabilities overlap so as either confirm or deny a land use. A planner, developer, or government official can find these suitable land uses through adding features on top of each other to see how they interact. These features McHarg calls “major data subjects” (McHarg, 1969) include: climate, geology, hydrology, soils, plant ecology, wildlife, and land use (McHarg, 1969). This layering method can not only inform the planner where suitable land uses should be, but where development should be unsuitable.

A Planning and Design Methodology: Professor Richard E. Toth’s design methodology was constructed to be independent of location, content, time, scale and technology. It also was constructed to be independent of a predefined user (Toth 1974). This independence allows a universality and applicability to a broad range of planning and design problems. Toth’s methodology is broken down into nine phases, listed in Figure 4. Although these phases are linear in order, they are actually cyclical, constantly looping back into previous phases (Toth 1974). This way, Toth’s methodology remains dynamic and constantly self-checking.

- | |
|---|
| <p>Toth’s Planning and Design Methodology</p> <ol style="list-style-type: none"> 1. Pre analysis (problem formulation) 2. Data inventory and file 3. Full-scale analysis 4. Criteria-evaluation development 5. Concept development 6. Concept evaluation and selection 7. Site planning 8. Site design 9. Implementation |
|---|

A Framework for Theory and *A Framework for Geodesign*: Professor Carl Steinitz’ framework states that a definition of theory must be “broadly encompassing” (Steinitz 1990) and therefore a framework for landscape planning should be broad and “integrative as well” (Steinitz 1990). Steinitz framework for landscape planning is organized using six questions to guide to process. These questions are identified as levels of inquiry relating to a “theory-driven model type.” (Steinitz 1990). These questions and model types are listed in the following table.

Steinitz’ Six Questions and Model Types

Question	Model Type
I. How should the state of the landscape be described in terms of content, boundaries, space, and time?	Representation Models
II. How does the landscape work? What are the functional and structural relationships among its elements?	Process Models
III. How does one judge whether the current state of the landscape is working well?	Evaluation Models
IV. By what actions might the current representation of the landscape be altered?	Change Models (Projection Models; Intervention Models)
V. What predictable differences might the changes cause?	Impact Models
VI. How is a decision to change the landscape to be made? How is a comparative evaluation to be made among alternative courses of action?	Decision Models

Like Professor Toth's methodology, Professor Steinitz' provides feedback loops to cycle back to revisit past questions and model types at different stages of the planning process. Unlike Professor Toth's methodology, these feedback loops can go in reverse order once a "run through" of the questions and models has been completed. This means that once you run through the question sequence in order, one can then go back through the process starting with Question VI and revisiting the Decision Models, then Question V and Impact Models, etc. What is not clear in this framework is the logic of revisiting in this order, other than the statement by Professor Steinitz that it "would be advantageous to organize a landscape (or other) design study in reverse order" (Steinitz 1990).

There are other landscape design processes and methodologies that have led to or compliment the three reviewed (Lynch and Hack 1986; Simonds 1997). However, these three methodologies provided the template for constructing a specialized methodology for this study area.

Other literature reviewed includes studies that were based upon the aforementioned methodologies. It also included a review of the different general plans for the cities of Willard, Perry and Brigham City and Box Elder County.

Methodology for Study Area

The language and text to describe the methodology in this study was written by the author in the Bioregional Planning Studio Project, Uintah Basin Revisited (Toth, Coombs, & Gottfredson 2013). The language was modified and changed to fit the scope and scale of this project. However, even though the language was written by the author, it is based on the framework developed by Toth (Toth 1974). This can be broken down into several phases: *problem formation*, *data inventory*, *full-scale analysis*, and *criteria-evaluation development*.

Problem Formation

Identify Issues: "Quick Picture"

The pre-analysis is a part of the Problem Formulation phase of the study. The primary objective of the pre-analysis is to get a "feel" for the region, and to gain an understanding of the issues and opportunities present in the study area. Several sources of information were explored during this phase. Case studies representing seminal works in large-scale environmental planning were reviewed to establish an appropriate foundation for this study. Site visits were made to allow face to-face meetings with local officials and stakeholders. These visits also allowed an "on the ground" perspective of the region. Finally, issues were identified that are most important to the people of the region when it comes to land-use change and the landscape. Though many of these issues will be addressed by this study, others will need to be addressed in future projects. For more information on the pre-analysis, please see page 10, and the "Pre-Analysis" section of the Appendix.

Data Inventory

Gather Data: Landscape Function and Structure- “Regional Inventory”

The landscape function and structure is the primary component of the Data Inventory phase. The primary objective of this phase was to research the structural and functional aspects of the region to gain an understanding of the landscape-level processes that exist in the study area – more simply put, the way that everything works and why. While these aspects were delineated as physical, biological, and social/cultural aspects, careful attention was paid to the relationships between and among them. The primary aspects addressed directly included the region’s geology, climate, soils, vegetation, and wildlife as well as human settlement, culture, and impacts. Economic drivers are also discussed. For more information, please see page 15.

Full-scale Analysis

Data Modeling: “Significant Regional Attributes”

Once an inventory of data and knowledge has been established, the data can be organized together based upon relationships and attributes. This is done for comparison and analysis. The data combined together represent operationally significant attributes and processes occurring in the study area. The best way to do this organizing is through the modeling ability of a geographic information system (GIS).

What are the significant attributes of a region? How will these attributes be affected by change? These questions can be answered through the creation of assessment models, and are part of the Full-scale Analysis phase of this study.

But what is a model? A model is the output of a structured GIS analysis. The spatial representations that are created in this part of the study are called “assessment models.” The primary use of these models are to assess the impact of any proposed action or planning strategy on the regional resources identified.

These models can be stand alone models, representing one aspect of a region, such as water quality, or sensitive lands. Or, they can be combined to represent a set of attributes, such as water quality and sensitive lands combining in model to represent public health, safety, and welfare.

For this study, the assessment model that will be developed represents critical lands. For more information, please see page 63.

These models will also be used to analyze the alternative future scenarios.

Allocation Models: “Land-Use Suitability”

The second component of the Full-scale Analysis phase of the study are allocation models. Allocation models are spatial representations of potential activities or land uses as they might occur in the landscape. Like assessment models, these are organized by significant attributes, but are more focused on human development. For this study, the model that will be developed will be for residential land-use.

These models will be used to identify areas on the landscape that are suitable for these different types of development. This is most helpful when looking at the development of the commuter-rail line, and if the route chosen by UTA would best be suited for its proposed route. They will also be used to help analyze alternative future scenarios.

Alternative Future Models: “Landscape Storylines”

“What will the landscape look like if...” “Where should we focus our efforts for future development?” “What would happen if we placed the future FrontRunner train stations at ‘X’ location?”

These questions can be answered through the development of *alternative future models*, or scenarios, the final component of the Full-scale Analysis phase. These models are like storylines: they can be created by putting different elements together to form a narrative. For example, if the people of southeastern Box Elder County wanted to focus their development efforts around mass-transit, that could be mapped on the landscape using an alternative future model. If the people of Box Elder County wanted to focus their future development on only lands with the least impact on the environment, or the safest places to develop, or along current transportation corridors, all this could be shown as individual alternative futures. How development is posed to move forwards now according to current plans is also an alternative future, called a *plan trend*.

For this study, only three alternative futures will be developed: (a) plan trend; (b) FrontRunner Transit-Oriented Development (TOD); and (c) community center development. These will be assessed against the assessment models and allocation models for analysis for impact and suitability.

It is important to note that these alternative futures are amendable, and the different attributes that are calculated within the scenarios can change to best reflect the views of the user. The “storyline” can change based upon whatever the user desires.

Criteria Evaluation Development

Evaluation of Alternatives

The evaluation will compare the three alternative future models to the assessment and allocation models. Based upon this evaluation, it will become apparent which alternative future will have the most or least impact, or best or least suitability, in the study area.

Conclusions and Recommendations

After the evaluation, the final step of this iteration of the study will be to draw conclusions and recommendations for the people of southeastern Box Elder County. These conclusions will be based on previous phase, and should be self-evident. The recommendations will be based on best practices in the planning field, and will also include ideas for further study by the planners, governments, or students interested in the future growth of this area.

PREANALYSIS

What is a “Pre Analysis?”

A pre-analysis is a preliminary investigation of the issue at hand. If you were given the task by a superior to do something you have never done before, say, to see if form-based code would be feasible in your city or community, how would you proceed? Before you would write any ordinance, you would probably need to know a little about form-based code. The same is for this project. To move forward, we need to know how others have approached similar areas and circumstances, what the area is like, meet with the people who are making decisions about future land use and development, and identify the issues and values that matter to the people of Box Elder County. A Bioregional Studio Project from Utah State University says “(t)he primary objective of the Pre-Analysis is to get a ‘feel’ for the region, gain an understanding of the issues and opportunities that may need to be addressed through the course of the project, and to begin to develop a suitable methodology” (Toth, Coombs, and Gottfredson, 2013). We will follow this outline.

The pre-analysis for this study includes case studies and literature research, site visits, stake holder meetings, and the issues and values identified from these meetings. For the planner or practitioner, this section may be useful to review as to why the author set up this study and report the way he did. For the results of the analysis, please go to page 10.

Site Reconnaissance

As in Uintah Basin Revisited, and other Bioregional Planning projects, “site visits were made to allow face-to- face meetings with local officials and stakeholders as well as to get an ‘on the ground’ perspective of the region.” (Toth, Coombs, and Gottfredson, 2013). These stakeholder meetings took the form of informal interviews with local planners and elected officials between the fall of 2013 and the fall of 2014.

In addition to the different meetings that have been held in the study area as mentioned before, the first designated trip to area occurred in January 2014. During that time, the author visited different sites and communities and recorded thoughts and impressions.

Sites visited included the following:

1. Trail connections, recreations sites, and neighborhoods in South Willard, Box Elder County.
2. Parks, neighborhoods, trail connections, highway corridor, and Willard Bay in Willard, Utah.
3. Parks, neighborhoods, rural roads, highway corridor, and commercial district of Perry, Utah.
4. Highways 91, 89, and 13.
5. UTA’s proposed FrontRunner stops at Willard and Brigham City.

Stakeholder meetings

Starting in the fall of 2013, the author joined the informal group, The Box Elder Planners Association, for their monthly meetings. This was to establish a professional relationship with the planners of southeastern Box Elder County and to have a forum to discuss the issues that affect land use and the environment as it pertains to commuter rail transit. As mentioned, and in addition to these meetings, the author met with the city planners of Willard City, Perry City, Brigham City, and the county planner for Box Elder County. Through work at BRAG, the author also met with a Box Elder county commissioner, the mayor of Perry City, leaders from the Utah Transit Authority, representatives from the Weber Pathways organization, and planners from the Wasatch Front Regional Council. These meetings cumulatively provided perspective into the values, expectations, research, and planning that has already been done by these individuals and organizations.

<u>Data Name</u>	<u>Page</u>	<u>Data Type</u>	<u>Steward</u>	<u>Source</u>
Aerial Imagery	49	Raster	National Agricultural Statistics Service	https://nassgeodata.gmu.edu/CropScape/
Aquifer Recharge	46	GIS Shapefile	Utah Department of Environmental Quality-Division of Drinking Water	https://gis.utah.gov/data/geoscience/
Flood plain	46	GIS Shapefile	Digital Flood Insurance Rate Map Database	https://gis.utah.gov/data/water-data-services/
Hospitals	47	GIS Shapefile	Utah Automated Geographic Reference Center	https://gis.utah.gov/data/society-overview/
Industrial Areas	46	GIS Shapefile	Box Elder County	Box Elder County parcel data
Landslide/liquefaction	46	GIS Shapefile	Utah Geologic Survey	https://gis.utah.gov/data/geoscience/
Other Residential Areas	46	GIS Shapefile	Box Elder County	Box Elder County parcel data
Prime Agricultural Land	41	GIS Shapefile	Natural Resource Conservation Service	https://gis.utah.gov/data/geoscience/soil/
Recreation Facilities	46	GIS Shapefile	Utah Automated Geographic Reference Center	https://gis.utah.gov/data/recreation/ ; Bear River Association of Governments
Roads	46	GIS Shapefile	Utah Department of Transportation	https://gis.utah.gov/data/sgid-transportation/
Schools	46	GIS Shapefile	Utah Automated Geographic Reference Center	https://gis.utah.gov/data/society-overview/
Seismic Fault Zones	46	GIS Shapefile	Utah Geologic Survey	https://gis.utah.gov/data/geoscience/
Shopping Centers	46	GIS Shapefile	Utah Automated Geographic Reference Center	https://gis.utah.gov/data/aerial-photography/
Soil	46	GIS Shapefile	National Resource Conservation Service	https://gis.utah.gov/data/geoscience/soil/
Steep Slopes	41, 46	Digital Elevation Model	U.S. Geological Survey	https://gis.utah.gov/data/elevation-terrain-data/
Streams, Lakes, and Wetlands	42	GIS Shapefile	National Hydrography Dataset; U.S. Fish and Wildlife Service	https://gis.utah.gov/data/water-data-services/
Wildlife Habitat	42	GIS Shapefile	Utah Division of Wildlife Resources	https://gis.utah.gov/data/bioscience-overview/department-wildlife-resources-habitat-areas/