LINKING COMMUNITIES IN BOX ELDER COUNTY

Land Use Trends & Alternative Futures

Plan B Project
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LINKING COMMUNITIES IN BOX ELDER COUNTY: LAND USE TRENDS & ALTERNATIVE FUTURES

Plan B Project

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I would like to thank all of my friends and family for their love, support, and words of encouragement. And finally, I wish to thank my wife Amanda, and my daughter Ruby for their support throughout my graduate education. Sorry for the late nights...now we can play!
Preface

This study is the result of discussions between Box Elder County, the Bear River Association of Governments, and Utah State University beginning in the summer of 2009. The Box Elder County Office of Community Development originally requested assistance with a county General Plan update, however, time and resources would not allow for a student project of that size and scope. Instead, an evaluation of the current plan was proposed that would include the analysis of historic, current and potential “alternative future” land uses in the county.

This land use and resource inventory is almost entirely spatial in nature, utilizing both science and Geographic Information Systems (GIS) technology developed by the Environmental Systems Research Institute (ESRI). The report identifies several social, economic and environmental resources that are considered vital to public health, welfare and safety in the region.

Additionally, this report follows similar planning frameworks successfully utilized in other bioregional planning studies, with the ultimate goal of providing communities with critical information, and the direction to help guide future planning efforts in the region.

“Utah has experienced a significant net population increase over the past 10 years. Communities with populations less than 2,000 do not have the personnel or fiscal resources to engage professional planning assistance. In addition, they do not have the appropriate data for their communities environmental, cultural, and economic resources in a form to make appropriate physical planning decisions.

A primary objective of the (Bioregional Planning) program is to provide community decision makers with that material, including the production and evaluation of alternative futures, from which they can make informed decisions concerning the quality of growth for their community.” (Bioregional Planning, 2010)
Study Area

Figure 1 Context map of the study area - Box Elder County, Utah.
Chapter 1 - Introduction

Study Area

Box Elder County is situated in the northwest corner of the state of Utah. The county is the state’s fourth largest with over 5,700 square miles of land and just over 1,000 square miles of water (USDA, 2005). The county, created by Territorial Legislature in 1856, is situated in the northeast corner of the Great Basin physiographic province, and also comprises the northern extent of the hydrologic Great Basin.

Despite hundreds of thousands of developable acres that are found throughout the landscape, nearly all development occurs in the eastern portion of the county. The small, agriculturally based towns to the west experience a type of geographic isolation, due mainly in part by the northern extent of the Great Salt Lake, and the several hours driving time this creates from more urban areas and the highly populated Wasatch Front to the east (USDA, 2005).

As Weber and Davis Counties to the south fast approach build out levels, there is increasing development pressure from the expanding Wasatch Front. This growth, combined with future interstate and commuter rail expansion projects, is expected to act as a major driver towards the intensification of land-use and conversion of open space and farmlands to more urban related uses in eastern Box Elder County (GOPB, 2008; UDOT, 2007).

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. “Once completed, UTA’s Frontrunner will extend from Brigham City to Payson, connecting nearly the entire Wasatch Front.” (Summers, 2008)

Figure 1.1 View of the Raft River Mountains near Park Valley, Utah in western Box Elder County. A majority of federal and state lands are in this portion of the county. This is also where a majority of the dry land agriculture and cattle ranching occurs in the steppe desert climate (Godfrey, 2005). Photo courtesy of Zac Covington, Bear River Association of Governments.

Figure 1.2 View of Brigham City looking west.
A recent study by the Utah Governor’s Office of Planning & Budget estimates Utah’s population of 2.7 million to double by the year 2060 (GOPB, 2008). The same report estimates that 64% of the State’s population in 2060 will be concentrated along the Wasatch Front, with a significant proportion in Box Elder and Cache Counties. For Box Elder County, given an Average Annual Rate of Change (AARC) of 1.8%, population estimates project a doubling by the year 2049.

This helps to illustrate the importance of developing a planning framework to identify human and environmental drivers of change in the region. Once those drivers of change are identified, it is equally important to identify and understand landscape resources and how they may be affected by changes in land use and population growth (Toth et al., 2002).

For example, given the expected growth that is projected for this region, a major challenge facing the area is how to deal with growth given the patterns of land ownership and the distribution of cities and towns along the eastern portion of the county. Both the positive and negative effects of growth will depend on such things as how and where people build homes, where infrastructure and industry will be located, and what lands will be targeted for open space conservation.

An important purpose of this study is to combine expected population growth and spatial models that will help identify, evaluate, and plan for regional resources and public safety. Through various types of land use analysis and futures modeling, the results provided by this study are meant to serve as a base for decision-makers and the public in Box Elder County to develop a comprehensive land use and development plan at the county scale.

<table>
<thead>
<tr>
<th>NAME</th>
<th>2008 ESTIMATE</th>
<th>% OF COUNTY POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bear River</td>
<td>833</td>
<td>1.7</td>
</tr>
<tr>
<td>Brigham</td>
<td>18,709</td>
<td>38.2</td>
</tr>
<tr>
<td>Corinne</td>
<td>677</td>
<td>1.4</td>
</tr>
<tr>
<td>Deweyville</td>
<td>334</td>
<td>0.7</td>
</tr>
<tr>
<td>Elwood</td>
<td>877</td>
<td>1.8</td>
</tr>
<tr>
<td>Fielding</td>
<td>422</td>
<td>0.9</td>
</tr>
<tr>
<td>Garland</td>
<td>2,059</td>
<td>4.2</td>
</tr>
<tr>
<td>Honeyville</td>
<td>1,354</td>
<td>2.8</td>
</tr>
<tr>
<td>Howell</td>
<td>245</td>
<td>0.5</td>
</tr>
<tr>
<td>Mantua</td>
<td>756</td>
<td>1.5</td>
</tr>
<tr>
<td>Perry</td>
<td>3,889</td>
<td>7.9</td>
</tr>
<tr>
<td>Plymouth</td>
<td>364</td>
<td>0.7</td>
</tr>
<tr>
<td>Portage</td>
<td>276</td>
<td>0.6</td>
</tr>
<tr>
<td>Snowville</td>
<td>164</td>
<td>0.3</td>
</tr>
<tr>
<td>Tremonton</td>
<td>6,789</td>
<td>13.9</td>
</tr>
<tr>
<td>Willard</td>
<td>1,747</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Figure 1.4 This table shows 2008 population estimates for all 16 municipalities in the county. Source: US Census Bureau, 2010
Figure 1.5 The illustration above shows the conceptual framework for this research project. Although there is an order to the steps in this process, it is important to keep in mind that each component feeds backwards and forwards to help inform and refine each step in the model. Planning is very much an iterative process, and there is a cyclical and repetitive process that is important to follow as new players and information become available. These new people and/or data have the opportunity to be cycled through this process to help build on prior knowledge and identify new issues or points of consideration that were not previously identified (Toth et al., 2006; Hurst, 2009).
This study is organized and influenced by successful planning frameworks addressing similar issues regarding population growth and land use change. Those worth mentioning here are those developed by Toth (1974; 2002; 2009), Steinitz (1990), and Brody (2003).

From Toth, this study incorporates several methods from prior landscape scale planning projects. This includes graduate directed theses, one-on-one instruction, and biophysical planning theory (1974) that gives guidance on devising “...a framework of analysis in which geographical uniqueness, cultural needs, and time are all considered.” A sample of past projects includes the following studies listed below:

Graduate Team Studio Reports

- Upper Colorado River Ecosystem- Alternative Futures Study (Phase I)
- Alternative Futures Study: Little Bear River Watershed
- Cache Valley 2030
- Alternative Future Growth Scenarios for Conserving Space along Utah’s Wasatch Front

Graduate Theses

- Bear Lake Project
- Ogden Valley Alternative Futures
- Uintah Basin Alternative Futures Study
- A Rural Character Planning Tool: Modeling Components of Settlement Pattern

From Steinitz (1990), this research incorporates prior seminal case studies, along with six questions for landscape level analysis that include:

1. How should the landscape be described in content space and time?
2. How does the landscape operate?
3. Is the landscape working well?
4. How might the landscape be altered?
5. What differences might the change cause?
6. How should the landscape be changed?

Finally, from Brody (2003), this project incorporates theories for developing successful plans based on components and indicators of Plan Quality such as:

1. The factual basis of plan components regarding items such as the location and extent of resources, population estimates, drivers of land cover and land use change, the function and structure of the landscape;

2. The level of clearly articulated goals for things like the economy, the physical environment, and social or public interest concerns;

3. The number of appropriately directed policies regarding action awareness and education, regulations or ordinances, incentives, etc.

By combining the goals of this project with these prior case studies and planning frameworks, the resulting research design developed for this project is a seven step regional planning process. As with any plan, it is important to keep in mind that the steps are iterative and in continuous feedback to help identify, clarify, and further enhance the planning process.

Planning Steps/Framework

1. Research Problem
2. Background Research
3. Land Use Analysis
4. Assessment Model Development
5. Alternative Futures Development
6. Land Use & Futures Evaluation
7. Final Recommendations
STEP ONE

Research Problem

Step one is used to define the study area, identify regional issues, and establish a purpose and need for research. For this study, step one involved meetings with the Graduate Committee, Bear River Association of Governments (BRAG) staff, and Box Elder County officials to outline the expected deliverables for this project. The current 1998 Box Elder County General Plan (summarized in Appendix B) is also used to identify county values and concerns regarding development, land use, and natural resources.

The research goals identified in step one are combined with my own interests in Geographic Information Systems (GIS) to provide a plan document that is spatial in nature, and will assist with current and future planning efforts in the region.

STEP TWO

Background Research

Step two is comprised of both site visits and literature research to gain familiarity with the study area. The goal here is to identify strategies for addressing issues identified from consultation in step one. This includes literature review of seminal case studies, review of interdisciplinary journals in Geographic Information Systems (GIS) technology, planning, policy, and environmental science, as well as frequent site visits to the study area.

Step two is also where data needs are identified for assessing land use and developing the assessment and alternative futures models that are described in steps four and five.

STEP THREE

Land Use Analysis

Step three documents land use in the study area and includes a brief description of the history and culture, geography, climate, land cover, land ownership, land use drivers, and expected change in the region. Step three also includes the analysis of all development types in the county occurring from 1900 - 2008. This is done with a combination of ESRI ArcGIS and Microsoft Excel to identify county level development patterns and trends.

The purpose of this analysis is to familiarize stakeholders with past trends, and also to construct a plan trend future growth model that shows the relationship between population, housing, and land needed to accommodate new growth in the county.

STEP FOUR

Assessment Models

Step four includes the development of land use and environmental assessment models that represent the spatial land use and resource concerns identified in steps 1 -3. Each model is discussed separately in the Assessment Model section of this report that includes a description of the resource, and suggested use or management criteria identified by resource experts, case study, and literature review.

The main purpose of the assessment models are to evaluate the outcome and impacts of growth to regional resources of concern using various GIS techniques (Toth et al. 2006; Kenczka, 2009). This allows citizens, planners, and decision makers to evaluate land use decisions or plans based on the potential impacts to assessment model resources.

Upon completion of the project, these assessment models, with all accompanying data will be transferred to the county so that
planners and decision makers can use the information to assess all new development projects prior to their approval.

**STEP FIVE**

*Alternative Futures*

Step five includes the development of alternative futures to show the potential impacts of land use trends over time. The goal of futures modeling is not to predict “the future,” but rather to show possible outcomes of various land use trends or policies that are expected to guide the development of a region.

According to Liotta and Shearer (2006), alternative futures modeling is useful to identify challenges and opportunities of the future that may be modified or maintained by decisions made today. There are three alternative futures modeled for this project that include a Plan Trend future (doubling of the current population), a Reducing Infrastructure Costs future, and a Public Safety future.

**STEP SIX**

*Land Use & Futures Evaluations*

Step six is where current land use trends and alternative futures are evaluated. For current land use, development occurring from 1900 to 2008 is evaluated to show the relationship between land use and the potential impact to resources or public safety concerns identified in the assessment models. This is also done for the period from 1998 to 2008 to show how current land use policy is “performing” relative to the assessment models.

The Plan Trend future is evaluated based on the relationship between new land needed to accommodate future growth, and concerns raised by the intersection of new housing with assessment model criteria. As a result of this model development, county GIS users will be provided with the same tool to assess all proposed development projects prior to their approval.

A user can simply input the parcels seeking development approval and identify whether or not they intersect areas of concern based on the assessment models. If so, the model identifies the land use and/or resource concerns, and the agency responsible for developing the spatial layer.

**STEP SEVEN**

*Final Recommendations*

Step seven includes final recommendations of this project to Box Elder County. All recommendations are the result of detailed study and analysis of all previous steps seeking to identify future land use strategies to plan for the health, safety and welfare of the county.
In August of 2009, while working as a planning intern at the Bear River Association of Governments, I met with the Box Elder County Development Office to discuss a potential Plan B Master’s project. At this meeting, the County Development Director expressed the need for a county general plan revision. While time and resources would not allow for a project of that size, instead an extensive land use assessment was proposed to identify deficiencies in the current general plan and help guide future revision efforts.

The county was especially concerned with projected growth numbers for the region that estimated a doubling of the county population by 2049 (GOPB, 2008). County residents and elected officials expressed concern over the current sprawl type development and the loss of open space and agricultural lands. Officials were also concerned with the higher infrastructure costs associated with low density sprawl type development, and sought a model that would help protect county fiscal resources.

Following meetings with the Planning Commission, GIS department, and Development office, several models and data needs were identified. Using the current general plan components as a guide (shown in figure 1.6), a list was compiled of land use issues and concerns to address in this study. Each component is identified with the section of the report where it is discussed and/or mapped (figure 1.7).

### Chapter 2 Land Use Analysis
- Land use drivers
- Unzoned areas in county jurisdiction
- Past development trends
- Residential vs. commercial development
- Conversion of lands for urban uses
- Influence of urban environment on natural lands

### Chapter 3 Assessment Models
- Natural hazards such as floodplains, faults, liquefaction, landslides, dam inundation, and steep slopes
- Agricultural lands
- Surface water resources
- Ground water resources
- Wildlife habitat

### Chapter 4 Alternative Futures
- Plan trend growth at double the current county population
- Reducing infrastructure costs associated with sprawl type development
- Securing public safety by combining natural hazards and hydrologic assessment models to guide future development

Figure 1.7 This table shows the list of land use and resource concerns discussed in this document.

---

1998 Box Elder County General Plan Components

1. Land use
2. Development
3. Sensitive Lands & Resources
4. Housing
5. Wetlands
6. Human & Community Services
7. Economic Development
8. Tourism
9. Water/Wastewater Management
10. Transportation

Figure 1.6 This table shows the ten components identified in the 1998 general plan.
An important component of any regional planning process is familiarization with the study area (Toth, 1974). This step included several case study examinations, monthly meetings with project participants, personal communications, site visits, and extensive literature research.

Meetings with the Box Elder County Development Office occurred nearly each month from August 2009 to May 2010, with three separate presentations to discuss assessment and futures model criteria. This provided an important opportunity to modify the spatial models, and to verify the results of each land use analysis and modeling exercise.

In the early stages of this project, it became apparent that the current general plan was lacking several useful components to make it an effective document for guiding development. There were no current maps to identify the location of resources or amenities. The land use recommendations also lacked measurable criteria to influence or even restrict development where there were concerns for county preservation or public safety goals.

Due to the extremely generalized land use, development, and resource protection goals, I recommended the development of more current and useful assessment models and criteria. These assessment models are identified from basic county values found in the general plan, and then incorporated with current land use and resource criteria from similar studies and/or resource professionals.

This information is then used to identify how much development has occurred in or around resources that are critical to human health, welfare or safety. The information also provides county officials with a comprehensive understanding of the location of resources and the degree to which they will need to be addressed in future planning or policy.

Several site visits also took place during the same time period, providing a unique perspective of the study area. These visits coincided with each of the monthly meetings, and helped to clarify county issues and concerns addressed in the land use and development analyses. This also provided an important opportunity to document and photograph related content to show throughout the report.

Finally, extensive literature research took place throughout the project to help identify useful modeling strategies and data needs. Due to the large spatial extent of this project, it is important to consider scale in the spatial models that are presented herein. Oftentimes, the availability of useful data defines the types of questions or issues that can be addressed in a useful manner. As such, this project is regional in scale, and meant to provide a baseline of models that can be improved over time as new data becomes available.
Chapter 2 - Land Use Analysis

History & Geography

The geography of the region features northeast to southwest trending mountains, with expansive valley floors that divide the often towering steep mountain ranges. The elevation of the county ranges from 4,200 feet (the average level of the Great Salt Lake) to 9,925 feet at Dunn Peak in the county’s northwest Raft River Mountains. There is also no outlet to the sea for waters within the basin, which is why in 1845 explorer John C. Fremont coined the term “Great Basin” after recognizing it as a land of internal drainage (Grayson, 1993).

Due to its size and extreme topographic variability, the region is characterized by a diversity of land cover and resource rich environment known by both prehistoric and historic inhabitants who have populated the area for centuries (Madsen, 1989).

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. Fur trappers like Peter Skene Ogden, and Joseph R. Walker also visited the area frequently, exploring many parts of the county (Powell, 1994).

Permanent white settlement took place in 1851, and 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 (Powell, 1994).
Figure 2.3 This map shows the average annual precipitation (inches) for Box Elder County. The map is produced from DAYMET average annual climate summaries from 1980 to 1997 (Thornton et al., 1997 - www.daymet.org). Due to its size, Box Elder County experiences a range of climatic patterns. The differences are most pronounced along the elevation gradient, with some variation from east to west as well. In the western portion of the county, yearly precipitation averages are from 5 to 10 inches, and to the east annual precipitation levels can reach 60 inches (USDA, 2005).

Figure 2.4 This map shows the average annual temperature (°F) for Box Elder County. The map is produced from DAYMET average annual climate summaries from 1980 to 1997 (Thornton et al., 1997 - www.daymet.org). Similar to precipitation, yearly temperature averages tend to follow the same elevation gradient, with warmer valley temperatures that decrease with rising elevation.

Figure 2.5 This map shows regional land cover classifications for northwestern Utah. This map is produced using the US Geological Survey 2001 National Land Cover Dataset (NLCD).
Land Use Drivers

The region today is defined by large tracts of agricultural land, vast arid deserts, marshlands, and thousands of acres of critical wetland habitat located at the delta of the Bear River as it flows into the largest freshwater lake west of the Mississippi - The Great Salt Lake (Utah State Parks & Recreation, 2010).

Of the several different land cover types in the region, nearly 43 percent are under agricultural production in the form of livestock or crops. This historic use of the landscape, along with an extensive natural landscape, are cited among the most valued physical characteristics for those who live here (USDA, 2005; UDWS, 2010).

Manufacturing is also a significant economic driver in the region, which accounts for a little under half of the non-agricultural employment of the county, and includes such industries as space technology, motor vehicle parts, and steel and iron products (UDWS, 2010).

The county has brought several major commercial industries to the region in recent years. There are several reasons this is an attractive place for industry which includes the presence of a highly skilled workforce, as well as the close proximity of major interstate, rail, and aviation transportation options (USDA, 2005).

Currently, 43 percent of land cover in the county is related to agriculture in the form of livestock or crops. However, there continues to be significant growth in housing that is replacing agricultural land at a rapid rate. The conversion of land for housing represents the most significant land use in the county and from 1998 to 2008 occurred at a rate of roughly 2.5 acres per day.

Figure 2.6 Sandhill cranes in an agricultural field vocalizing with their heads in the air. Photo by Ron Stewart, Utah Division of Wildlife Resources.

Figure 2.7 Looking east across a large corn field northwest of Corinne, Utah.
There are several commercial, industrial, and manufacturing facilities in the County that provide thousands of jobs to the region. The County is attractive to many industries due to the close proximity of interstate, rail, and air transport. Several companies rely on efficient transportation networks to ship products from facilities similar to the ones shown here. From left to right: Malt-O-Meal, Autoliv, Walmart.

**Figures 2.8** A Graph of the labor force profile for Box Elder County (Source: Utah Governor's Office of Planning and Budget). Following the announcement for a phase-out of the space shuttle and the Minuteman III ballistic missile (Dougherty, 2010), several hundred jobs were lost at ATK Thiokol that were a significant source of higher paying space technology and engineering jobs in the County. This graph does not reflect those recent job losses.

**Figures 2.9** There are several commercial, industrial, and manufacturing facilities in the County that provide thousands of jobs to the region. The County is attractive to many industries due to the close proximity of interstate, rail, and air transport. Several companies rely on efficient transportation networks to ship products from facilities similar to the ones shown here. From left to right: Malt-O-Meal, Autoliv, Walmart.
Land Ownership

At present, the largest portion of lands in Box Elder County are government owned. Most of this ownership is in the western portion of the county divided between state and federal agencies.

As seen in the figure below, a majority of private lands are found in the eastern portion of the county in the form of residential living space, farmland, and agriculture (Godfrey et al., 2005). This area includes all of the county’s 16 municipalities, the Utah State University Extension Campus, and the I-15/I-84 thoroughfare for citizens and industries accessing other major cities and states in the country.

### Land Ownership in Box Elder County

<table>
<thead>
<tr>
<th>Owner</th>
<th>Acres</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>1,908,815</td>
<td>44</td>
</tr>
<tr>
<td>Federal</td>
<td>1,461,831</td>
<td>34</td>
</tr>
<tr>
<td>State</td>
<td>935,724</td>
<td>22</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,306,370</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Figure 2.10 This figure shows the breakdown of land ownership in the county. These figures were obtained using the calculate geometry function in ArcGIS.

Roughly 44% of all land in Box Elder County is privately owned. A majority of this ownership is located in the eastern portion of the county where several valleys are currently un-zoned.

Box Elder County Land Ownership

Figure 2.11 This figure shows the current distribution of land ownership for Box Elder County. Note the stark contrast in private vs. public lands from east to west. Government lands make up the majority of ownership in the region.
Figures 2.12 & 2.13 The map on the left shows where there is currently some form of land use zoning regulation (zoned areas in yellow). The map on the right shows land ownership at the same scale. Important to note is the amount of unzoned private lands in the county. In order to prevent future sprawl and undesirable growth, county residents, stakeholders, and elected officials should begin to plan a vision of the future that protects the values of those who have a social, economic, and environmental interest in the region. This includes zoning policy in areas where development is likely to occur.
Development Trends 1900 to 2008

Development of land for settlement is considered to be one of the most remarkable human activities related to the conversion of the natural environment (Hasse, 2007). Unparalleled urbanization rates and dispersal patterns have resounding implications to community and environmental health, transportation, energy use, and social and economic well being.

Due to the unique geography of Box Elder County, development is generally limited to areas that are suitable for housing, roads, and other urban related uses. Throughout the county, there are several large mountains, water logged soils, and barren desert that influence the siting of new residential and commercial development to a relatively small geographically defined area (USDA, 2005).

This urbanizing area also forms the northern extent of the emerging Wasatch Front. This is a region that continues to grow in population and exert greater pressure into Box Elder County for increased housing, transportation options, and economic development opportunities.

As the County grows and population expands, adequately defining county values and goals related to development, as well as establishing a regional vision for future growth and development is key to creating sustainable and livable communities for future generations.

From 1900 to 2008, roughly 38,000 acres of land, or 60 square miles of land were developed for all residential and commercial uses in the county, with an average parcel size of 2.85 acres.

Growth occurred mostly along the county’s eastern boundary around the cities of Tremonton, Brigham, Perry, and Willard (figure 2.15). The eastern half of the county is where all 16 municipalities and 24 of the county’s 39 cities are located.

Figures 2.14 & 2.15 The photo to the left is south of Brigham City in the early 1990s. To the right, in this 2009 photo of the same area you can see the urbanization of the emerging Wasatch Front that is moving up from the south. This development trend is expected to continue and will likely be the first area in the county to experience build out in the near future.
In this section, land use and development patterns are analyzed to identify trends resulting in the conversion of lands to urban related uses. This analysis includes all commercial/industrial and residential development with basic statistics and summaries provided.

These data are then used in subsequent sections to project future development in the region through alternative futures modeling. This is done to show the difference in the consumption of lands that occur from plan trend versus smart growth development strategies.

It is important to note that land use is analyzed for two different temporal phases. The first, and more general land use assessment is based on all development types that occur from 1900 to 2008. This includes basic parcel statistics, and simple density analyses.

The second temporal phase, includes all development types that occur from 1998 to 2008. The purpose of focusing on recent land use trends is important for several reasons. First and foremost, this period represents the most recent trends regarding land use and the conversion rates of natural land for urban related uses. This is important in order to understand what land cover types are most threatened by development, and the rates at which this conversion takes place.

Second, and more importantly, this period represents the implementation of goals and strategies related to the 1998 Box Elder County General Plan. Understanding whether or not development follows the strategies outlined in this plan is an important first step in assessing and/or revising this or any other related planning document.

**Figure 2.16** This map shows the location of all developed parcels that were built from 1900 to 2008.
Commercial Land Use

Spatial analysis of all commercial/industrial development from 1900-2008 shows that these projects generally take place within municipal boundaries, with the highest overall density of commercial developments in the cities of Brigham and Tremonton (figure 2.17). Similar analysis for the years from 1998-2008 also shows the majority of commercial development within municipal boundaries, with the highest density in Brigham City, Corinne, and Perry.

The siting and location of commercial development is important when considering the costs of utilities and services required to maintain this type of land use. It is also important that commercial/industrial projects are near an adequate workforce that may help reduce Vehicle Miles Travelled (VMT), travel costs, and vehicle emissions. Box Elder County is unique for having several large scale industrial operations that are located inside of, or within close proximity of current municipalities and adequate infrastructure.

As the county population continues to grow, this type of use is expected to increase in order to meet the economic needs of the region through jobs and commercial/industrial services. As such, citizens and stakeholders have an opportunity to play an active role in the types of industry that will support the values of county residents, and reflect the long terms goals and strategies of the region.

From 1900 to 2008, roughly 2,763 acres of land were developed for all commercial/industrial related land use.

From 1998 to 2008, 1,148 acres or 52% of all commercial/industrial development took place during this ten year period.

Prior to 1950, the number of projects per year ranged from 2 to 5, after which the number jumped from 6 to 16 per year.

Where's the density?

Figure 2.17 This is a map of commercial parcel density for every commercial/industrial facility developed from 1900 to 1998. Density is calculated using a half mile radius around each point.
Residential Land Use

From 1900 to 2008, residential land use reveals a similar pattern of slow and steady growth until about the mid 1950s. At that time however, the county began to experience significant boom and bust cycles, adding as many as 450 new residential units in a single year, totaling anywhere from 100 to 1,500 total acres of new development per year.

From 1998 to 2008, Box Elder County experienced continued population growth and development. To accommodate the increased demands for housing and other necessary services, roughly 7,500 acres of land were developed for residential or commercial use. This equates to roughly 2.5 acres per day of new parcel development, and nearly 12 total square miles of land converted to urban use.

This conversion of land does not include the acreage consumed by roads and other related services but is likely a close estimate of total lands consumed when considering urban influence. Although each parcel is never 100 percent “developed”, there are roads and other public infrastructure that consumes land outside each parcel.

An important finding regarding residential development is the low densities at which development is occurring throughout the county. Despite the low parcel sizes of new homes built from 1998 to 2008, average housing densities are also low, which results in higher infrastructure installation and maintenance costs. Over time, low housing density can also lead to sprawl type patterns on the landscape that often lead to costly social, economic, and environmental problems.

Where’s the density?

From 1900 to 2008, roughly 34,505 acres of land were developed for residential uses. From 1998 to 2008, 6,087 acres or 18% of all residential development took place during this ten year period.

Prior to the mid 1950s, the number of homes built per year ranged from 50 to 100, after which the average rate of new home construction rose to as many as 450 per year.

There are currently twenty three residential structures for every commercial/industrial facility in the county.

Figure 2.18 This is a map of residential parcel density for all properties developed from 1900 to 1998. Density is calculated using a half mile radius around each residential unit.
Conversion of Land 1998 to 2008

In order to assess how development impacts or consumes important landscape resources, it is important to know where development is occurring, and the types of lands that are consumed by it. To help answer this important question, parcel data from 1998 to 2008 was intersected with land cover data developed by the Utah State University RS/GIS Laboratory (Lowry et al., 2005) to show what lands were consumed by new growth during that time.

Of the 7,500 acres (6,087 residential; 1,448 commercial) of developed parcels, over 4,051 acres or 62% took place on what was previously classified as agricultural land. Around 26% took place on previously forested or “natural” land. This represents a significant threat to both the agricultural economy and to several wildlife species dependent on these mostly rural/natural landscapes for food and reproductive success. Due to the projected growth that is facing the region, Box Elder County is facing a major crossroads in the coming decades for several reasons.

First, development in the County is constrained by its unique geography and hydric soils. In the Bear River Valley where most development occurs, the ground is made up of poorly drained soils that easily retain water. Settlers recognized this problem early on, and in the 1900s the U & I Sugar Beet Company helped to install field drains throughout the Bear River Valley to increase agricultural productivity (USDA, 2005; Fuller, 2009). This transformed farming in the region by creating prime agricultural land that was well drained of excessive water and alkali.

From 1998 to 2008, 62% of all new development occurred on what was previously agricultural land. As growth continues, this relationship is expected to continue due to the limited amount of developable acres that are not currently classified as productive agricultural land in the county.

Figure 2.19 This graph shows the relationship between the amount of land consumed by commercial and residential development from 1998 - 2008 and the land cover replaced in the process. The broad valleys of the County have traditionally been used for farming, but as demands for new housing and commerce continue to rise, these valleys are also the only places best suited for new homes and commercial facilities. As long as population growth continues in the county, agricultural land will continue to be lost to accommodate demands for housing and other related services.
Over time, the drains were somewhat forgotten about, and as new housing is built over previous agricultural land, these drains are often damaged or destroyed, resulting in underground pools of water that flood crops and home basements (Fuller, 2009).

Now, as the eastern portion of the County continues to develop, the agricultural economy and lifestyle are threatened in several ways. The first is through the loss of agricultural land itself. With the demand for new housing in these areas, the value of land for housing is much higher than what the land can provide in the form of crops.

When homes are built, there is also increased demand for new infrastructure and commercial or public facilities. The footprint and urban influence associated with these uses can often result in several miles of impervious surface and large parking lots that consume thousands of acres annually.

As long as there is new growth in the county, agricultural lands will continue to be consumed by residential and commercial land uses. In order to help protect some of the attributes associated with the county’s agricultural heritage, an assessment model was developed to help with future land use decisions (provided in Chapter 3). This model can be used by county residents and decision makers to identify important agricultural lands and prioritize areas for future open space or corridor preservation.
Both planners and resource managers alike recognize the sphere of influence that urban developments can have on the environment. This influence represents the direct and sometimes indirect impacts to environmental quality and ecosystem services that may be immediately apparent, or manifest themselves later in the form of cumulative, long-term impacts.

The concept of urban influence relates to the understanding that the true environmental costs of urban development extend far beyond the perimeter of a building’s foundation. Some examples of urban influence include things like increased sediment or nutrient loads in streams from impervious surface runoff, air pollution carried downwind from industrial sites or congested traffic zones, and wildlife disruption or displacement through changes in what was once suitable habitat (Wade et al. 2010).

One of many important models developed for this research project includes the mapping of urban influence through multi-scale analysis and spatial statistics. In the article, “A Multi-Scale Method of Mapping Urban Influence” by Wade et al. (2010), the authors provide a method for mapping urban influence using ArcGIS.

By analyzing urban lands at multiple scales with different moving window sizes, maximum likelihood classification and cluster analysis, this model identifies the relative amount of different land cover classes of core urban, suburban, transitional, and core rural lands in the county.

While the model itself is meant to show the sphere or “halo” of urban influence around urban land cover, the final product has great utility in planning future conservation and
Figures 2.22 & 2.23 These maps were developed to show the amount of urban influence associated with parcel development and roads in the county. The inputs used to develop the urban influence models are all developed parcels and mapped roads for two different time periods (1900 to 1998 & 1900 to 2008). These maps are useful to show the net gain in urban related use of the landscape, as well as the location and quantity of changes that occurred from 1998 to 2008. The models also provide a way for local leaders and land developers to anticipate infrastructure installation and maintenance cost differences related to in-fill, reuse, or raw land development.
development opportunities. Some examples of other uses with this model include:

- **Identifying opportunities for reuse development in core rural areas**;
- **Identifying opportunities for infill development in suburban and transitional zones**;
- **Identifying urban growth zones to help conserve county fiscal resources by minimizing infrastructure cost expenditures**;
- **Identifying opportunities for rural and agricultural land conservation**;
- **Identifying opportunities for habitat conservation through the intersection of core rural zones and critical wildlife habitat**;

For this project, urban influence is modeled for both 1998 and 2008 land cover. The purpose for modeling these times is for consistency with other analyses in this report, and due to the availability of sufficiently accurate base data needed to run the model. This is also to show the location and amount of land cover change since implementing the 1998 Box Elder County General Plan.

In recognizing the range of uses of this model, this project incorporates the Urban Influence layer as a base map for the *Wildlife Habitat Assessment Model* and the *Reducing Infrastructure Costs* and *Public Safety* alternative futures models.
Chapter 3 - Assessment Models

The purpose of this section is to identify components of the landscape that are important to the quality of life of Box Elder County residents. Also included, are assessment layers that identify potential threats to public safety and environmental quality.

The goal is to inform developers, citizens, and county officials of the potential risks associated with each new development proposal. This is so appropriate steps may be taken to investigate and/or mitigate any threats to public health, welfare and safety through more detailed study or rejection of unsafe development projects.

For each assessment model, a brief description is provided of its importance to land use decisions. This includes the addition of several useful criteria to reduce resource impacts. The maps shown herein do not interpret levels of risk or threat, and should not be used for site-specific decision making without further investigation.

By providing this information however, it is anticipated that residents and county officials will seek to incorporate assessment model criteria into the planning process. This will allow for greater dialogue between county officials, the public and resource specialists. Doing so will also help identify any data gaps or needs and create a forum where policies and ordinances may be proposed to protect public safety and important resources.

Figure 3.1 This is a photo of the Salt Lake Valley with homes that are encroaching into areas of multiple geologic hazards such as flood, fire, landslides and earthquake faults. Photo source: Utah Geological Survey.

Figure 3.2 This graphic is taken from the conceptual framework for this study, and shows the assessment models that are used throughout this study. Each assessment model is comprised of several criteria related to it, and helps identify each resource spatially in order to assess any current or potential impacts to resources identified in the model.
Natural Hazards

There are six layers included in the Natural Hazards assessment model. These layers represent data that is readily available, with added levels of protection applied with GIS software under the guidance of several related agency resource plans and studies.

For each component, there is also a summary showing the acreage of parcels developed from 1998 to 2008 that overlap with these hazardous areas. The six layers presented here include:

- **Floodplains (Federal Emergency Management Agency, FEMA 100 year floodplains)**

- **Liquefaction (High Risk of liquefaction, Utah Geological Survey)**

- **Mapped landslides with a 100ft buffer (Utah Geological Survey)**

- **Dam inundation area with a 100ft buffer (Division of Water Rights)**

- **Wasatch fault with a 500ft buffer (Utah Geological Survey)**

- **Steep slopes of 15% or higher (county ordinance, created with ArcGIS Spatial Analyst using a USGS Digital Elevation Model)**

Figure 3.3 There are several state and federal agencies that provide spatial data and technical planning assistance to prevent natural hazards. There are also grants that are available to communities to help offset the costs of developing hazard plans, ordinances, or mitigation projects.
Floodplains

A floodplain is “any land area susceptible to being inundated by flood waters from any source” (FEMA, 2010). Generally, this inundation occurs during moderate to extreme weather events and can result in several public safety and environmental concerns such as: flooding of basements or structural loss, sewer and septic rupture or overflow, soil erosion, surface or ground water contamination, loss of critical infrastructure, and even loss of life (GOPB, 2005). In 2006 alone, the United States Geological Survey estimated annual economic losses from flooding to be over 6 billion dollars (USGS, 2006).

In Box Elder County there are several areas that are prone to flooding in and around developed parcels that in extreme weather events, could result in serious losses to persons or property. This assessment model identifies areas delineated by the Federal Emergency Management Agency that have a 1% per year risk of flooding in the area known as the 100 year floodplain.

Due to the age of floodplain maps and changes in the physical environment, the National Map Modernization Program was Instituted in Utah in 2004. The intent of the program is to provide more accurate digital floodplain maps, improve the accessibility of these maps for the public, and improve community planning efforts and land use regulation in hazardous areas (Utah Department of Public Safety, 2010).

From 1998 to 2008, roughly 1,127 acres of residential development occurred within or in close proximity to the FEMA 100-year floodplain.

**Figure 3.4** This is a map of the FEMA 100 year floodplain for the area of the county between Corinne and Bear River city. There are several hundred acres of land along the Malad and Bear River that are within the 100 year floodplain that also have a high potential for future development if floodplain ordinances are not properly regulated.
Quaternary Faults

In Utah, earthquakes are quite common. The Utah Geological Survey (UGS) records hundreds of annual earthquake events, the majority of which are minor and cause little to no damage. Every 10 to 50 years however, there are earthquake events with magnitudes ranging from 5.0 to 6.5, and more serious 7.0 to 7.5 magnitude events every 150 years (UGS, 1997).

According to the Utah Geological Survey (UGS, 1996) the following is true for earthquake hazards in the state of Utah;

‘In addition to ground shaking, other hazards are soil liquefaction, surface fault rupture, flooding, and slope failure. Not only are buildings including homes endangered by these hazards, but water tanks, dams, roads, bridges, railways, airports, and utility corridors carrying electricity, water, sewage, natural gas, petroleum, and telephone service are all at risk.

There are two risks associated with earthquakes that are incorporated into the Natural Hazards assessment model. The first is the threat of a serious seismic event associated with the Wasatch fault (shown in figure 3.5) resulting in ground shaking and/or fault rupture. The second is the threat of liquefaction, described in the following section.

Under the advice of the UGS (McDonald, 2010), to mitigate some of the risks associated with quaternary fault rupture in the county, all faults are mapped with a 500 foot buffer. Despite the coarse scale fault data that is currently available for the state, any future development that is proposed within this buffer warrants discussion with the UGS and potentially a more detailed study by a qualified engineer.
Liquefaction occurs when water saturated sandy soils lose their strength and liquefy, similar to quicksand. This is caused by the combination of soils with liquefaction potential, and a major ground shaking event such as an earthquake. Utah, especially Box Elder County have significant risks associated with earthquakes and liquefaction because of the high probability of moderate to large earthquakes, as well as soil and groundwater characteristics that are vulnerable to liquefaction (UGS, 2010).

As is the case for many cities and towns in the state of Utah, settlement occurred long before residents had an understanding of the risks associated with natural hazards. In the case of liquefaction risks, nearly the entire eastern portion of the county where a majority of development occurs, is believed to have a moderate to high risk of liquefaction, should a major seismic event occur (UGS, 2010).

As such, it is not logical or economically feasible to relocate entire towns or infrastructure because of liquefaction potential. Therefore, the liquefaction layer included in this assessment model incorporates only areas of the county with a “High Potential” for liquefaction. This designation refers to a 50% probability that within a 100-year period there may be an earthquake strong enough to cause soil liquefaction.

When considering future development, this layer will be useful for siting critical facilities or infrastructure to ensure their construction is outside of the “High” potential liquefaction zone.

“Two conditions must exist for liquefaction to occur: (1) the soil must be susceptible to liquefaction (loose, water-saturated, sandy soil, typically between 0 and 30 feet below the ground surface) and (2) ground shaking must be strong enough to cause susceptible soils to liquefy. Northern, central, and southwestern Utah are the state’s most seismically active areas.

Identifying soils susceptible to liquefaction in these areas involves knowledge of the local geology and subsurface soil and water conditions. The most susceptible soils are generally along rivers, streams, and lake shorelines, as well as in some ancient river and lake deposits.” (Utah Geological Survey, 2010)
A landslide is defined by masses of earth or rock that move down slope by falling, toppling, sliding, spreading, or flowing (Crudden & Varnes, 1996). Landslides represent the most common geologic hazard in the state of Utah, and generally occur when ground water builds up from rain, snow melt, or landscape irrigation which increases weight of material in excessive slopes. This increased weight from water increases pore pressure, hydrates and expands clay materials, dissolves stabilizing materials, and decreases the overall strength of the slope (Case, 2010).

Each year, landslides kill anywhere from 25 to 50 people and result in nearly $3.5 billion in damages. Landslides are capable of destroying homes, washing away cars, roads and bridges, wiping out utility lines, and obstructing streams and roadways (GOPB, 2005; USGS, 2005). According to the Utah Geological Survey, as of 2006 there were 841 mapped landslides in Box Elder County. This includes both past slide or rock fall events, as well as active movement of slopes that pose unknown risks to development in and around these areas.

There are several strategies to mitigate slide risk when there are persons or property threatened by a landslide. However, avoiding the building of homes on steep slopes eliminates nearly all of the risks associated with landslides and can help prevent any costly damage to new homes or critical infrastructure. This is an important consideration for municipalities who usually pay for damages caused by landslides (GOPB, 2005).

“Landslides are common natural hazards in Utah. They often strike without warning and can be destructive and costly. The most common types of landslides in Utah are debris flows, slides, and rock falls and are usually associated with rising ground-water levels due to rainfall, snowmelt, and landscape irrigation.” (Utah Geological Survey, 2010)
The Utah Division of Water Rights maintains information on Utah dams, including the hazard risk they pose to persons and property throughout the state. For dams with a measurable threat to human safety, dams are classified with a high, moderate, or low hazard risk. Each dam also includes an inundation map to show where potential flooding may occur given dam failure or severe overtopping.

The dam inundation layer included in this assessment model shows all flood prone areas as delineated by the Utah Division of Water Rights, with an additional 100ft buffer to identify critical facilities or infrastructure that may be threatened by inundation during a major disaster. This is also to help identify the level of risk associated with new construction of critical facilities or infrastructure that are within the dam inundation zone.

**Box Elder County Dams**

<table>
<thead>
<tr>
<th>Box Elder County Dams</th>
<th>Hazard Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bar B Ranch</td>
<td>Low</td>
</tr>
<tr>
<td>2. Bear River Club Co. Elwood Dam</td>
<td>Low</td>
</tr>
<tr>
<td>3. Blue Creek</td>
<td>High</td>
</tr>
<tr>
<td>4. Box Elder County - Holmes Canyon</td>
<td>Moderate</td>
</tr>
<tr>
<td>5. Death Creek</td>
<td>Low</td>
</tr>
<tr>
<td>6. Dejarnatt</td>
<td>Moderate</td>
</tr>
<tr>
<td>7. Etna</td>
<td>Moderate</td>
</tr>
<tr>
<td>8. Mantua</td>
<td>High</td>
</tr>
<tr>
<td>9. Meadow Creek</td>
<td>Low</td>
</tr>
<tr>
<td>10. Perry City Sewage Treatment Facility</td>
<td>Low</td>
</tr>
<tr>
<td>11. Peterson Brothers</td>
<td>Low</td>
</tr>
<tr>
<td>12. Rose Ranch</td>
<td>Low</td>
</tr>
<tr>
<td>13. Rosebud</td>
<td>Low</td>
</tr>
<tr>
<td>14. Sandarosa</td>
<td>Low</td>
</tr>
<tr>
<td>15. South Junction</td>
<td>Moderate</td>
</tr>
<tr>
<td>16. Three Mile Creek (Perry City FCD)</td>
<td>High</td>
</tr>
<tr>
<td>17. Utah Power &amp; Light - Cutler</td>
<td>High</td>
</tr>
<tr>
<td>18. Warm Springs</td>
<td>Low</td>
</tr>
<tr>
<td>19. Willard Creek Debris Basin</td>
<td>Moderate</td>
</tr>
<tr>
<td>20. Yost</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Figures 3.8 & 3.9** In Box Elder County there are a total of twenty dams, four of which have a high risk hazard rating (shown in the table on the right). Hazard ratings are based on several criteria that include the size of the dam and the amount of people at risk in the event of a major storm event or dam failure. Understanding the risks associated with dams and dam failure is important information for emergency managers in order to expedite evacuation of these areas when there is a threat to public safety. The photo to the left is of the Cutler Dam pump house. Part of the Bear River system, Cutler Dam is the largest dam in the County and impounds water that forms Cutler Reservoir.
Steep Slopes

Steep slopes are becoming increasingly popular for residential development in Utah. These areas provide extensive views of the large valley floors that are characteristic of the region, along with close access to public lands and trails along what is deemed the Wildland Urban Interface (WUI). It is often more costly to develop properties on steep slopes due to cut and fill, earthwork, retaining wall, and erosion prevention costs (GOPB, 2005).

In Box Elder County, the Wasatch fault, and several active landslides intersect in areas that also have steep slopes. There are several small mountains and steep benches throughout the county that have slopes that would not be advisable to permit development.

These areas of steep slopes in the county are popular sites for the public due to their aesthetic values and visual quality. There are significant natural features such as vegetation, cliffs, and rock outcrops that are valued by the public (UGS, 2010). The elevated valley benches are also important to wildlife as development consumes habitat in the lower valley floors and animals use the benches to migrate around urban areas and major roads.

In the county, the Sensitive Lands ordinance is meant to prevent development on slopes greater than 15%, however spatial analysis shows that there are many communities and areas in the county that allow construction in these areas.

From 1998 to 2008, roughly 308 acres of residential development occurred on slopes greater than 15%.

Figure 3.10 This illustration is from the Utah Governor’s Office of Planning & Budget - “Critical Lands Planning Toolkit” and shows how to calculate slope with a simple rise over run equation. The Box Elder County Sensitive Area Ordinance regulates development on properties with slopes greater than 15%.
Figure 3.11 This map shows the combined layers and assessment criteria for all natural hazards discussed in this section.
Box Elder County has a rich agricultural history shown both in lasting architecture and continued farming practices. There are currently 19 Historic Barns in the region and 42 Century Farms. There are also nearly 447,000 acres of cultivated irrigated and non-irrigated cropland.

From 1998 to 2008, roughly 4,613 acres of residential development occurred on what were previously classified as productive agricultural soils.

Figure 3.12 There are several historic barns in the county. Through the efforts of the Bear River Heritage Area, historic barns are mapped and photographed to show historic structures that are unique to the region in their type or style, and the time period they represent in the county’s history. Currently, there are nineteen historic barns in Box Elder County shown on the map in figure 3.17. This photo is of the Owens barn in Corinne, Utah. Photo courtesy of Lisa Duskin-Goede of the Bear River Heritage Area.

Agriculture

Box Elder County has a rich history of farming that continues to play an important role in the current economy of the region. A significant portion of the county’s arable land is in some form of agricultural production, with standard row crops in the region that include hay, grain, alfalfa, and corn (USDA, 2005).

Row crop cultivation occurs mostly in the northeast and eastern portion of the county, with commercial ranching occurring mainly to the west. Box Elder County boasts the state’s largest inventory of beef and cattle that is ubiquitous throughout the entire county (Godfrey et al., 2005).

It is clear from several prior planning documents and public surveys, that county residents value a rural atmosphere that is centered around the agricultural heritage of the region. By combining different agricultural related values in the county, residents and local official can identify priority areas to try and preserve aspects of this important way of life. As such, this assessment model incorporates several agricultural related attributes that may be used to help guide future development that include:

- **Agricultural soils (Natural Resource Conservation Service, Agricultural Soils Classification)**

- **Cultivated crops, both irrigated and non-irrigated (Utah Division of Water Resources)**

- **Historic barns (Bear River Association of Governments)**

- **Century farms (State of Utah)**
The first layer in the Agricultural assessment model identifies agricultural soils delineated by the U.S. Department of Agriculture - Natural Resource Conservation Service (NRCS). Tabular soils data from field surveys were joined to a spatial layer of soil types to show the location of all agricultural soils in the county. Soil types with classification descriptions are shown in figure 3.13.

The cultivated crops layer is from the Utah Division of Water Resources and references water related land use for all agricultural areas of the state of Utah. The spatial information is compiled from Digital Orthophotos and surveys of land use, crop type, irrigation method, and associated attributes (UDWR, 2009).

**NRCS AGRICULTURAL SOILS CLASSIFICATION**

<table>
<thead>
<tr>
<th><strong>Prime Farmland</strong></th>
<th>“Land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oil seed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion.”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unique Farmland</strong></td>
<td>“Land other than prime farmland that is used for the production of specific high-value food and fiber crops...such as, citrus, tree nuts, olives, cranberries, fruits, and vegetables.”</td>
</tr>
<tr>
<td><strong>Farmland of Local or Statewide Importance</strong></td>
<td>“Land identified by state or local agencies for agricultural use, but not of national significance.”</td>
</tr>
</tbody>
</table>

**Figure 3.13** This figure shows the definitions for soils classifications that are included in the Agricultural Assessment Model. Source: USDA - NRCS Soil Survey, Box Elder County 2006.

**Figures 3.14 & 3.15** The photo in the upper left is an apple orchard near Brigham City, Box Elder County, Utah, circa 1904. Gift of Philadelphia Commercial Museum. Digital Image © 2009 Utah State Historical Society. All Rights Reserved. One unique characteristic of Box Elder County farming is the long tradition of orchard crops that line the eastern “fruit way” portion of the County along highway 89/90. This area provides a near perfect environment for a range of fruit and vegetable crops that draws thousands of tourists and patrons annually. However, despite the number of visitors who are drawn to the diversity of fruits and vegetables provided by this unique growing environment, it is also the area most threatened by new development due to increasing land values.
Agricultural lands continue to be the most threatened type of land cover in the region. As population and growth pressures increase, so do land values and the economic benefit for landowners to sub-divide and develop agricultural properties.

Over time, it will be increasingly important to identify areas of the landscape that residents would like to preserve for future generations so that efforts can be centered on preserving high priority areas.

This can be accomplished through various strategies and programs related to land use management, zoning, conservation, or incentive programs to buy or transfer development rights and compensate land owners for the social, economic, and environmental values these lands provide to citizens in the region.

“The century farm/ranch recognition is intended to honor the accomplishments of Utah agriculture through the state’s first 100 years. It is also an effort to help preserve farms for the future by reminding consumers of the food, fiber and open spaces provided by Utah agriculture.” (UDAF, 2010)

Figure 3.16 Century farms are identified by the state of Utah as farms that are owned by the same family for one hundred years or more. This project of identifying historic farms in Utah began in 1995 and has continued thanks to the Utah Department of Agriculture and Food, the Utah Farm Bureau, the Utah State University Extension Service, the Utah State Fair Board and Brigham Young University (UDAF, 2010). There are currently forty-two Century Farms in all of Box Elder County.
Figure 3.17 This map shows the combined layers and assessment criteria for agricultural resources discussed in this section.
Water is a critical resource that is essential for many basic human needs. Aside from domestic uses like drinking and bathing, water is important in several other capacities related to food production, recreation, industrial use, and even transportation (Spano, 2007).

Utah is the second driest state in the nation, which becomes a high priority issue when the state experiences drought conditions that lead to water deficits and use restrictions. In years of moderate to extreme drought, this region experiences increased fire risk, damage and failure of crops and pastures, and water shortages in reservoirs, streams and wells (Summers, 2008).

Except for some high elevation lakes and streams that are far from human settlements, most water resources today have also changed significantly due to water use, land use and pollution (SREP, 2004). Understanding the dynamic relationships that exist between land use and how it affects surface and groundwater resources is increasingly critical as population expands and resources are exposed to new and increasing threats from the urbanizing environment.

In Box Elder County, there are several hydrologic resources in the form of springs, lakes, rivers and wetlands. The Bear River is the largest river in the county providing water to several thousand acres of farmland each year.

The Bear River is also the largest tributary that connects to an inland sea in the United States, and currently supplies over half of the total annual surface water, or 1.2 million acre feet to the Great Salt Lake (UWRL, 2010).

“Below Cutler Reservoir, concentrations of sediment and phosphorus increase as the Bear travels south. In this watershed, the Malad River contributes nutrients and high concentrations of total dissolved solids, which it receives from thermal springs and human activities. Because of the high concentrations of phosphorus, the Utah Department of Environmental Quality (DEQ) has designated the entire reach of the Bear River between Cutler Reservoir and Great Salt Lake as impaired. As a result, a watershed plan (known as a Total Maximum Daily Load or TMDL) was completed and approved in 2002.” (Utah Water Research Laboratory, 2010)
This project outlines two assessment models for surface water and ground water resources in the county. These models are useful first for identifying the location and extent of hydrologic resources, as well as adjacent land uses that may contribute to the overall health and safety of water in the region.

The criteria developed for each model represents a basic approach to surface and ground water protection to help identify potential problem areas, and help prevent the need for costly water treatment facilities. This basic level of protection is important to public health and fiscal responsibility by promoting safe and healthy water use and development, especially as municipalities grow and have greater dependence on this valuable and critical resource.

**WATER QUALITY CONCERNS IN BOX ELDER COUNTY**

<table>
<thead>
<tr>
<th>Water Quality Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedimentation</td>
</tr>
<tr>
<td>Excessive nutrients and organics</td>
</tr>
<tr>
<td>Fecal coliform bacteria</td>
</tr>
<tr>
<td>Excessive salinity</td>
</tr>
<tr>
<td>High water temperature</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pollutant Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal feeding operations</td>
</tr>
<tr>
<td>Grazing</td>
</tr>
<tr>
<td>Agriculture</td>
</tr>
<tr>
<td>Wastewater treatment</td>
</tr>
<tr>
<td>Urban development</td>
</tr>
<tr>
<td>Roads</td>
</tr>
<tr>
<td>Degraded stream banks</td>
</tr>
</tbody>
</table>

*Figure 3.19* This figure lists some of the county’s water quality concerns and major pollutant sources. These data are from the Utah Water Research Laboratory - Bear River Watershed Information System, and the Natural Resource Conservation Service - Box Elder County Resource Assessment.

“The Bear River Development Act ensures that additional development of waters of the Bear River and its tributaries in Utah will benefit communities outside the basin, including Weber, Davis and Salt Lake Counties. The plan is to connect the Bear River to Willard Bay via a pipeline or canal and construct a conveyance and treatment facility to deliver water from Willard Bay to the Wasatch Front. Developing new reservoirs or enlarging existing reservoirs within this watershed and other watersheds in the Bear River Basin is also possible.” (Utah Water Research Laboratory, 2010)

“The Bear River Basin is one of the few remaining areas with a significant amount of developable water in the state of Utah. Bear River water will likely be developed to satisfy the growing needs of areas within and outside the basin. Planners project that with urban growth along the Wasatch front, primarily in Salt Lake, Davis, and Weber counties; there will be a need to import Bear River water in the next 20 to 30 years.” (Utah Water Research Laboratory, 2010)
Surface Water

Surface waters in Box Elder County are part of a dynamic and complex network of wetlands, springs, rivers, lakes and streams. County residents depend on adequate systems of surface water delivery for agriculture and irrigation, recreational uses, power generation, and municipal and industrial uses. Similarly, plant and animal species in the region also rely on surface water resources for access to food and several other habitat related ecosystem services.

In Box Elder County, nearly all rivers and streams drain into the Malad and Bear Rivers before eventually reaching the Great Salt Lake. In order to protect and sustain a healthy network of surface waters in the county, the Surface Water Assessment model identifies the following layers, with additional protection measures to help plan for the future delivery of clean surface water resources that includes:

- **Springs with a 100ft buffer (National Hydrography Dataset)**
- **Frequently flooded soils with a 100ft buffer (Natural Resource Conservation Service)**
- **Occasionally flooded soils with a 50ft buffer (Natural Resource Conservation Service)**
- **Lakes with a 100ft buffer (National Hydrography Dataset)**
- **Wetlands with a 100ft buffer (U.S. Fish & Wildlife Service, National Land cover Dataset)**

From 1998 to 2008, roughly 1,091 acres of residential development occurred on or within 100 feet of a wetland.

Several hundred acres of development also occurred within the buffer zones for rivers, lakes, and streams during the same time period.

Figure 3.20 This is a photo of the Bear River and the dense riparian vegetation that surrounds it. Allowing riparian growth to occur adjacent to rivers and streams helps to filter and purify water, as well as protect residents from flooding during extreme weather events. Some of the financial benefits of riparian buffers include the minimization of property damage from flooding, decreased need for expensive storm water treatment and pollution removal, and increased property values through increased aesthetic value (Presler, 2006).
- **Perennial streams with a 75ft buffer** *(National Hydrography Dataset)*
- **Intermittent streams with a 50ft buffer** *(National Hydrography Dataset)*
- **Riparian areas with a 50ft buffer** *(Utah Division of Water Resources)*
- **Canals with a 50ft buffer** *(National Hydrography Dataset)*

One method that has proven highly successful for water quality planning is through the use of riparian buffers (USDA, 2003). A riparian buffer is a vegetated area adjacent to rivers, ponds, lakes, or wetlands that is fully or partially protected from human disturbances (Presler, 2006; Spano, 2007).

These areas perform several natural functions such as filtering sediment, nutrients, and other harmful contaminants, providing flood and erosion control, and reducing imperviousness and drought. They also help to control light and temperature along rivers and streams to sustain fish and other aquatic habitat, and they are a significant source of habitat for terrestrial wildlife (SREP, 2004).

Deciding how wide a riparian buffer should be depends on several factors related to adjacent land uses and the outputs people hope to gain from instituting a riparian buffer program. For example, a buffer that is 20 to 50 feet wide may be effective for bank stabilization and erosion prevention, while a buffer of at least 100 to 300 feet may be necessary to provide useful habitat for songbirds or other large mammals (Klapproth & Johnson, 2001).

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**Figure 3.21** The figure above shows the relationship between buffer widths and the potential benefit or function to the environment. As illustrated here, there are several benefits to both people and the environment as a result of riparian area protection. Also, because these areas have a high aesthetic value, they can also increase the value of adjacent properties illustrating the economic benefits of riparian area conservation.

Due to the variable nature of riparian buffers and programs for implementing them, it is recommended to utilize a simple surface-water assessment model with very basic and general resource buffers. The buffers are intended to help planners and developers identify these high value areas and to come up with land use and development practices that will protect them from future development or degradation.
Figure 3.22 This map shows the combined layers and assessment criteria for surface water resources discussed in this section.
Although ground water resources are hidden, they are an important resource to the terrestrial and aquatic health and viability of communities and ecosystems in the region. Groundwater typically accumulates in aquifers that are continually in motion, and in Box Elder County, groundwater enters primary and secondary recharge aquifers in or near mountains, and emerges at discharge zones in the lower valleys (Peralta, 1995).

Ground water aquifers are comparable to underground lakes or reservoirs. At the upper surface of the ground, water moves very slowly. This rate of movement can occur from tens of meters, to hundreds of meters a year which allows pollutants reaching an aquifer to accumulate over time (Forman, 2008).

“Shallow groundwater within meters of the ground surface saturates earth and soil spaces, with the water table being the top of the saturated zone. Shallow groundwater flows through the ground into, and commonly helps maintain, surface water bodies such as streams and lakes. It also sustains plant roots and vegetation.” (Forman, 2008)

Ground water is the source of culinary water in the county and this same groundwater is also part of the complex network of springs, streams, lakes, and wells that are ubiquitous throughout the county. These waters contribute to the ecological health of the entire region and are of critical importance to both human and wildlife populations.

The Ground Water Assessment model incorporates several layers of data to identify areas of the county that should be monitored or protected from future development projects or certain types of


There were also 932 acres of residential development that occurred within a Primary Aquifer Recharge Zone.

Figure 3.23 This graphic was developed by Delphine Digout, UNEP/GRID-Arendal depicting the urban water cycle. This graphic illustrates the impact of human activity on groundwater and shows how groundwater is obtained from periurban wellfields and urban wells, then used and disposed of as wastewater through pluvial drainage, piped sewage and on-site sanitation and industrial effluent disposal. It also shows that wastewater is treated and then reused for irrigation, with excess flows re-entering the aquifers (Brian Morris, British Geological Survey, 2001). Urban regions generally experience four types of water pollution through 1) agricultural runoff, 2) storm water runoff; 3) septic and sewage effluent, and 4) industrial wastes (Forman, 2008). This graphic is from Delphine Digout, UNEP/GRID-Arendal. http://maps.grida.no/go/graphic/urban_water_cycle
land use in sensitive areas. This is to ensure the delivery of clean and potable water for current and future generations of county residents and includes:

- **Water sources (Utah Division of Drinking Water)**
- **Drinking Water Source Protection Zones (Utah Division of Drinking Water)**
- **Source Water Assessment Zones (Utah Division of Drinking Water)**
- **Primary aquifer recharge zones (U.S. Geological Survey)**
- **Secondary aquifer recharge zones (U.S. Geological Survey)**
- **Aquifer discharge zones (U.S. Geological Survey)**

Some of the threats to ground water quality in Box Elder County are related to anthropogenic pollution, and the increased use and development of hydrologic resources in the Bear River Basin. With the likelihood of increased reservoir storage or diversion projects that are expected to occur, groundwater recharge may be reduced that ultimately affects the amount of water available to boost stream flows, as well as the amount of riparian vegetation found along perennial streams (Peralta, 1995).

This has significant impacts to wildlife and wetland communities that depend on springs, seeps, and year round stream flows that are reduced from pumping or reservoir storage. This alteration of the current hydrologic regime may also result in inadequate ground water recharge that communities depend on for culinary uses.

“In the western U.S., natural river flows fluctuate sharply with spring snow melt and autumn drought, with roughly 70% of water flow coming during the months of April-June. During this peak flow period, streams often overflow their channels and inundate adjacent flood plains, providing water to wetlands. Water from wetlands and streams seeps below ground, supplying groundwater. In a reciprocal fashion, during times of low precipitation, riparian areas and wetlands may serve as sources of water recharge for creeks and streams, and groundwater may supply water to streams and wetlands via seeps, springs, and direct stream-water recharge.” (SREP, 2004)
Source Water Protection Zones

**Critical**

Well

100 feet

250 day

3 year

15 year

Mountains

Ground water movement

**Figures 3.25 & 3.26** In Utah, the Division of Drinking Water delineates Source Water Protection Zones around culinary water sources. This is done to help communities understand the movement of water as it enters the ground and flows towards critical water sources that may become polluted from adjacent land use. Of concern are pollutants from commercial, industrial, or agricultural operations, as well as high concentrations of polluted surface water runoff from streets or other impervious surfaces. Jurisdictions should incorporate Source Water Protection Zones into land use ordinances that protect the public from threats to culinary water sources. The graphic above (3.25) shows the different protection zones with a detailed description of each zone in the table to the right (3.26). Source Water Protection Zones are incorporated into the Ground Water Assessment Model and are shown on the map in figure 3.27.

<table>
<thead>
<tr>
<th>Source Water Protection Zones</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
</tr>
<tr>
<td>Zone One</td>
</tr>
<tr>
<td>Zone Two</td>
</tr>
<tr>
<td>Zone Three</td>
</tr>
<tr>
<td>Zone Four</td>
</tr>
</tbody>
</table>
This map shows the combined layers and assessment criteria for ground water resources discussed in this section.
Wildlife Habitat

Utah is known for its high biological diversity, due primarily in part to the state’s complex geology and climate. Statewide, there are over 700 vertebrate wildlife species, and thousands of invertebrate species supported by such habitat types as lowland riparian, wetland, mountain riparian, shrub steppe, mountain shrub, lotic, wet meadows, grasslands, lentic, aspen forests, and desert scrub (Gorrell, 2005).

Despite this rich biological diversity, Utah wildlife species have experienced a continuous decline in numbers for the past 30 years. This can be attributed to several human and natural causes such as land use, air quality, water quality/quantity, climate, natural disasters, disease and so on. Often times, the lack of species ecological information and funding are also to blame for inadequate conservation measures (USDA, 2005).

Due to species decline and the importance of wetlands in the county to regional biodiversity, a Wildlife Habitat Assessment model is presented here to identify habitat priority areas in the landscape. This model is developed to help prevent further species decline by sustaining appropriate levels of habitat that support wildlife needs. Similar to other models in this report, the Urban Influence Model provides a useful base layer to build upon.

Utilizing the Core Rural land cover type in the Urban Influence Model (pg. 21), this model identifies areas that are potentially valuable for maintaining species richness and biodiversity. Rivers and streams are then identified to show where potential corridors may exist that connect these natural areas, and will help support the movement of wildlife.
**UTAH COMPREHENSIVE WILDLIFE CONSERVATION STRATEGY (CWCS) AT-RISK-SPECIES LIST FOR BOX ELDER COUNTY (2005)**

<table>
<thead>
<tr>
<th></th>
<th>Common Name</th>
<th>Group</th>
<th>Primary Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEDERALLY-LISTED</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endangered:</td>
<td>June Sucker</td>
<td>Fish</td>
<td>Water</td>
</tr>
<tr>
<td>Threatened:</td>
<td>Bald Eagle</td>
<td>Bird</td>
<td>Lowland Riparian</td>
</tr>
<tr>
<td></td>
<td>Lahontan Cutthroat Trout</td>
<td>Fish</td>
<td>Water</td>
</tr>
<tr>
<td>Candidate:</td>
<td>Yellow-billed Cuckoo</td>
<td>Bird</td>
<td>Lowland Riparian</td>
</tr>
<tr>
<td></td>
<td>Fat-whorled Pondsnail</td>
<td>Mollusk</td>
<td>Wetland</td>
</tr>
<tr>
<td><strong>STATE SENSITIVE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservation Agreement Species:</td>
<td>Northern Goshawk</td>
<td>Bird</td>
<td>Mixed Conifer</td>
</tr>
<tr>
<td></td>
<td>Bonneville Cutthroat Trout</td>
<td>Fish</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Bluehead Sucker</td>
<td>Fish</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Least Chub</td>
<td>Fish</td>
<td>Water</td>
</tr>
<tr>
<td>Species of Concern:</td>
<td>American White Pelican</td>
<td>Bird</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Bobolink</td>
<td>Bird</td>
<td>Wet Meadow</td>
</tr>
<tr>
<td></td>
<td>Burrowing Owl</td>
<td>Bird</td>
<td>High Desert Scrub</td>
</tr>
<tr>
<td></td>
<td>Deseret Mountainsnail</td>
<td>Mollusk</td>
<td>Mountain Shrub</td>
</tr>
<tr>
<td></td>
<td>Ferruginous Hawk</td>
<td>Bird</td>
<td>Pinyon-Juniper</td>
</tr>
<tr>
<td></td>
<td>Grasshopper Sparrow</td>
<td>Bird</td>
<td>Grassland</td>
</tr>
<tr>
<td></td>
<td>Greater Sage-grouse</td>
<td>Bird</td>
<td>Shrubsteppe</td>
</tr>
<tr>
<td></td>
<td>Kit Fox</td>
<td>Mammal</td>
<td>High Desert Scrub</td>
</tr>
<tr>
<td></td>
<td>Lewis's Woodpecker</td>
<td>Bird</td>
<td>Ponderosa Pine</td>
</tr>
<tr>
<td></td>
<td>Long-billed Curlew</td>
<td>Bird</td>
<td>Grassland</td>
</tr>
<tr>
<td></td>
<td>Lyrate Mountainsnail</td>
<td>Mollusk</td>
<td>Mountain Shrub</td>
</tr>
<tr>
<td></td>
<td>Northwest Bonneville Pyrg</td>
<td>Mollusk</td>
<td>Wetland</td>
</tr>
<tr>
<td></td>
<td>Pygmy Rabbit</td>
<td>Mammal</td>
<td>Shrubsteppe</td>
</tr>
<tr>
<td></td>
<td>Sharp-tailed Grouse</td>
<td>Bird</td>
<td>Shrubsteppe</td>
</tr>
<tr>
<td></td>
<td>Short-eared Owl</td>
<td>Bird</td>
<td>Wetland</td>
</tr>
<tr>
<td></td>
<td>Townsend’s Big-eared Bat</td>
<td>Mammal</td>
<td>Pinyon-Juniper</td>
</tr>
<tr>
<td></td>
<td>Utah Physa</td>
<td>Mollusk</td>
<td>Wetland</td>
</tr>
<tr>
<td></td>
<td>Western Pearlshell</td>
<td>Mollusk</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td>Western Toad</td>
<td>Amphibian</td>
<td>Wetland</td>
</tr>
<tr>
<td></td>
<td>Yellowstone Cutthroat Trout</td>
<td>Fish</td>
<td>Water</td>
</tr>
</tbody>
</table>

**Figure 3.31** This is a table of all Federal and State at-risk species in Box Elder County. The list was compiled from the Utah Wildlife Conservation Strategy (CWCS) and lists prioritized species based on conservation need (Gorrell, 2005). These species were identified through species biology and life history, populations, distributions, and threats (USDA, 2005). This list also identifies all the species included in the species richness layer of the Wildlife Assessment Model.
Recently, researchers have also begun to discuss the role of wetlands in atmospheric maintenance. Wetlands, like other plant communities, have the ability to store carbon in vegetation and soils. This prevents the release of carbon into the atmosphere, thus helping to moderate both local and global climate conditions (EPA, 2009).

All of the layers included in the Wildlife Habitat Assessment Model are:

- **Core rural natural areas - habitat** *(Urban Influence Model)*

- **Rivers & Streams - movement corridors** *(USGS National Hydrography Dataset)*

- **Wetlands** *(National Wetlands Inventory, National Land Cover Dataset)*

- **Riparian areas** *(Water Related Land Use - AGRC)*

- **U.S. Bear River Migratory Refuge** *(U.S. Fish & Wildlife Service)*

- **At-risk species richness** *(Utah Division of Wildlife Resources)*

The goal of this model is for land use administrators to incorporate wildlife concerns into short and long-term planning strategies to help sustain wildlife in the region for current and future generations. This can be accomplished by working with wildlife agencies and the public to establish networks of open space patches that are connected by riparian corridors. Corridor preservation not only permits the movement of wildlife, but protects rivers and streams from pollution, and keeps homes from being constructed in critical floodplains.

Similarly, open space patches can serve dual purposes by providing natural habitat for wildlife, or as open space in the form of community parks or preserved agricultural land. Over time, as development continues, corridors and natural patches can be used to develop complex trail networks and open spaces for the benefit of both humans and animals.

In the past, wetlands were often considered nuisances before recognizing their ability to perform several costly and necessary ecosystem services such as providing species habitat, filtering water, retaining storm water runoff, and recharging groundwater aquifers (Urban Planning Tools for Quality Growth, First Edition and 2002 Supplement, Envision Utah).

**Figure 3.34** Recently, researchers have also begun to discuss the role of wetlands in atmospheric maintenance. Wetlands, like other plant communities, have the ability to store carbon in vegetation and soils. This prevents the release of carbon into the atmosphere, thus helping to moderate both local and global climate conditions (EPA, 2009).
Figure 3.35 This map shows the combined layers and assessment criteria for wildlife resources discussed in this section.
Plan Trend Growth

The purpose of alternative futures modeling is not to predict the future, but rather to show the relationship between planning or policy decisions and their potential effects over time (Toth et al., 2002). One example may include a policy decision such as land use zoning. The combination of zoning administration and a community General Plan will not allow one to predict the placement of each new home that is built, but will show where development types are likely to occur. This relationship can be modeled over time at different rates to show the relationship between zoning, community values, and anticipated growth rates.

For this report, there are two different types of futures models that are presented. The first, and most robust is a Plan Trend alternative future model. This model takes into account past land use and development trends to allocate new growth on the landscape to an end point which is simply a doubling of the current population.

The other two futures do not allocate future population on the landscape, but rather advise new growth using the assessment models and resource protection strategies discussed in chapter 3 of this report.

**Figure 4.1** This graphic shows the alternative futures models that are used in this study as depicted in the conceptual framework presented in chapter 1. Alternative futures models are useful for planners, policy makers, and the public to see how growth may occur on the landscape, and to evaluate the measurable impacts to important community values and resources. The futures models, along with past development trends are then evaluated to assess and compare their impacts to the assessment models presented in the previous chapter. This helps stakeholders, decision makers, and the public make effective and informed future land use and policy decisions that consider public health, welfare, and safety concerns for all current and future residents in the region.
Developing the Plan Trend Baseline

Identifying land use trends is an important way for communities to create models or “visions” of the future. While it is difficult to predict the exact location of future development, modeling population growth is a useful technique to show how current land use planning and policy may direct or influence development over time. It is also a useful technique to assess how this future growth may impact critical social, economic, and environmental resources.

In order to develop a plan trend future model, a baseline must first be established that describes current land use patterns and trends throughout the County. The baseline or Plan Trend Development Model is developed through the combination of ArcGIS modelling software and Microsoft Excel spreadsheet analysis for residential development occurring from 1900 - 2008.

Using techniques developed by Steinitz et al. (2006), Hurst (2009), and Kenczka (2009), histograms are created from basic development attributes of all built parcels in the county (Appendix E). For each residential parcel, this includes:

- **Distance from the closest town**
- **Distance from a major road**
- **Distance from a minor road**
- **Residential parcel density**
- **Parcel slope characteristics**

For each of these spatial attributes, parcels are overlaid separately to attach each development attribute to the parcel (figure 4.2). Once the development attributes are attached, the parcel data is exported from ArcGIS into an Excel spreadsheet to construct histograms (figure 4.3).

The histograms graph the relative proportion of parcels that share similar development attributes for each of the five measurements. This is done individually for each attribute, and then the newly constructed histogram classes are imported back into ArcGIS to reclassify the distance attribute layers.

Once reclassified, the individual layers are combined or stacked. The result of this stacking is an “attractiveness” surface raster showing different zones where there is high to low overlap of the 5 housing characteristics based on the histograms for all developed parcels in the county (figure 4.4).

**Sample of Model Inputs**

![Figure 4.2 & 4.3](image)

The model on top is a distance raster showing the euclidean distance from towns. The histogram shows the relative proportion of homes that have similar distance attributes extracted from this distance raster.
Once the distance layers are created, they are stacked to create a single development attractiveness surface.

**Figure 4.4** This is the final attractiveness surface raster for eastern Box Elder County. Once the development attributes are combined, a single layer is created to show where there are overlapping spatial characteristics that attract development. The areas in dark green show where there is the highest level of development for the five combined attributes. The areas in red indicate little to no development based on the development attributes. This surface is used as the baseline for allocating the Plan Trend Alternative Future population projections.
Once the attractiveness surface is created, the number of homes in each of the current zones can be estimated to show the frequency of homes with certain overlapping development characteristics. After determining the number of homes that were built within each zone of the attractiveness surface raster, future population projections can then be modeled following past trends and ratios within the attractiveness zones.

Some important things to consider about this model include land use zoning which could not be incorporated into the model due to time and data constraints. However, because much of the county is unzoned, any development proposal in an unzoned area would have to be considered if there were no other ordinances preventing it.

Also, despite the availability of developable land in the western portion of the county, this model only projects future growth where the current municipalities exist in eastern Box Elder. According to county officials, this eastern portion of the county is where all new future development is expected to occur.

<table>
<thead>
<tr>
<th>Development Classes (attractiveness)</th>
<th>Number of Homes in Each Site Class</th>
<th>Existing Units in Each Site Class (%)</th>
<th>New Units in Each Site Class (future growth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>432</td>
<td>3.23</td>
<td>510</td>
</tr>
<tr>
<td>2</td>
<td>885</td>
<td>6.61</td>
<td>1,044</td>
</tr>
<tr>
<td>3</td>
<td>1,203</td>
<td>8.99</td>
<td>1,419</td>
</tr>
<tr>
<td>4</td>
<td>1,223</td>
<td>9.14</td>
<td>1,443</td>
</tr>
<tr>
<td>5</td>
<td>1,537</td>
<td>11.48</td>
<td>1,813</td>
</tr>
<tr>
<td>6</td>
<td>1,028</td>
<td>7.68</td>
<td>1,213</td>
</tr>
<tr>
<td>7</td>
<td>1,034</td>
<td>7.73</td>
<td>1,220</td>
</tr>
<tr>
<td>8</td>
<td>1,543</td>
<td>11.53</td>
<td>1,820</td>
</tr>
<tr>
<td>9</td>
<td>3,173</td>
<td>23.71</td>
<td>3,743</td>
</tr>
<tr>
<td>10</td>
<td>806</td>
<td>6.02</td>
<td>951</td>
</tr>
<tr>
<td>11</td>
<td>269</td>
<td>2.01</td>
<td>317</td>
</tr>
<tr>
<td>12</td>
<td>91</td>
<td>0.68</td>
<td>107</td>
</tr>
<tr>
<td>13</td>
<td>63</td>
<td>0.47</td>
<td>74</td>
</tr>
<tr>
<td>14</td>
<td>38</td>
<td>0.28</td>
<td>45</td>
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<td>15</td>
<td>17</td>
<td>0.13</td>
<td>20</td>
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<td>16</td>
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<td>13</td>
<td>0.10</td>
<td>15</td>
</tr>
<tr>
<td>18</td>
<td>2</td>
<td>0.01</td>
<td>2</td>
</tr>
<tr>
<td>19</td>
<td>8</td>
<td>0.06</td>
<td>9</td>
</tr>
</tbody>
</table>

Figure 4.5 This table shows how Plan Trend Future Growth is allocated in the development attractiveness surface shown in figure 4.4. By identifying the number of current homes in each of the development site classes, the frequency of those combined development attributes can be used to allocate projected future growth. The Utah Governor’s Office of Planning & Budget analyzes population growth throughout the state and makes yearly projections of new population for each county. In Box Elder County, the GOPB estimates a doubling of the population from the 2010 estimate of around 50,000 people, to over 100,000 by the year 2050 (GOPB, 2009). Given the current housing density of 3.22 persons per household, the added 50,000 persons equates to roughly 15,790 new housing units. Using the known frequency of existing units in each of the development site classes, the same frequencies are used to allocate the number of new units needed for double the current population.
**Figure 4.6** This image shows where current development exists in the eastern portion of the county today. Each light blue dot represents a single home built between 1900 and 2009, with the current municipalities shown with a white boundary.

**Figure 4.7** This image shows the same built structures in blue with the additional plan trend future growth units shown in yellow. This image helps to illustrate the amount of land needed to accommodate future growth projections.
Reducing Infrastructure Costs

With each new development project, there is an increase in the demand for public services for things like roads and road maintenance, emergency services, and sewer/waste disposal and treatment (DeNormandie & Corcoran, 2009). An increase in service needs also results in higher municipal and county infrastructure expenditures.

Through several meetings with the Box Elder County Office of Economic Development, one important concern expressed by planners and elected officials in the county is regarding the current and future costs of public infrastructure. As identified in the Urban Influence Model presented in chapter 2, there was significant growth from 1998 to 2008 leading to the creation of several miles of new roads, and thousands of acres of new urban land cover.

During this period of growth and development in the county, roughly 65% of all new residential parcels were less than an acre in size. Despite the small parcel sizes however, 40% of all homes constructed had a housing density of one unit per acre or less. This relationship illustrates an important pattern occurring on the landscape related to the issue of sprawl. If density remains low as more and more homes are built, the cumulative results will likely be an extremely fragmented landscape with exacerbating infrastructure costs.

This trend raises concern for two important reasons. The first, is if county residents hope to preserve rural or agricultural lands in the county while allowing new growth and development, there will have to be greater effort to preserve valuable open, natural or agricultural landscapes. Continuing to allow piecemeal development will consume vast amounts of land that in this region,

From 1998 to 2008, the amount of linear road miles in the county increased from roughly 4,758 miles to 6,390 miles. This represents a 34% increase in the amount new roads constructed in the county in only a ten year period.

Figure 4.8 This photo is an example typical non-municipal residential development patterns in northern Utah. Development that occurs at these low densities have high transportation costs due to the amount of roads needed per capita. Although these homes are generally on septic systems and wells and do not require water and sewer services, they are generally far from other necessary services such as police, fire, education, and shopping (Fiscal Impacts Toolkit, 2006). Photo source: Jay Baker from Fiscal Impacts Toolkit, 2006.
are mostly productive agricultural lands. This type of land management can be accomplished through land use and zoning regulation, Transfer of Development Rights (TDR), conservation easements, cluster development, or infill and reuse development types.

The second concern for low-density growth is regarding the cost of roads and other housing related infrastructure. When sprawl type development is allowed, often times the costs of providing services to these areas far outweighs the amount of service revenues collected. This creates an increasing fiscal responsibility to local or regional jurisdictions, that over time will lead to increased taxes, or a decrease in the amount of public services that can be provided (GOPB, 2006).

Understanding how different land uses relates to budget and service implications is important for local governments and residents to making better, more informed decisions for their communities. This requires that decision makers, land owners, and residents be actively engaged in developing land use goals and policies that reflect the values of the people, while keeping in check the true costs associated with unplanned or irresponsible growth.

To do so, demands the involvement of several stakeholders to increase public understanding of the issues related to land use development. It is up to planners in the region to invite stakeholders to participate in planning, provide citizens with information and alternatives to the problems facing the region, and to establish continued and meaningful dialogue between citizens and public officials (Burby, 2003).

To help address infrastructure cost concerns for new development in the county, this project uses the Urban Influence Model presented in Chapter 2, combined with an infrastructure cost analysis for the Greater

<table>
<thead>
<tr>
<th>LOCAL GOVERNMENT SOURCES OF REVENUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Property taxes (real and personal property)</td>
</tr>
<tr>
<td>• Sales taxes</td>
</tr>
<tr>
<td>• Fees in lieu of tax (for federal properties)</td>
</tr>
<tr>
<td>• Franchise taxes</td>
</tr>
<tr>
<td>• Licenses, fees and permits</td>
</tr>
<tr>
<td>• Utility and service revenues</td>
</tr>
<tr>
<td>• Fines</td>
</tr>
<tr>
<td>• Intergovernmental revenues (from state or federal government appropriations)</td>
</tr>
</tbody>
</table>

**Figure 4.9** This chart shows the median cost (per dollar of revenue raised) to provide public services for different land uses. Based on these figures, residential development costs more to service than is generated through municipal sources of revenue. This data is provided by the American Farmland Trust, Cost of Community Service Studies (COCS) and is generated to “provide a baseline of current information to help local officials and citizens make informed land use and policy decisions” (Fiscal Impacts Toolkit, Appendix A, 2006).

**Figure 4.10** This figure shows government sources of revenue for local or County jurisdictions in Utah. This information is provided in the Utah Governor’s Office of Planning & Budget Fiscal Analysis Tool (GOPB, 2006).
Wasatch Area conducted by the Utah Governor’s Office of Planning and Budget, Psomas Engineering, and the Utah Division of Water Resources (FHA, 2007).

Although the cost analysis is reflective of infrastructure costs in a different region of the state, the estimates are useful to show the relationship between potential infrastructure installation and maintenance costs based on housing density and land cover type (shown in figures 4.13 & 4.14).

As described earlier, the Urban Influence Model shows areas of the landscape that are mostly rural, urbanizing, or urban based on developed parcels and constructed roads. To review, the land cover classifications of the model are; rural roads, core rural, transitional, suburban, and core urban.

Due to the fragmented development that is occurring in the county, this Infrastructure Cost Assessment Model incorporates the Urban Influence land cover map, with the On-Site and Off-Site infrastructure cost schedules described on the following page. The goal of this model is to relate land cover with potential installation and maintenance costs of new development, and to help communities, developers, and public officials engage in land use planning and development that seeks to protect public fiscal resources.

“Higher-density development expands transportation choices by making it easier to use non-automobile transportation (walking, bicycling, bus and rail transit) by locating activities closer together. Studies indicate that the average resident in a compact neighborhood will drive 20 to 30 percent less than residents of a neighborhood half as dense.” Source: John Holtzclaw www.sierraclub.org/sprawl/articles/designing.asp

### LOCAL GOVERNMENT EXPENDITURES

- **Administration** (mayors, council members, judges, attorneys, planning and zoning, office buildings, appraisers, economic development)
- **Public Safety** (police, fire, ambulance, corrections, inspection)
- **Environment and Housing** (sewer, storm water, solid waste, parks, libraries, cemeteries, etc.)
- **Transportation** (roads, sidewalk, curb & gutter)
- **Health** (hospitals, public health services)
- **Municipal debt** (interest on bonds or other loans)
- **Utilities** (for government owned utilities)

**Figure 4.11** This figure shows government expenditures associated with local or County jurisdictions in Utah. This information is provided in the Utah Governor’s Office of Planning & Budget Fiscal Analysis Tool (GOPB, 2006).
Figures 4.13 & 4.14 These tables show on-site and off-site infrastructure cost schedules. On-site infrastructure is classified into the categories of roads, water transmission lines, sewer transmission lines, dry utilities (telephone, electric, etc.), and storm drains. Private developers generally finance the bulk of on-site infrastructure and reclaim their money through the sale of improved lots. Off-site infrastructure services are maintained by the municipality or service district and includes water and waste water treatment facilities along with distribution lines, storm drain lines and basins, and minor arterial roads. These projects are financed by local governments through the sale of bonds, levying of impact fees, or use of tax revenues. The sources for this information include the Federal Highway Administration Toolbox http://www.fhwa.dot.gov/planning/toolbox/utah_methodology_infrastructure.htm and the Envision Utah Quality Growth Strategy (FHA, 2007; Envision Utah, 1999).
As the cost schedules show, infill or reuse development strategies conserve a significant amount of public and private infrastructure costs. Several smart growth strategies include locating new developments in areas of existing density or in areas of the community where redevelopment could occur in economically distressed areas (Local Government Commission, 2003; Smart Growth Network, 2009).

Because these areas already have infrastructure in place, redevelopment will help to conserve public and private fiscal resources. This strategy also help stimulate local economies with new opportunities for local businesses and/or higher density housing opportunities in the urban environment.

For example, developers and economic development offices could locate core urban areas in the community that have been abandoned or are no longer vibrant, and could redevelop or reuse these areas of the community at little expense to the developer and the community.

Similarly, an infill strategy can be used to increase density and conserve infrastructure costs by siting new development in transitional and suburban zones of the landscape. These areas can be expanded to provide new opportunities for small business development, job creation, shopping, and housing. This helps build core urban areas of the community to attract new growth in areas that are already developed. Not only are public fiscal resources conserved, but this strategy has the added benefit of preserving core rural and natural landscapes surrounding the community.

“A report by the U.S. Office of Technology Assessment (OTA) found that it cost a western city $10,000 more to provide infrastructure to a lower density suburban development than to a more compact urban neighborhood. Similarly, the Urban Land Institute (ULI) found that infrastructure costs per housing unit drop dramatically as density increases. The combined cost of utilities, schools, and streets falls from $90,000 for one dwelling sited on four acres to just over $10,000 per unit for developments of 30 units per acre. (OTA-ETI-643, 1995; ULI, Wieman, 1996)” From the Local Government Commission (2003).

Figure 4.15 This is an example of reuse and infill development that creates a healthy, mixed use downtown community. The photo is of Saratoga Springs in upstate New York with a population of around 30,000. “With homes, shops, the senior center, doctors’ offices, a library, and more, downtown Saratoga Springs has everything seniors need to feel safe, welcome, and active in their retirement years.” Source: Smart Growth Network, 2009.
Finally, if agricultural, wildlife, or conservation agencies sought to prioritize areas for future conservation and open space protection, the core rural areas identify a base layer to begin prioritization.

Although these areas are attractive for their rural and natural landscapes, without some level of permanent conservation or density requirements, they will continue to be development at great expense to the community’s important cultural and natural resources.

**Figure 4.16** This is a photo of 40,000 permanently protected acres in southern New Jersey. “Over the past 20 years, the New Jersey Pinelands Transfer of Development Rights (TDR) program has permanently conserved more than 40,000 acres of farms and forests in the nation’s most densely populated state.” Source: Smart Growth Network, 2009.

**Figures 4.17 & 4.18** These photos are an example of visualization tools that can be used to show how to implement some of the infill and reuse strategies described in this section. This example shows how a run down or under used main street can be transformed to create a more attractive and pedestrian friendly urban environment where residents and tourists come to shop and socialize with other community members. In Box Elder County, there are several ways to bring the agricultural heritage to main street through local produce or craft markets that help connect the community and support local downtown businesses. These photos are from “Urban Advantage - Envisioning Urbanism” http://www.urban-advantage.com/images.html.
Every day, natural hazards occur with varying consequences to individuals, communities, and in extreme cases, state or national economies. Many happen without serious consequence to persons or property, while others result in substantial loss of life, property, or irreplaceable economic gains. Despite our knowledge of natural hazards through scientific research, local expertise, and recurrent events, costs associated with hazardous events are increasing (Burby, 2006).

Here in the United States each year, disasters cause hundreds to thousands of human deaths, and cost billions of dollars in disaster relief, loss of facilities and infrastructure, and disruption of commerce (USGS, 2007). There are several theories to explain why losses from hazards are increasing that include widespread urbanization of metropolitan areas, population growth, concentration of growth in hazardous areas (Lagorio, 1980; Quarantelli, 1999), urban sprawl, low priority of hazards to other community issues (Berke, Song, & Stevens, 2009), and differences in wealth or access to safe and affordable housing (Cutter, Mitchell, & Scott, 2000).

Despite what we know about hazards, an abundance of vulnerable development projects continue nearly unabated in metropolitan areas, with significant recurrent losses from natural disasters (Berke, Song, & Stevens, 2009; Burby, 2006). It is important to note, that the rise in costs associated with hazards is not due to the increase in the number of hazardous events, but is largely due to the amount of people exposed, the cost of impacted structures and infrastructure, and the increased economic dependency between municipalities and populations affected by hazards at the regional scale (Thomas, 2009).

Even with innovations in structural design, hazards planning methodology, and improved hazards data, costs of hazards will continue to increase despite our best efforts to plan for them. This begs the question – how do communities plan the built environment that takes into account the forces of nature that are destructive and sometimes lethal? (Thomas, 2009; Lagorio, 1980). This is especially important in Box Elder County due to several known hazard threats that include flooding, quaternary...
fault rupture, active landslides, liquefaction, and dam inundation.

While it is not always economically feasible or necessary to relocate homes when hazard or resource threats are identified following construction, there are ways to mitigate future threats through improved land use and development policy. The purpose of this public safety model is to incorporate the models mentioned previously, into a GIS tool that can be used to assess new development proposals before homes or structures are built.

This public safety user tool incorporates all of the previous layers of the Natural Hazards, Surface Water, and Ground Water Assessment Models. This allows the user to evaluate future development decisions based on natural hazard threats, and public health and safety concerns associated with county hydrologic resources.

For example, a developer may submit a project for review with the location of proposed homes and their respective parcels. Planners and other land use officials then have an opportunity to conduct spatial analysis using the tool developed in conjunction with this model to show where the proposed development intersects any of the layers included in the model. Once the model has run, the output includes the identification and location of potential threats or concerns, along with the agency or resource specialist to contact for guidance or further assistance.

Figure 4.20 This model shows the intersection of assessment model criteria into a combined mitigation zone. This simply means that any proposed development that is located in this zone may warrant the help of consultants or resource professionals to help identify the significance of potential threats.
Chapter 5 - Land Use & Alternative Futures Evaluations

In order to assess the positive or negative outcomes of any plan, establishing goals and performance measures are critical to learning and understanding how a plan or its associated policies are performing (Toth, 2006). Throughout this document, assessment models and criteria are constructed using basic resource advisements from various academic and professional sources. These models, on their own are a useful source of information to show the location and extent of important resources and hazardous areas throughout the county.

More importantly however, with the use of geospatial analysis and ArcGIS, they become a useful set of criteria to measure the effectiveness of current land use and development policies in the region. To give an example of how this is accomplished, the table on the following page (figure 5.1) shows how land use assessment models and their associated criteria are used to evaluate historic, current, and future land use decisions (Toth et al., 2006). For this evaluation, a high, medium, and low impact assessment is used based on the amount of acres that intersect any of the criteria listed in the table.

For example, the column labeled 1900 to 1998 (past) includes the evaluation of all parcels developed during those years. Using tools in ArcGIS, this parcel layer is overlaid with the assessment model layers in the far left column labeled Assessment Models & Criteria. The results of the spatial analysis identify where the two layers intersect on the landscape and by how much. From there, an evaluation can be made about whether the amount of overlap is favorable (green), worrisome (yellow), or potentially dangerous (red).

From the evaluation summaries shown in figure 5.1, it is evident that there are several parcels in the county that were built on or near important social, economic, and environmental resources. For example, several thousands of acres of residential parcels are located in areas with natural hazard concerns. Similarly, a significant amount of development is located in close proximity to important hydrologic resources that are critical to human health, welfare, and safety.

The greatest conversion of land for residential homes or other urban use, occurs on what were previously agricultural lands used for the production of livestock or crops. This is not surprising, due to the limited availability of non-agricultural developable land in the county. It does however, shed light on the need for planning strategies that will promote responsible growth in the region, and preserve this heritage and livelihood important to generations of Box Elder County families.

“Planning technology and scientific knowledge have made major strides from rudimentary overlays to GIS, remote sensing, computer modeling, and a far greater understanding of biology, botany, geology, and hydrology and how humans impact the environment. The biggest problem environmental planning faces may be lack of political will, not scientific uncertainty.” (Daniels, 2009)
EVALUATION SUMMARIES OF HISTORIC LAND USE & ALTERNATIVE FUTURES DEVELOPMENT

<table>
<thead>
<tr>
<th>Assessment Models &amp; Criteria</th>
<th>1900 to 2008 (past)</th>
<th>1998 to 2008 (current)</th>
<th>Plan Trend (future)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Hazards</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• FEMA 100 year floodplain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Liquefaction (High risk)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mapped landslides w/100ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Dam inundation area w/100ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Quaternary faults w/500ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Slopes of 15% and higher</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Agricultural soils</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cultivated land, irrigated &amp; non-irrigated</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Springs w/100ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Frequently flooded soils w/100ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Occasionally flooded soils w/50ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Lakes w/100ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Wetlands w/100ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Perennial streams w/75ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Intermittent streams w/50ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Riparian areas w/50ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Canals w/50ft buffer</td>
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<tr>
<td>Ground Water</td>
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<tr>
<td>• Drinking water sources w/100ft buffer</td>
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<tr>
<td>• Source water assessment zones</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Drinking water source protection zones</td>
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<td></td>
</tr>
<tr>
<td>• Primary aquifer recharge zone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife Habitat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Agricultural lands (core rural)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Wetlands w/100ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Perennial streams w/75ft buffer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Intermittent streams w/50ft buffer</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Figure 5.1 This table shows one method for evaluating the outcomes of past, current, and future land use decisions. This particular evaluation uses a simple green, yellow, red color map to indicate whether development outcomes are favorable (green), worrisome (yellow), or potentially dangerous (red) to either the community, or to important resources identified in the assessment models.
Land Use & Alternative Futures

Box Elder County is a vast and expansive landscape of diverse livelihoods and abundant natural resources. Prior to the early 1990s the region experienced slow and steady growth associated with other similar rural areas the state. In the last decade however, the county has experienced significant increases in population, residential and commercial structures, roads, and other infrastructure to support this growth.

Because nearly all growth is concentrated in the eastern portion of the county, the western mountains, hills, and valleys remain a rural and mostly natural landscape. This area is isolated from the urbanizing Wasatch Front, and is expected to remain this way in the coming decades.

The east however, is a different story. In this portion of the county, homes, roads, and infrastructure continue to modify the landscape and transform what were once natural landscapes, orchards, or productive agricultural fields, into an ever expanding urban environment. Despite having a general plan that outlines several land use goals and strategies for responsible growth, the evaluation summary identifies several areas where there is little to no consideration or implementation of general plan components.

For instance, the 1998 Box Elder County Plan calls for residential and commercial growth that is compact, considers impacts to environmental quality, restricts development in natural hazard areas, and conserves prime agricultural land (Box Elder General Plan, 1998). From the land use and assessment model evaluation however, it is evident that a significant amount of development continues in critical areas of the landscape. The Plan Trend future also illustrates just how much of these critical areas may developed if historic trends continue, placing an increasing number of residents and important resources at risk as the population expands.

Recommendations

As the county transitions from a mostly rural to an increasingly urban landscape, communities will likely seek ways to improve their material living standards while trying to maintain the values associated with a rural lifestyle (Lapping, Daniels, and Keller 1989; Sargent et al. 1991). This will require that planners and policy makers in the county pay close attention to building strong rural communities that do not sacrifice local social values, cultural traditions, or the use of natural resources for economic viability (Hibbard and Romer, 1999).

Due to the levels of growth that are expected for this region, along with the potential impacts to persons, infrastructure, and critical environmental resources, there are several suggested strategies as a result of this planning document that includes:

1. An update of the county general plan;
2. A well defined and measurable vision of the future;
3. Changes in zoning administration;
4. Riparian area protection;

To help illustrate the importance of these
recommendations, this report concludes with a brief discussion of each that can be used to help initiate discussion between elected officials, stakeholders, and the public to identify new projects and opportunities for collaborative planning.

**General Plan Update**

The first recommendation as a result of this study is a General Plan update for Box Elder County. The current plan was adopted in 1998, and since that time, there are significant changes in both the physical and social environment. With improving technologies and rapid innovation, there are also significant changes in the quality and quantity of useful data to help inform new policies regarding land use.

Once the decision to revise the General Plan is made, it is recommended that the planning framework introduced in this document be used to guide the plan update process. This framework is described in Chapter 1, and should focus on a concerted effort to engage the public through open community forums, meetings, and visioning workshops to identify current county issues and concerns.

This information feeds directly into the development of assessment models that reflect the values and concerns of county residents, and can be used to inform new policies or ordinances that will guide future development.

**Vision of the Future**

Once the assessment models are defined, participants will have the opportunity to develop different desired scenarios of the future and perform their own evaluation using assessment model criteria. With regional values identified and a vision of the future in place, the county can then focus on revising any land use policies or ordinances that will achieve the desired results of Box Elder County citizens.

With the amount of new growth that is expected in the region, having a well defined vision of the future is critical to achieving county goals and objectives. Agricultural preservation, wildlife conservation, water quality, and fiscally responsible development cannot occur without measurable goals and objectives to follow.

**Zoning Administration**

There are two concerns regarding future growth that deal with zoning administration in the county. The first, is that despite efforts to preserve agricultural land or open space through zoning administration, the current land use zones are having limited success in preventing sprawl. As demonstrated earlier in the residential growth summary, while average parcel sizes are decreasing in the county, density remains extremely low and several sprawl type developments continue to occur at a rate of nearly 2.5 acres per day.

Of concern also, are portions of the county that are currently unzoned. In the northeast Bear River Valley, there is a significant amount of developable unzoned property that is expected to be used for residential development as other areas in the county grow and expand. This includes areas west of Elwood, Tremonton, and Honeyville that have close access to shopping centers and major roadways.

With 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.

There are several critiques with modern zoning principles suggesting that the current practice of local zoning ordinances and subdivision ordinances are exclusionary, inhibit smart growth, stifle healthy forms of
development and lead to sprawl, single use and car dominated development patterns (Talen & Knaap, 2003).

The Environmental Protection Agency (EPA) is an important source of knowledge regarding the practice of smart growth principles throughout the nation. Recognizing the link between land use, affordable housing, and transportation, the purpose of EPA Smart Growth is to ...“help communities grow in ways that expand economic opportunity, protect public health and the environment, and create and enhance the places that people love.” (EPA, 2010).

The EPA offers several case studies, sample ordinances, and technical assistance through various programs and funding sources. There are also several other organizations and agencies that offer alternatives to traditional zoning practices. It is recommended that the county look to incorporate newer strategies that are being implemented across the country to help plan for expected growth in the form of more inclusionary and higher density zoning policies.

**Protecting Riparian Areas**

The final recommendation is regarding the use and protection of county riparian areas. Throughout the development of the assessment models used in this study, it became apparent that several of the model criteria shared significant overlap in these important natural areas.

For example, in the Public Safety assessment model, riparian areas are part of the 100 year FEMA floodplain. If this area is allowed to be developed or modified, it may alter the base flood elevation in other areas, placing new and previously built homes at risk. The vegetation along rivers or streams also has the added benefit of preventing stream bank erosion, especially during high water episodes or flooding.

In the Surface Water assessment model, this riparian area buffer represents the critical zone that prevents adjacent land uses from degrading county rivers and streams, or reducing water quality caused by the removal of important natural filters and purifiers. Also, because surface and ground water networks are linked, any alteration or modification of riparian vegetation on the surface also has impacts to important ground water processes that are described in chapter 3.

Finally, in the Wildlife Habitat assessment model, riparian areas represent the most significant source of natural corridors to facilitate the movement of wildlife species in the region. Riparian areas contain the most critical and diverse habitat for the region’s native species, and represent a significant source of homes or stop-over sites for many migratory species (Forman, 2008).

When working with stakeholders, residents, and elected officials to develop riparian area buffers or land uses in and around them, it is important to introduce alternative uses and the funding or compensation mechanisms that will be utilized. For example, a useful strategy being used in similar areas today is the combination of Transfer of Development Rights (TDRs), Conservation Easements, and the construction of nature walks or bike trails for public use.
In recognition of the many models, concepts, and strategies introduced throughout this document, the task of planning for so many variables can at first seem daunting. Important to keep in mind are the many individuals and agencies in the community whom are eager and willing to work with county officials to plan for the future of the region.

There are also several planning resources and success stories to look towards for information and examples. Important to keep in mind also, are the many local, regional, State, and Federal agencies with helpful information, staff, and data that is easy to obtain and incorporate into any planning activity.

Aside from the Assessment & Alternative Futures discussed in chapter’s 3 & 4, the appendices of this report also contain a list of planning and geospatial data sources to improve the level and quality of all future planning efforts in Box Elder County.

“In the planning and designing of new communities, housing projects, and urban renewal, the planners both private and public, need to give explicit consideration to the kind of world that is being created for the children who will be growing up in these settings. Particular attention should be given to the opportunities which the environment presents or precludes for involvement of children both older and younger than themselves.”

- Urie Bronferbrenner, Two Worlds of Childhood (1917)
Appendix A


Box Elder County. (1998). 1998 Box Elder County General Plan Revision. Brigham City: Box Elder County - Economic Development Department.


UDWS - Utah Department of Workforce Services. (2010). Box Elder County Facts. Salt Lake City: Utah Department of Workforce Services.


1998 Box Elder County General Plan (summary)

Land Use

Future Land Use Decisions

- Maintain the current quantity and quality of public services and facilities through balancing growth and development with facility/service capacity e.g. water, sewer, waste disposal, transportation and roads, law enforcement, emergency services;
- Protect rural, agricultural, mineral, wildlife and other County interests or traditional land uses;
- Promote development patterns consistent with and sensitive to, resident preferences;
- Balance private property rights with public interests;

Development

Residential Development

- Not allowed on steep hillsides or unstable slopes;
- Not within designated floodplains and wetlands;
- Not within designated stream corridors;
- Not within environmentally sensitive areas;

Commercial Development

- Within or adjacent to existing communities or service areas;
- Along major thoroughfares where adequate services can be provided;
- Support seasonal use of roadside fruit stands and markets;
- Ensure proposed development complements community aesthetics and design standards;
- Adequate guidelines for outdoor advertising billboards and signs;
- Encourage expansion of existing County industries through value-added programs;

Economic Development

- Diversify the nature and number of economic contributors;
- Encourage growth that is consistent with preserving the County’s quality of life;
- Preserving and strengthening the viability of agriculture in the County economy;
- Pursue a target growth rate that encourages and supports a diversified economic base;
Coordinate and integrate economic development planning with the County General Plan;

- Enhance retention, expansion, and recruitment of businesses;
- Create an attractive business environment for retail, manufacturing, and large employers;

### Industrial Development

- Support expansion of industrial land uses adjacent to major transportation corridors (railroads and roadways) and public utility/service areas;
- Recommend annexation of industrial areas near municipalities to reduce costs for services;
- Locate manufacturing uses adjacent to population centers to discourage urban sprawl and reduce costs of utilities and services;
- Engineer mineral extraction, gravel pits, and other county resource extraction that manages for environmental compatibility, aesthetics, and reclamation;

### Cultural Historical Areas

- Identify and survey cultural/historical resources within the County;
- Explore alternative cultural/historical site and easement acquisition strategies;
- Develop and coordinate collaborative process of regular consultation with State Historic Preservation Office (SHPO);
- Support and coordinate preservation planning efforts of other entities;

### Public Health, Welfare, and Safety

#### Floodplains

- Localized floodplain standard to determine appropriate levels of development;

#### Hillsides & Steep Slopes

- A maximum height for buildings on steep hillsides;
- Storm water management element as part of development review process;
- Grading guidelines for cross slope cuts, grading, and roads;
- Development standards addressing location, siting, materials, height, and colors;

#### Open Space Preservation

- River/stream corridors;
- Critical wildlife habitat corridors;
- Historical/cultural areas;
- Prime agricultural areas;
- Prominent hillsides and ridge lines;
- Wetlands;
Vegetation

- Responsible development of areas consisting of natural vegetation to maintain storm water control and erosion prevention;
- Vegetation removal guidelines as part of development approval;

**Surface Water**

**Water/Waste Water Management**

- Coordinate County-wide water planning efforts;
- Identify and develop (as necessary) additional water sources;
- Develop additional water storage reservoirs for County use;
- Maintain current level of water quality;
- Review zoning ordinances to determine water protection measures;
- Coordinate County wastewater management planning;
- Encourage commercial development within existing communities or in areas with adequate wastewater services;
- Support for experimental wastewater handling systems;
- Explore secondary water systems;
- Setbacks from streams;

**Watershed Protection**

- Establish watershed use restrictions in appropriate watershed areas;
- Develop watershed protection partnerships with communities, neighboring counties and relevant state and federal land management agencies;

**Groundwater**

**Groundwater Recharge Areas/Wellhead Protection**

- Identify primary and secondary water recharge areas;
- Support source protection measures for springs, groundwater recharge areas, and wellhead protection;
- Include groundwater recharge areas and wellhead locations as part of sensitive lands overlay and ordinance (includes community and private wells);
- Complete County soil-type and water table study and establish appropriate development restrictions and standards;
- Enforce State/County health standards for septic tanks, wells, etc;
Farmlands

Agricultural Development

- Protect prime agricultural land;
- Maintain the County’s rural character and lifestyle;
- Protect private property rights;

Agricultural Land Preservation

- Zoning for agricultural areas to reduce conflicts between agricultural and non-agricultural land uses;
- Conditional development for non-agricultural uses within designated agricultural zones (approval based on compatibility with agricultural land uses);
- Encourage owner-initiated agricultural protection areas (APA’s);
- Encourage cluster-type development within agricultural areas;

Prime Agricultural Land Identification

- Location to developing areas;
- Compatibility with adjacent uses;
- Soil type and quality;
- Irrigated/non-irrigated;
- Regionally/locally significant;
- Consistent with County and City master plans;

Wildlife

Wildlife Habitat

- Identify critical wildlife habitat as conditional development areas;
- Consult with Division of Wildlife Resources for development review decisions;
- Identify and acquire wildlife habitat easements as part of the development approval process;
- Encourage cluster development within critical habitat areas;
- Solicit Division of Wildlife Resources (DWR) assistance in wetland/riparian wildlife habitat enhancement efforts;

Wetlands

Wetland Planning

- Wetland mitigation program to identify priority wetlands and establish General Permit for development within wetland areas (Section 404 of the Clean Water Act);
- Require Special Area Management Plans as condition of development;
• Conserve and enhance wetland and riparian area functions and values;
• Conserve and enhance fish and wildlife habitat values;
• Increase public understanding of, and involvement in, wetlands conservation;
• Provide settings for outdoor recreation;
• Conserve “open space”;
• Improve water quality;
• Respect rights of landowners and water users;
• Respond to infrastructure needs, including flood control and transportation;
• Provide for economic development;
• Provide for human population growth;
• Ensure compatibility with a viable agriculture economic sector;
• Protect public health;

Box Elder County Great Salt Lake Wetlands Ecosystem Plan Steering Committee Objectives

• Inventory of existing natural resources including prioritizing wetland ecosystem needs;
• Identify socioeconomic needs, including prioritization;
• Establish a “desired future condition”;
• Prepare plan to attain desired future condition;

Box Elder County Great Salt Lake Wetlands Ecosystem Plan Steering Committee Implementation Strategies

• Special Area Management Plans (S.A.M.P.) and General Permits;
• Environmental Education Center
• Mitigation Banking
• Conservation Easements
• Land Acquisition
The resource guide found in “This Is Smart Growth”, provides a list of useful examples and planning tools to illustrate how land use and development goals can be translated into on-the-ground implementation. The guide is provided to help facilitate implementation of the recommendations of this study. This is especially true for recommendations regarding agricultural preservation, zoning administration, and infill/re-use development to protect county fiscal resources.

Resource Guide

Here are some of the many resources that can help you improve the quality of development in the place where you live.

General Smart Growth Resources

Smart Growth Online. www.smartgrowth.org. Provides comprehensive information about smart growth and lists publications produced by Smart Growth Network partners. You can also become a member of the Smart Growth Network at this site.

EPA's Smart Growth Program. www.epa.gov/smartgrowth. Tools, publications, and resources to help communities create great places.


Resources for Chapter 1


For more information about:

- The Kentlands, see: www.kentlandsusa.com.
- Live/work units, see: www.live-work.com.
- East Liberty, see: www.eastliberty.org.
- Moore Square Museums Magnet Middle School, see: moorequarum.wcpss.net/application.htm and www.smartgrowth.org/library/articles.asp?art = 1820&res = 800.
- Bethel New Life, see: www.bethelnwlife.org.

Resources for Chapter 2


For more information about:

- Stapleton, see: www.stapletonondenver.com.
- Fall Creek Place, see: www.fallcreekplace.com.
- Wellington, see: www.poplarhouse.com.
- Neighborhood organizations and smart growth, see: www.neighborhoodcoalition.org.

Resources for Chapter 3


Resources for Chapter 4


For more information about:
- Main Street communities, see: www.mainstreet.org
- Excelsior and Grand, see: www.excelsiorandgrand.com
- Burlington, see: www.downtownpartnersinc.com
- Florence, see: www.florenceyarnstudio.org
- Carroll County, see: www.tpl.org/tier3_cd.cfm?content_item_id=15776&folder_id=249

Resources for Chapter 5


EPA. Protecting Water Resources with Smart Growth. 2004. www.epa.gov/smartgrowth. Documents 75 policies that can be used to protect water quality through smart growth practices.


For more information about:
- Skagit County, see: www.skagitcounty.net
- East Bay Regional Park District, see: www.ebparks.org
- Cuyahoga County Housing Enhancement Loan Program, see: www.cuyahogacounty.us/treasurer/homeimprove/default.htm

Resources for Chapter 6

Association of Metropolitan Planning Organizations. www.ampo.org. Provides resources about integrating transportation and land use planning at the regional level.

Context Sensitive Solutions. www.contextsensitivesolutions.org. Includes hundreds of resources about designing transportation projects in a way that fits the physical setting and preserves scenic, aesthetic, historic, and environmental resources, while maintaining safety and mobility.


Institute of Transportation Engineers (ITE) and the Congress for the New Urbanism. Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities. 2006. www.ite.org. Provides engineers and planners guidance on designing major urban streets in a way that supports walkability and livability.

ITE. Guidelines for Neighborhood Street Design. 2001. Provides traffic engineers with information on how to build more neighborhood-scaled streets.


Reconnecting America. www.reconnectingamerica.org. Focuses on integrating all modes of transportation and has a Center for Transit Oriented Development.


Walkable Communities, Inc. www.walkable.org. Offers a variety of photos and publications.

For more information about:
- South Providence “Path to Health” program, see: www.gpsm.org/about/services/healthpromotion.shtml
- Carsharing, see: www.carsharing.net
- Missoula, see: www.mountainline.com
- Davis, see: www.citv.davis.ca.us/topic/bicycles.rtf

Resources for Chapter 7

AARP. www.aarp.org. Includes information on livable communities, transportation options, walking, and housing, focused on senior citizens but applicable to everyone.


Centers for Disease Control and Prevention. Designing and Building Healthy Places. www.cdc.gov/healthylivespaces. Describes health issues related to land use and development and links to resources.

Resources for Chapter 8


Project for Public Spaces. www.pps.org. Provides resources on how to design good public places.


For more information about:

- Traverse City, see: www.tcchamber.org/newdesigns.php
- Cotton District, see: www.cottondistrict.net
- Haile Village Center, see: www.hailevillagecenter.com and www.mns.net/towns_haile.html
- Portland, see: www.portlandonline.com/planning.

Resources for Chapter 9


National Trust for Historic Preservation. www.nationaltrust.org. Includes information on preservation, redeveloping Main Streets, and restoring significant structures.


Scenic America. www.scenic.org. Includes tools and resources focused on protecting natural beauty and distinctive community character in the U.S.

For more information about:

- Lowell, see: www.lowellma.gov.
- Southlake Town Square, see: www.southlatetownsquare.com and www.pps.org/pps/one?public_place_id=842.
- Konza Prairie, see: climate.konza.ksu.edu.

Resources for Chapter 10


For more information about:

- Belmar, see: www.belmarcolorado.com and www.tndtownpaper.com/Volume7/belmar_colorado.htm
- Baldwin Park, see: www.baldwinparkrl.com
- Littleton, see: www.goldlittleton.com
- Chattanooga, see: www.waterfrontchattanooga.com and www.nextstep.state.mn.us/casestudy/clid = 74.
The GIS database utilizes both vector and raster layers from a variety of Federal, State, local and regional sources. The table lists each of the layers used in this study, along with the source, format, and scale.

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Appendix E
Plan Trend Histograms & Development Attributes

Slope
The model on the left is a slope raster created from a digital elevation model. The histogram to the right shows the relative proportion of homes that have similar slope characteristics extracted from this slope raster.

Residential parcel density
The model on the left shows the density of all developed parcels in the eastern portion of Box Elder County. Density is calculated by the number of units per feet from one another. The histogram to the right shows the relative proportion of homes with similar density attributes.

Distance from minor roads
The model on the left is a distance raster showing the euclidean distance from a minor road. The histogram to the right shows the relative proportion of homes that have similar distance attributes extracted from this distance raster.
Distance from major roads

The model on the left is a distance raster showing the euclidean distance from a major road. The histogram to the right shows the relative proportion of homes that have similar distance attributes extracted from this distance raster.

Distance from towns

The model on top is a distance raster showing the euclidean distance from towns. The histogram to the right shows the relative proportion of homes that have similar distance attributes extracted from this distance raster.

Residential Development 1900-2008

Graph of the number of residential parcels developed per year from 1900-2008.

Commercial Development 1900-2008

Graph of the average parcel size of Commercial/Industrial parcels developed from 1900-2008.

Residential Development 1900-2008

Graph of the average parcel size of residential parcels developed from 1900-2008.

Commercial Development 1900-2008

Graph of the number of Commercial/Industrial parcels developed per year from 1900-2008.