Alternative Future Growth Scenarios for Conserving Open Space along Utah's Wasatch Front: A Case Study for the Mountainland Association of Governments

Utah State University, College of Natural Resources

Department of Environment and Society

Conversion of Open Space Photo by G. Busch

Cover Photo: Mount Timpanogos reflected in Deer Creek Reservoir (Photo by C. Wood)

ALTERNATIVE FUTURE GROWTH SCENARIOS FOR CONSERVING OPEN SPACE ALONG UTAH'S WASATCH FRONT: A CASE STUDY FOR THE MOUNTAINLAND ASSOCIATION OF GOVERNMENTS

Final Project Report
May 2004

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Supported by

Marriner S. Eccles Foundation
Utah Agricultural Experiment Station
Envision Utah

This report should be cited as:

Toth, R.E., T.C. Edwards, Jr., R.J. Lilieholm, J. A. MacMahon, J. M. Payne, and G.A. Busch. 2004. Alternative Future Growth Scenarios for Conserving Open Space Along Utah's Wasatch Front: A Case Study for the Mountainland Association of Governments. Final Project Report No. 2004-1, College of Natural Resources, Utah State University, Logan, UT 84322-5200 USA.

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INTRODUCTION

Over the past 20 years, rapid suburban and second-home development along Utah's Wasatch Front has threatened to irreversibly alter the region's character and quality of life. This rapid development has raised concern among federal, state, county and community leaders with respect to the protection of surface and subsurface water; public health, safety and welfare; public services and infrastructure, and open space. The major areas being developed include the valley edges and bottom lands, riparian zones, agricultural lands and bench areas. Since most of these areas are under private ownership, they are highly vulnerable to an array of development activities.

In 2001-2002, a conceptual open space study for the Wasatch Front Regional Council (WFRC) was carried out by faculty and students in the College of Natural Resources at Utah State University. Phase I of that work is summarized in a report titled "Alternative Futures for Utah's Wasatch Front: Conservation of Open Space." That study region included the counties of Morgan, Davis, Weber, Salt Lake, and Tooele. One of the study's main products was a map showing the spatial distribution of lands having high open space/conservation value and lands which have high development potential. The map also indicated where potential future conflicts would occur between conservation and development in the WFRC region.

As a consequence of the Wasatch Front Report, members of the Governor's Office of Planning and Budget and Envision Utah recommended that the study team approach the Mountainland Association of Governments (MAG) in order to provide them with a similar regional overview of open space and alternative growth scenarios. After several meetings with MAG staff, a number of objectives were outlined for the study, which took place during the 2002-2003 academic year.

The MAG study area that forms the basis of this report is defined by the counties of Summit, Wasatch, and Utah; hereafter referred to as the Region. The Region is expected to double in population by the year 2030. Currently there are 300,000 people living in the three counties. An additional 300,000 over the next 30 years suggests that an average of 10,000 new residents will move to the region each year. Without proper planning, the impact of such growth can seriously jeopardize quality of life for the residents of the region. Specific areas of concern include a wide range of risks to public health, welfare, and safety; reduced levels of ecosystem services, the loss and/or fragmentation of open spaces and related wildlife and aquatic habitats, and higher taxes to support poorly planned infrastructure.

Figure 1: Second Homes in Provo Canyon
Photo by G. Busch

In order to address these concerns, the study developed a number of objectives:

1) Create a GIS database describing various biophysical and socio-demographic characteristics of the study area, including the basic infrastructure of the region;
2) Define criteria by which regionally-significant open space can be identified and evaluated within the study area, including a 10-mile buffer surrounding the Region;
3) Construct several alternative future growth scenarios for the Region, including various environmental assessment models;
4) Describe various public and private implementation strategies to protect regionally-significant open spaces; and
5) Identify where multiple political jurisdictions affect important cultural and ecological characteristics to ensure that these features are integrated and protected across the larger Region.

In addition to these objectives, the staff at MAG asked that the team:
1) analyze projected heavy and light rail transportation infrastructure for the Region; and
2) analyze and identify potential sites for four to six "new towns" able to accommodate 25,000 to 50,000 residents.

The findings contained in this report represent an initial assessment of the potential impacts of continued growth along the Wasatch Front. How this report is used and the choices made to maintain quality of life for current and future residents of the Region are in the hands of the residents and their elected officials.

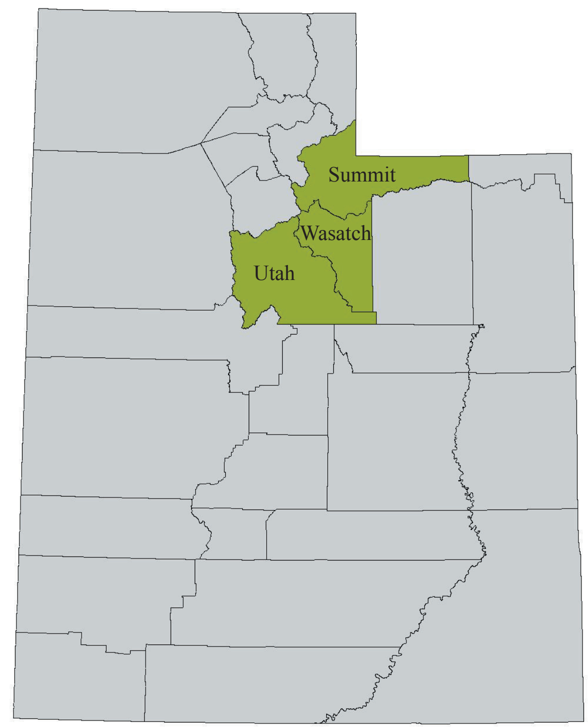

Figure 2: Study Area

Acknowledgments

The study team would like to thank the following individuals and agencies for their help and support during the study. We are particularly thankful for the assistance provided by Darrell Cook, Executive Director, and his staff at the Mountainland Association of Governments. Shawn Seager, Andrew Jackson, Andrew Wooley, and Jim Price all provided valuable insight and information on the Region. We are also very appreciative of the support received from Ted Knowlton, Bob Terragno and Tim Watkins at Envision Utah. Their encouragement was particularly helpful as we progressed through the various stages of the study, as was their generous invitation to have the study team attend their annual workshop. Kort Utley in the Governor's Office of Planning and Budget was instrumental in bringing the study team together with the staff at the Mountainland Association of Governments. Here in the College of Natural Resources, we would like to thank Kevin Bartsch and Nanette Bergeron for their presentations on Camp Williams, Bonnie Banner for her constant help and guidance in the CNR Computer Lab; and Nancy Mesner in the Department of Aquatic, Watershed, and Earth Resources for her presentations on water quality.

Figure 3: East Shore of Utah Lake Photo by G. Busch

STUDY TEAM LEADERSHIP

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Figure 4: Some members of the study team. From left: Professor Richard Toth, Chad Grave, David Jeppesen, Adam Lankford, Brent Feldt, Joan Randazzo, Glen Busch, and David Steckel.

Defining the study process is extremely important in order to understand its various phases and their sequence throughout the course of the project. The value of the process is that it allows for feedback between each of the phases since both data and planning issues change over time and space. The result is an approach that allows continual analysis of the region as the study develops. The study process adopts a user-friendly language in order to be accessible to a broad audience of users, policy makers and stakeholders.

There are five major phases of activity: pre-analysis, analysis of the regional landscape, data identification and collection, the identification and design of alternative future models, and research on implementation strategies and policy. The process is patterned after approaches outlined by Toth (1974, 1988).

The pre-analysis phase consisted of on-site visits and over-flights by the study team in order to develop a better understanding of the scale and characteristics of the region. Several meetings with stakeholders also took place at this time, and from these experiences the study team was able to formulate a number of development issues examined in more detail in the analysis phase. Previous open space projects (case studies) were also reviewed in order to identify common themes that could be applied to the study region.

In the analysis phase, the team researched and documented many of the biophysical characteristics of the region and those dealing with its settlement and culture. During this period, additional meetings were held with stakeholders and county officials in order to get feedback into the process and to establish open space objectives. The base map and contextual buffer were examined and established at this time. Data needs were also brought forward during this phase.

Research and documentation on a range of alternative futures followed from the previous work. The conclusion of this phase resulted in various combinations of the alternative futures models to produce a conceptual open space plan for the region that includes areas of likely conflict between development and public health, welfare and safety.

The final phase of work consisted of research into a number of implementation strategies considered compatible with large scale open space planning. These were categorized as being under the purview of federal, state, or private trusts or foundations.

It should be noted that as various portions of the region are developed over time, new issues will surface. These may vary from biophysical concerns to those dealing with cultural and/or economic issues. The approach described here has the capacity to capture these issues over time for future analysis and resolution, either as part of this study, or as a separate alternative futures analysis. Similarly, new implementation strategies and mitigation measures may be developed to meet new and emerging issues across the study area.

METHODOLOGY

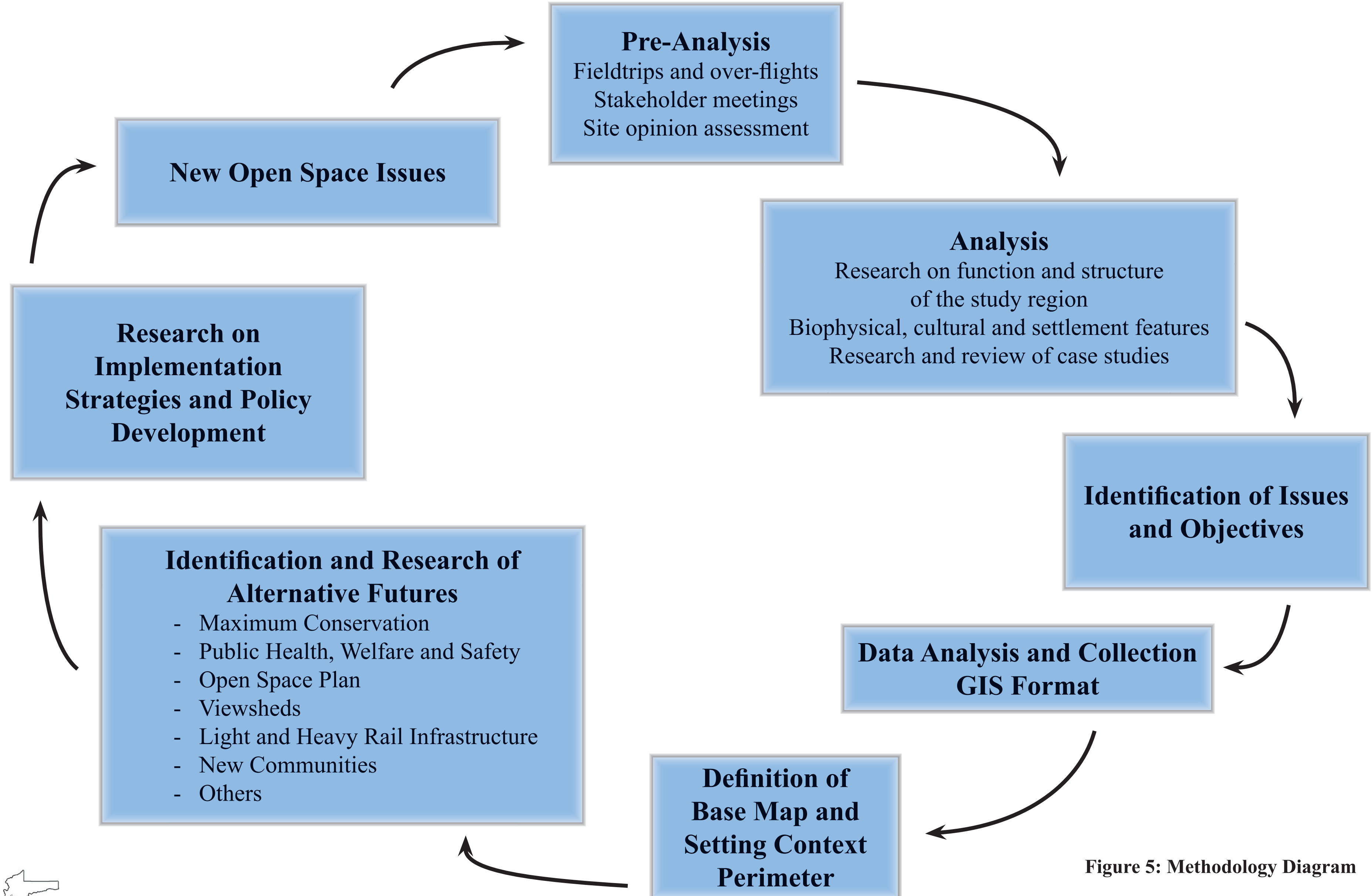


Figure 5: Methodology Diagram

SITE VISITS

To become more acquainted with the region, the study team engaged in a number of site-familiarization activities. The case studies and the research describing the function and structure of the region are addressed in other sections of this report. This section enumerates various site visits to the region.

Initial Visit

In preparation for the initial site visit, the study team held a meeting with a number of staff members at the Mountainland Association of Governments (MAG) in Orem. The discussion centered on identifying of major development concerns for the region. Briefly, these were: projected population growth, transportation issues including mass transit, conservation of open space, and the availability of GIS data.

Tour on the Ground

The team traveled via auto on a route that was recommended by MAG staff members. The tour went through Lehi, circled Utah Lake, returned north and then east through Provo Canyon up into Heber Valley, Park City, Kamas, and Coalville.

Air Tour

Following the ground tour, the study team did a series of flights in order to gain another perspective of the region. A flight pattern similar to the ground tour was followed and a number of photographs were taken, many of which are included in this report.

Written Summaries of Initial Site Analyses

The team members had several discussion sessions reviewing their observations from the tours and summarized them in a series of "project opinion papers," several of which are located in the appendix of this report.

Figure 6: Stake Holder Meeting in Orem Photo by R.E. Toth

GEOLOGY

The Mountainland Association of Governments (MAG) tri-county area is located within three physiographic Provinces: the Great Basin and Range Province, the Rocky Mountain Province, and the Colorado Plateau Province.

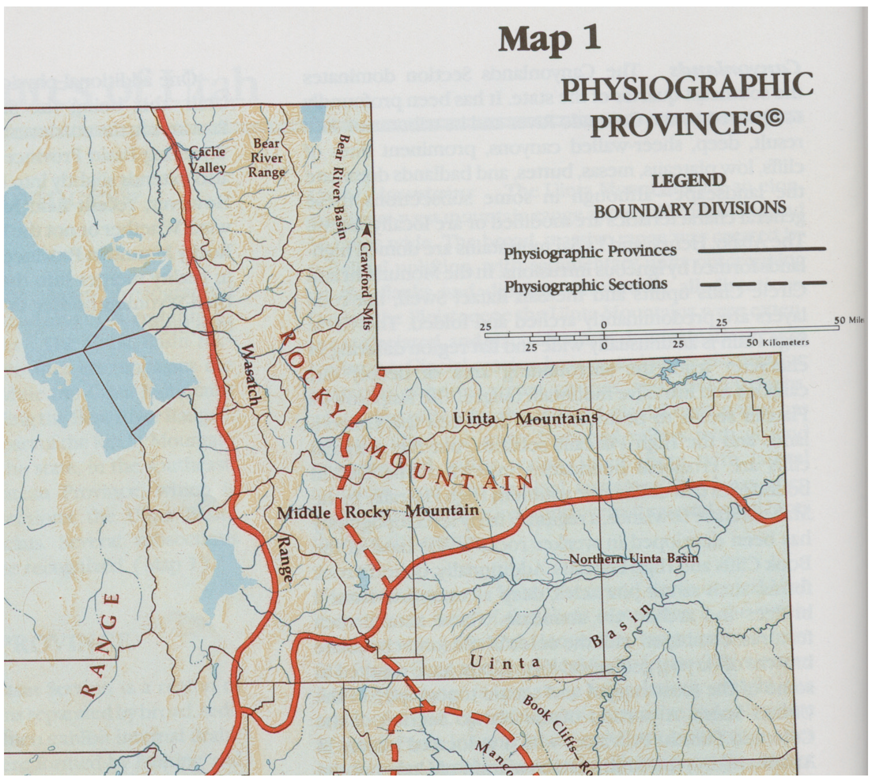


Figure 7: Physiographic Provinces, Source: Rangeland Resources of Utah (1989)

Great Basin and Range Province

This province consists of mountain ranges, large alluvial fans, and basins loaded with sediment. Erosion and ancient lakes, such as Lake Bonneville, deposited silty soils in the basins and produced wide terraces against the mountains. The Great Basin is a closed water system—water entering the basin never reaches the ocean. Water naturally leaves the Great Basin in two ways: evaporation and transpiration. Western Utah County is the only county in the study area within the Basin and Range Province. However, sections of all three counties are within the Great Salt Lake Watershed.

Rocky Mountain Province

This province contains the Wasatch and Uinta mountain ranges. The Wasatch Range is a north/south running tilted fault block consisting of an unusual assemblage of sedimentary, igneous, and metamorphic rocks (Stokes, 1986). The steep slopes, sharp ridges, and numerous rockslides indicate that the range is relatively young (Chronic, 1990). The Uinta Range, which runs east/west, is an anticline practically devoid of igneous rocks (Stokes, 1986). These two ranges intersect near Park City, making the geology of the area very complex.

The area east of the Wasatch Range is a high area of varied and unorganized hills

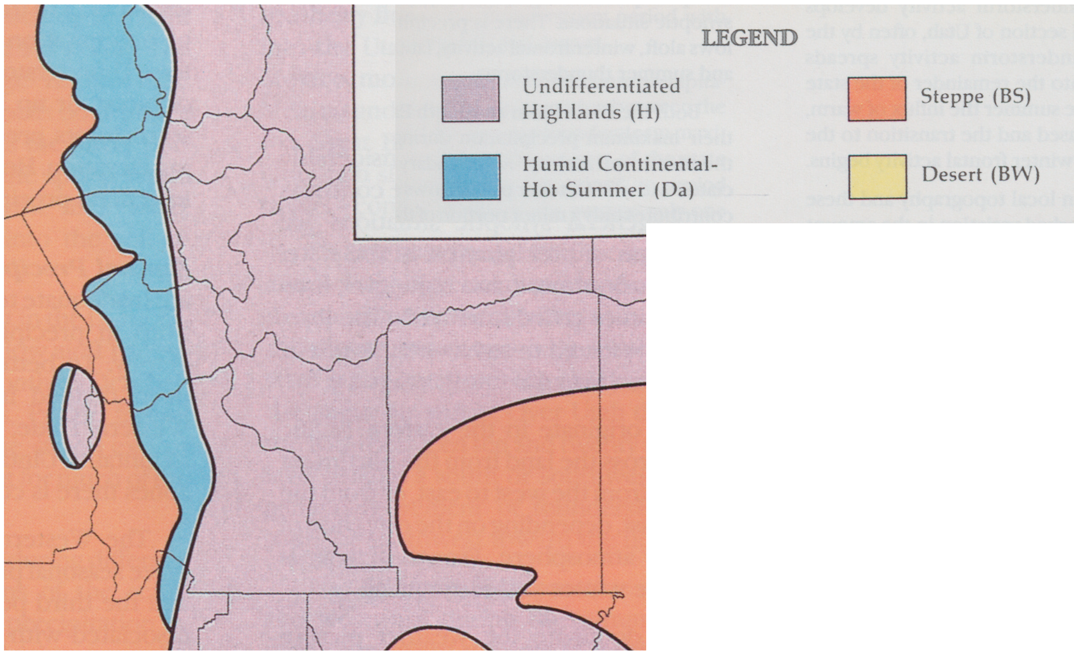


Figure 8: Climatic Zones Source: Rangeland Resources of Utah (1989)

that dominate valleys (Stokes, 1986). The back valleys on the east side of the Wasatch Mountains area include Snyderville Basin, Coalville Valley, Kamas Valley, and Heber Valley.

Colorado Plateau/Province

This province varies in elevation from 5,000 to 9,000 feet. The Uinta Basin is synclinal (gently rolling) as well as a topographical basin (deeply cut ravines and canyons) with an east/west axis running near the south flank of the Uintas. Water entering the Uinta basin naturally flows toward the Green river, the Colorado River and eventually to the Gulf of California.

CLIMATE

The study area contains three of Utah's four climatic zones: the Steepe climatic zone, the Humid Continental-Hot Summer climatic zone, and the Undifferentiated Highlands climatic zone.
Unless otherwise referenced, climate zones are described from the *Atlas of Utah* (Utah Water Research Laboratory, 2004) .

The Steppe Climatic Zone

The Steepe climatic zone is found in western Utah County. The average annual precipitation is between 8-14 inches. The evapotranspiration potential exceeds the annual precipitation of the zone, creating a semi-arid climate. The winters average below 32 degrees Fahrenheit and experience relatively long frost-free growing seasons in western Utah Valley.

Humid Continental-Hot Summer Climatic Zone

This zone is found in central Utah County. Total annual precipitation is more than the evapotranspiration potential, creating a humid environment. The winters average

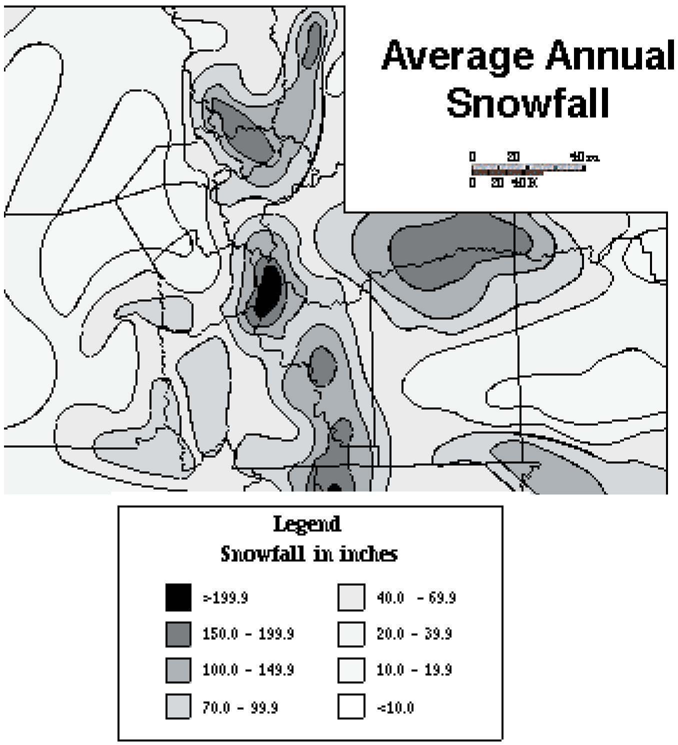


Figure 9: Snowfall, Source: Utah Water Research Laboratory. (2004)

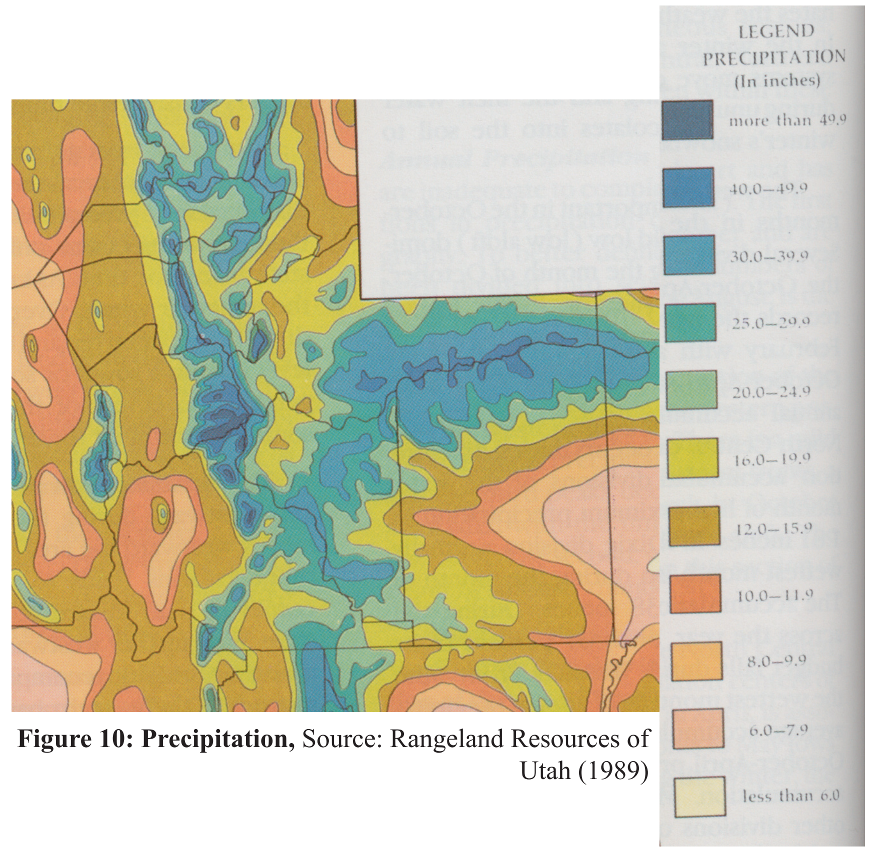


Figure 10: Precipitation, Source: Rangeland Resources of Utah (1989)

below 32 degrees Fahrenheit. The summers are warmer than the steppe climatic zone, averaging 77 degrees Fahrenheit in July. Early human settlement was most favorable in these areas along the mountain benches due to climate, crop growing conditions, water availability, and other natural resources.

The Undifferentiated Highlands Climatic Zone

The Undifferentiated Highlands climatic zone is located in eastern Utah County, Wasatch County, and Summit Counties. This climatic zone has severely cold winters, with heavy snow accumulation and cool summers. The mean summer temperature averages below 72 degrees Fahrenheit. There is great variety in temperature and precipitation due to the varied topography. The Wasatch Front acts as a barrier for winds laden with moisture, forcing clouds to rise over the range and releasing their moisture in the process. As much as 300 inches of snow falls in some areas (Ashcroft et al., 1992). This process produces most of the water used for cities and farms. Extensive systems of reservoirs, canals, and pipes have been created to disperse and prolong the release of this water.

More about Precipitation

The timing and amount of moisture received is a direct function of the climate and geography of the area. For example, if spring thaw is gradual, the counties benefit from good soil percolation and water table regeneration. If spring thaw is rapid, however, floods and mudslides may result.

Several climate scenarios for the area came from the Rocky-Mountain/Great Basin regional climate change workshop, held February 1998 involving the U.S. Geological Survey, Utah State University, the US Global Change Research Program, and the White House Office of Science and Technology Policy, among others (Wagner and Baron, 1998). The workshop focused on the impacts that climate change would have on the Great Basin and Rocky Mountains. It was projected that if the temperature rose just 2 degrees F in the Intermountain West, the ski industry, among many other industries, could be significantly impacted. Most notably, the timing and kind of precipitation received would cause the greatest intermountain climate change.

Areas with snow-related recreation economies such as Park City would be hit the hardest. The workshop identified a present day marginal range for skiing at around 7,000 feet. Park City resorts have a base elevation of 6,900 and 10,000 feet at the summit. Deer Valley, Park City and The Canyons are all located in this marginal

Figure 11: Mount Timpanogos Photo by: R. Lawson

HYDROLOGY

Rivers and Streams

Utah's major water-producing areas are mountains which harbor a series of depressions and ravines that continuously merge to form perennial rivers and streams. These in turn converge, forming large drainages or river basins. Four important rivers in our study area are the Weber, Provo, Jordan, and Strawberry.

The Weber River begins in Summit County on the northwestern flank of the Uinta Mountains, and terminates in the Great Salt Lake. It receives runoff from all of Morgan County and much of Weber and Summit counties.

The Provo River originates in the southwestern margin of the Uinta Mountains and drains portions of Wasatch, Summit, and Utah Counties. It flows through the Jordanelle and Deer Creek reservoirs before terminating in Utah Lake.

The 40-mile-long Jordan River originates in Utah Lake and empties into the Great Salt Lake. According to Ralls (1991), "The size and location of the population centers within this drainage make the distribution of surface water the most complex in the state. Practically all of the flow of the Jordan River is diverted for irrigation during the summer months before it reaches the Great Salt Lake."

The source of the Strawberry River is in the western Uintas. It flows south into Strawberry Reservoir, exits from the east end of the reservoir, and joins the Green River in Duchesne. At the point where it exits the reservoir, its annual mean streamflow for 1993 was only 16.7 cubic feet per second (USGS, 2002).

Reservoirs

Reservoirs are used to protect against periods of drought and periodic flooding. According to Sorensen (1991), "Agricultural, municipal, and industrial

Figure 12: Jordanelle Reservoir Photo by G. Busch

water uses rely heavily on spring runoff from mountain snowpacks stored in reservoirs to meet summer water needs. Efficient use of dams, reservoirs, and water systems is essential to obtaining maximum benefit from the state's scarce water resources."

The Echo and Rockport Reservoirs in Summit County are fed by the lower Weber-Provo River. Jordanelle Reservoir was built in 1993 and provides water to the Wasatch front.

Deer Creek Reservoir is located in Provo Canyon, west of Heber Valley. This earth-fill dam has a capacity of 150,000 acre-ft and was constructed in 1938-1941. Water use from the reservoir includes power production, irrigation, and municipal purposes. Irrigation water distribution is via canals, including the Provo Reservoir Canal (Hyatt et al., 1969).

Strawberry Reservoir is 23 miles southeast of Heber. In 1971, as part of the Central Utah Project, the Soldier Creek Dam was built seven miles downstream of the dam. The new dam increased the size of the reservoir four-fold, and made it an important source for water.

Utah Lake

There are many beautiful natural lakes within the study area, such as Mirror and Amethyst Lake located in the High Uintas. For the purpose of brevity, we will focus on the largest water body in our study area, Utah Lake.

Utah Lake receives its water from groundwater flows and the Provo and Spanish Fork rivers. Other important drainages into Utah Lake are Hobble Creek and American Fork River. Utah Lake was developed as a storage reservoir in 1872. The optimum water elevation was set at 4,489 feet, with three feet above that level considered extreme (Hyatt et al., 1969). Utah Lake is used mostly for irrigation in the Salt Lake and Northern Utah Valleys, with some water uses for industrial purposes in the Salt Lake Valley. Under exchange agreements, lake water used for irrigation replaces some mountain stream water entering the Salt Lake Valley from the east, permitting the latter to be used for municipal and industrial purposes (Hyatt et al., 1969).

Utah Lake is home to several fish species, including the endangered June Sucker. It is a shallow lake, with a depth of only 13 feet, spread over 150 square miles. The south side of Utah Lake is bordered by a protected wetland.

Wetlands

Wetlands are areas characterized by the periodic presence of water, hydric soils, and hydrophytic (water-loving) plants. They are crucial for the well being of any ecosystem. Wetland vegetation slows water movement, providing flood control and allowing time for sediment, excess nutrients, and harmful pollutants to filter out. They provide important habitat for wildlife, including fish, birds, mammals, and invertebrates. Wetlands occur throughout the study area, surrounding most water bodies, rivers, and stream corridors.

Groundwater

Groundwater is found throughout the state, but in many places it is not found in sufficient quantity and/or quality for economic use. Areas where groundwater is found in recoverable quantities and quality are referred to by some as *groundwater reservoirs* (aquifers). *Known reservoirs* are those that have experienced significant development and use. *Probable reservoirs* have had little or no development, but geophysical evidence suggests that a viable resource may exist (Olds et al., 1990).

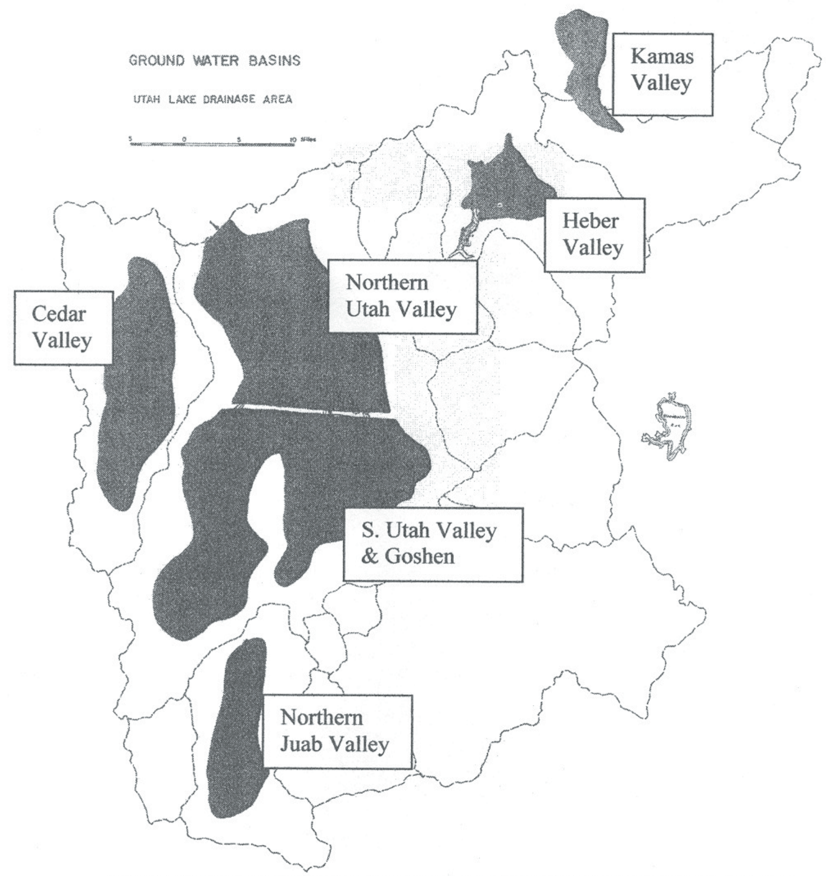
In wetter areas, groundwater often supplements surface supplies. Where more arid conditions exist, groundwater supplies most local water needs. Some communities obtain all of their water from wells and springs, as do numerous rural and suburban households. Water moves from the fractures of the consolidated aquifer of the mountains into the unconsolidated formations of sand, gravel, silt, and clay that comprise most aquifers in mountain valleys. As water enters the valley aquifers, it moves more readily through the unconsolidated formations where permeability is greatest. Groundwater withdrawals generally originate from wells or springs (Schlotthauer, 1990).

Large quantities of groundwater are contained within the consolidated rocks of the Wasatch Range and Uinta Mountains. Most groundwater resides in fractures and solution openings, with numerous springs discharging water from the consolidated rocks. Even though the springs are abundant in the study area, most wells are in consolidated rock and are of small yield, unless they intersect a fracture or solution opening (Baker, 1970)

Most of the productive wells in the Heber-Kamas-Park City area derive their water from the unconsolidated alluvial fill in the three valleys. Zones of either very high or very low permeability do not seem to exist in the valleys. The valleys are, however, generally saturated to within a few feet of the land surface with mostly unconfined groundwater. Unconsolidated deposits in the mountains do not have significance as aquifers. According to Baker (1970), "The highly fractured rocks of the Wasatch Range can be regarded as a single homogeneous aquifer, and the same is probably true of the rocks in the Uinta Mountains." Many wells obtain their water from volcanic rocks since they are the shallowest consolidated rocks in which the wells are sunk. Springs and wells are the principle water sources for those people living in the mountains (Baker, 1970). Park City, Kamas, and Heber Valleys sit on unconsolidated alluvian groundwater acquifers.

The principle groundwater basins located in the Utah Lake drainage area are the Cedar Valley, Northern Juab Valley, Northern Utah Valley, Southern Utah Valley (including Goshen Valley), Kamas Valley, and Heber Valley. Groundwater in the Cedar Valley occurs in unconsolidated deposits under both water-table and artesian conditions, with most wells being located in the artesian aquifer. Northern Juab Valley groundwater occurs chiefly in the valley fill, with a majority of the wells in this aquifer producing less than 10 gpm. Groundwater within the Northern Utah Valley basin moves in a westerly direction towards Utah Lake, although deep aquifers may discharge into the Jordan River or through the Jordan Narrows. Southern Utah Valley and Goshen Valley appear to be hydrologically independent. Groundwater occurs in the alluvium in the valleys under both artesian and phreatic conditions, but most wells are completed in the artesian aquifers. As of 1969, no specific information had been found on the Kamas and Heber valley aquifers (Hyatt, 1969). Major development of groundwater has occurred in the Utah and Goshen Valleys (exclusive of the west side of Utah Lake), with less significant development in Heber Valley. In 1987, withdrawal from wells in Utah/Goshen Valleys exceeded 100,000 acre feet for both agricultural and public supply (Gordy et al., 1988).

To provide baseline data on the state's groundwater resources, a network of observation wells have been installed in known groundwater basins. Water level measurements and water quality samples are taken from these wells periodically. Data reveal both short- and long-term trends in water levels, and long-term trends in water quality. The data obtained from the observation well network are published annually by the United States Geological Survey (USGS), the Utah Division of Water Rights, and the Utah Division of Water Resources in a Cooperative Investigations report. The USGS also publishes the data annually in tabular form in its "Water Resources Data for Utah" series.



Principal groundwater basins in the Utah Lake drainage area.
(Original taken from Hyatt, et al., 1969)

Figure 13: Ground Water Basins

Hydrology Issues

Utah is the second driest state in the U.S., second only to Nevada. Despite this, the state has the second highest rate of water consumption: 293 gallons of water per capita per day.

Population within MAG counties is projected to grow by 300,000 people by the year 2030. Assuming current use rates remain unaltered, the MAG counties will require 87,900,000 *additional* gallons of water per day. Given the region's water resources, this requirement is likely to be unattainable.

Several options are available for conservation. For example, according to the Utah Rivers Council (Frankel, 2002), 70**%** of residential water is used outdoors.

Furthermore, the Utah Division of Water Resources (2003) estimates that "If Utahans can reduce per-capita consumption of water 25 percent by 2050, they will conserve the equivalent of 400,000 acre-feet of water per year. That is more water than can be held in Jordanelle Reservoir, and more than any water project Utah has developed."

According to the Central Utah Water Conservancy District, the cost of constructing the Jordanelle Dam was $114 million. Given the high costs of new dam construction, water conservation may be the most economical way to meet the needs of a growing population.

Figure 14: Jordan River Photo by G. Bush

VEGETATION

Early accounts describe the Salt Lake Valley as a large prairie suitable for grazing cattle. Subsequent overgrazing however, became one of the major drivers for the conversion of grasslands to the sage- and juniper-dominated landscape we see today. Indeed, age class studies have found that junipers were formerly confined to dry rocky ridges, but have since invaded many lowland sites that became more xeric from overgrazing and erosion. For example, while many lowland junipers were established between 1900 and 1920, trees on the rocky ridges were nearly 1,000 years old. These were probably the seed source for the younger trees. *Bromus tectorum* was also present to support the development/grazing disturbance theory.

Grasses are the climax species of the region, and in the past, grass populations were much larger than sage and oak. Development, overgrazing, and fire disturbances have changed the vegetative structure. Now large expanses of rabbitbrush and sagebrush are dominant. These changes have been especially significant on the benches, where development is widespread. With bench development, alkalinity has increased in low areas due to irrigation water leaching from uplands.

Fire Disturbance Regimes

Fire is an important process in many ecosystems. Fire can renew soil and vegetation or restart a successional pattern. Natural fire regimes are often disrupted by development when fire suppression used to protect homes alters the natural ecology of the area. The effects vary from degrading native plants and favoring exotics, to erosion and slope stability. If fire suppression leads to heavy fuel loads, large devastating fires can occur. Historically in the study area, large fires have triggered ground instability and mudslides. Rabbitbrush is encouraged by fire, and may replace sagebrush in former meadows that have been drained by erosional gullies.

Habitat

Four basic habitat types are represented in the valley: These are:
Openland, Woodland, Wetland, and Rangeland. Perhaps the most important and limited vegetated areas are riparian corridors which support a wide range of plant and animal species.

Ecology

Study area fauna often utilize several of these habitats during the year. Some animals, like elk, have different summer and winter habitats. Others breed in the study area, but live elsewhere during other times of the year. Still others may use the study region as wintering grounds.

Openlands

Open grasslands, agricultural fields, and pastures are often sources of food for wildlife living in the study area. Many animals roost or den in trees surrounding pastures and meadows. Openland wildlife include red fox, elk, deer, coyotes, gopher snakes, Great Basin rattlesnakes, and Swainson's and red-tailed hawks. Some animals are listed as federally threatened and endangered, or classified in Utah as "Species of Concern," either because the population or their habitat is limited.

Woodlands

Woodlands provide habitat for both foragers and predators. Forested areas are generally not populated by humans, and hence attract species that require isolation from human habitation. Deer and elk commonly utilize woodlands near pastures. Additionally, mountain lion, bobcat, and coyote, rely upon wooded areas. Moose and black bear forage throughout woodlands.

Wetlands

Wetlands encompass a variety of habitats. Within forests and meadows are riparian zones, where small trees and thick shrubs line the riverside. Fish live within the small rivers flowing through the area. Common fish include warm water white bass and cold water sport fish such as brown and rainbow trout.

Additionally, there are wet meadows where willows and cottonwoods grow, and marshes filled with cattails. Finally, there is open water, such as small ponds and lakes. Amphibians like the western chorus frog and the northern leopard frog abound in these areas, which provide both water and food. Riparian zones usually sustain many species of migratory songbirds by providing an excellent source of insects. Additionally, mink, raccoon, and other predators live along riparian zones, searching for small mammals, amphibians, and fish. Moose, bear, and beavers frequent marshes and wet meadows, as do many species of waterfowl.

Rangeland

Much of our open land in the West is comprised of rangeland vegetation. This dry land is home to lizards, coyote searching for jackrabbits, and mule deer foraging on shrubs. Several avian species of the range environment prefer habitat unaltered by human development.

Figure 15: Wetlands along the Jordan River Photo by C. Bagnes

WILDLIFE

Utah's overall population density is 21 people per mile^2, an increase of 15 percent since 1982. The amount of developed land increased 24 percent between 1982 and 1992. Increased development poses a high risk to native ecosystems. For example, Utah has experienced a 30 percent loss of wetlands since 1780.

Animal Damage Control

Utah's animal damage control program is operated cooperatively with the federal government. Some of the day-to-day operations supervision is provided by state personnel. The state also has a landowner compensation program for predator damage to livestock, poultry and crops. By statute, owners of livestock damaged by bears and mountain lions may receive compensation for 50 percent of the fair market value of the damage (Utah Code Ann. 23-24-1; Utah Admin. R. 657-24).

Money Generated from Hunting

Utah provides numerous opportunities for world-class hunting and fishing, including world record game animals and blue ribbon trout fishing. These activities generate significant conservation and management funds from the sale of permits and licenses. Other significant conservation funding sources include: Rocky Mountain Elk Foundation, Ducks Unlimited, Pheasants Forever, the Nature Conservancy, Audubon Society, Trout Unlimited, and the Rocky Mountain Turkey Federation.

Wildlife Viewing

The growing number of wildlife festivals in Utah are a popular pastime for residents and visitors to the state. Nature festivals are appealing because they bring people together, raise awareness about conservation issues, and generate economic benefits to local communities.

Wildlife Habitat

Wildlands in the study area provide habitat and forage for many species. Any manipulation or preservation of vegetation associated with the goals of this study should consider methods that ensure that native species will be able to use the vegetation to the maximum extent possible.

Habitat Acquisition

Utah has several habitat acquisition programs. For example, the Central Utah Project Mitigation Program acquires lands to preserve and restore wetlands and fish and riparian habitats. Monies come from the federal government, the state, water conservancy districts and the Western Area Power Administration. The 1992 estimated revenue was $13 million. In addition, state income tax check-offs are credited to a wildlife resources account that acquires land for habitat. Upland game stamp revenues are also used for acquisition.

Figure 16: Wild Turkey Photo by R.E. Toth

CULTURE AND HISTORY

The landscape of the MAG region has been significantly shaped by the culture of area residents. Conversely, the culture has been molded by the landscape. The landscape influenced the economic development of the early fishing, ranching and farming settlements 100 years ago. Today, the landscape continues to play a major role in the economics of the area, but in a different way. Indeed, tourism and recreation have now become multi-million dollar businesses in the area.

Millions of years ago, the region was covered by a series of inland seas. Eventually, these seas dried up and volcanic activity was dominant. Later, after the High Uinta and Wasatch mountains had been formed, glaciers moved in and carved out many of the valleys visible today (Hampshire, 1998). It is in these valleys that settlement of the region has focused.

European and Mormon Settlement

The first Europeans to visit the MAG region were Spanish missionaries from Mexico. They arrived in September of 1776 and tried to teach the "savage" natives how to farm and raise livestock (Holzapfel, 1999).

Mountain men were the next white people to enter the Salt Lake Valley. Etienne Provost, the city of Provo's namesake and one of the original mountain men in Utah, set up a temporary trading post on Utah Lake. The U.S. Army kept carefully detailed notes and observations during their 1843-44 expedition of the area, carefully describing the animals, vegetation, and general landscape.

Mormon leaders in Nauvoo, Illinois, carefully read the Army report when they were preparing to head West. Within three years of the Army's visit to Utah Valley, Mormons were traveling the Oregon Trail towards the Great Basin (Holzapfel, 1999). When they reached the valley of the Great Salt Lake, they felt as though God himself had guided them there and provided the area. This attitude influenced their relations with the landscape, Native Americans, the federal government and non-Mormons in the area.

In December of 1847, a group of 30 men became the first permanent white settlers in the area. The first pioneers faced many challenges establishing a permanent settlement. Despite the hardships, the settlers spread throughout the area.

The completion of the transcontinental railroad in May of 1869 at Promontory Summit, Utah ended the region's isolation from the rest of the United States. Also, the discovery of minerals brought increasing wealth to some communities. Despite the new-found prosperity, farming, and ranching continued as economic staples into the late 1800s.

Following the industrial revolution, new factories brought urbanization to some communities in the area. The railroad allowed easy access to outside markets. Mining flourished in mountain areas.

Silver mining fueled Park City's exponential growth during the late 1800s. A boomtown typical of the late 1800s, Park City was soon the largest town in Summit County. The men and women who came to Park City were not interested in building a Zion, like the Mormons. Instead, they wanted to get rich (Hampshire, 1998). The town dealt with many problems common to many mining communities in the late 1800s.

Fishing on Utah Lake was one of the first and most successful industries. Lake trout, suckers, and Utah Chub were all caught commercially. By the early 1870s, however, the yield of trout decreased as a result of over harvesting, poor fishing methods, lack of law enforcement, irrigation decisions and other practices that reduced water quantity and quality. In addition, the introduction of exotic species of fish to the lake also contributed to the decline of the fishery.

Figure 17: Utah Lake, ca. 1910
Photo by Rio Grande Railroad

Hot springs near the shores of Utah Lake lead to the establishment of more than six resorts in the late 19th century. Touring on the lake became popular. As early as 1855, the county court granted four individuals permission to use boats for exploring, fishing, and carrying passengers on pleasure trips. During the next 60 years, a fleet of excursion boats increased use of the lake as a means of income and recreation.

Statehood and the Early 20th Century

On January 4, 1896 area residents received word that President Grover Cleveland had signed a proclamation declaring Utah the 44th state. Statehood did not come without battles between the federal government and the Mormon church. Large amounts of land were confiscated, funds seized, and the church was pressured to end its practice of plural marriage.

Following statehood, the state's economy greatly diversified. New local chambers of commerce and banks promoted the national market economic system. Geneva Steel Works, a significant component of the area's growing economy, was established in 1928.

Geneva Steel was the largest and most important defense-related industry in Utah during WWII. Its success stemmed from Carbon County coal, Iron County ore, water from Deer Creek, Utah Lake, and artesian wells, and proximity to the railroad (Holzapfel, 1999). The foundry's interior location in the Great Basin was also of strategic importance.

The Mormon influence continued throughout the industrialization and urbanization of the 20th century. The National Council of Churches of Christ conducted a survey on U.S. churches and church membership in 1973 and found Utah to be the highest-churched state in the nation at nearly 82 percent.

Politically, at the present time, the area is strongly conservative and most Republicans can count on Utah in national elections (Holzapfel, 1999).

During the 1970s demographic differences between Utah and the rest of the nation increased. Utah had the lowest consumption of malt beverages, Provo/Orem had the lowest crime rates for a city its size, Utahans had a longer life expectancy than average, and Utah had a fast growing population due to large Mormon families (Holzapfel, 1999).

Today and Tomorrow

The region has become a major center for the LDS church. The Missionary Training Center and Brigham Young University (BYU) are both located in the MAG region. BYU is the largest church-sponsored private, post secondary school in the nation.

New companies like WordPerfect and Novell have centered themselves in the area. This boom created a major need for housing and services, and sparked concerns from residents regarding the pace and direction of new development.

Despite the rise of technology-based companies, agriculture remains an important cultural and economic practice. Raising livestock and growing crops continue to be important to the lifestyle of residents.

Today, travel and tourism are major contributors to the economy of the area, adding almost $500 million dollars each year. Ski resorts, world class trout fishing, boating, hiking, and numerous golf courses draw visitors from all over the world.

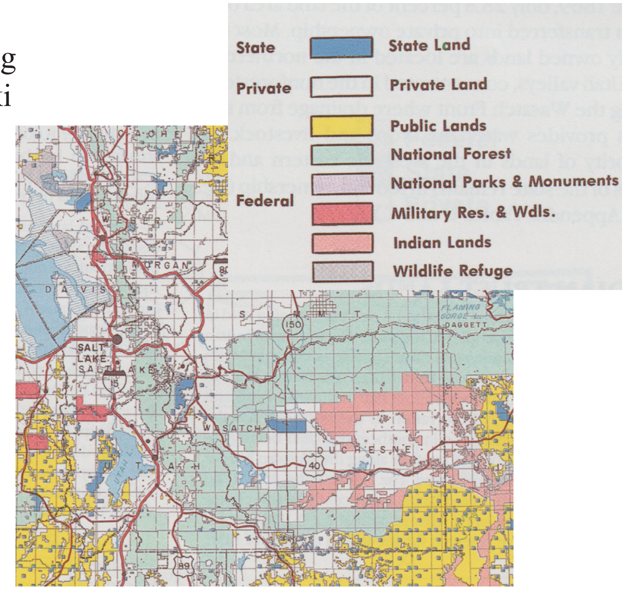


Figure 18: Land Ownership
Source: Rangeland Resources of Utah (1989)

Figure 19: Deer Valley Ski Resort Photo by G. Busch

CASE STUDIES

Major case studies within the regional planning discipline were examined in order to benefit from previous conceptual work and its scale of application to this region. Each study was read, summarized and discussed in class as part of the pre-analysis. Major areas examined were definition of data, methodology, identification of objectives, modeling techniques, and project evaluation. The following case studies were assigned:

Early seminal work in key areas

- Keene, J.C., and A.L. Strong, 1968. The Plan and Program for the Brandywine, Institute for Environmental Studies, 3400 Walnut Street, Philadelphia, PA. 19104.
- McHarg, I.L. 1969. Design with Nature. John Wiley & Sons, New York, NY. A Response to Values – Plan for the Valleys. Pages 79-93.
- Lewis, P.H. 1969. Regional Design for Human Impact-Upper Mississippi River Comprehensive Basin Study, Environmental Awareness Center, University of Wisconsin, Madison, WI.
- Murray, T., et al. 1971. Honeyhill: A Systems Analysis for Planning the Multiple Use of Controlled Water Areas for U. S. Army Corp of Engineers, Vol. 1, Institute for Water Resources. Department of Landscape Architecture Research Office, Harvard University, Cambridge, MA.
- Patri, T., et al. 1970. Early Warning System. The Santa Cruz Mountains Regional Pilot Study. Department of Landscape Architecture, University of California, Berkeley, CA.

Recent work

- U.S. Environmental Protection Agency, 1998. Guidelines for Ecological Risk Assessment. Office of Research and Development, Wash ington DC, EPA/630/R-95/002F.
- Courtney, E. 1991. Vermont's Scenic Landscape: A Guide for Growth and Development. Vermont Agency of Natural Resources, Water bury, VT, 05671-0301.
- Hulse, D., et al. 1997. Possible Futures for the Muddy Creek Watershed, Benton County, Oregon. Institute for a Sustainable Environment, University of Oregon, Eugene, OR.
- Steinitz, C., et al. 1995. Biodiversity and Landscape Planning: Alternative Futures for the Region for Camp Pendleton, California. Graduate School of Design, Harvard University, Cambridge, MA.
- Toth, R.E. et al. 1994. Bluff, Utah: A Study in Rural Community Planning, Part 1: General Plan. Department of Landscape Architecture and Environmental Planning, Utah State University, Logan, UT.
- Yaro, R.D., R.G. Arendt, H.L. Dodson, and E.A. Brabec. 1990. Dealing with Change in the Connecticut River Valley: A Design Manual for Conservation and Development. Lincoln Institute of Land Policy and University of Massachusetts, Amherst, MA.

DATA COLLECTION

Objective

The objective for data collection was to create a Geographic Information System (GIS) database that comprised the biophysical, socio-demographic, and economic attributes of the region for the purpose of identifying prime locations for open space designation. Regional information was primarily collected in GIS format.

Region

The region encompasses Utah, Summit and Wasatch counties. As planning should not ignore contextual considerations at the periphery of the study area, a 10 km buffer surrounding the region was included in the data and analysis. This buffer will also facilitate comparisons with the Wasatch Front Regional Council open space study completed earlier by Toth et al. (2002). While the 10 km buffer is somewhat arbitrary, it allows subsequent analyses to consider resources that are immediately adjacent to the planning area. ArcView's Spatial Analyst module was used to delineate the buffer zone.

Scale

Considering the large size of the region (10,000 square miles), it was important to identify the scale appropriate for the level of analysis. Information for regional mapping and analysis was obtained first. Large scale data (1:100,000) was primarily used for this purpose. This scale has proved useful for regional and county-wide open space planning. Data collected having a scale larger than 1:100,000 can only be used for very general mapping planning purposes due to inaccuracies. The regional data is in the geographic projection Universal Transversal Mercator (UTM) Datum NAD 1927, and the map units are in meters.

For more precise planning and analysis, smaller scale information is required. The scale of 1:24,000 is standard for a large portion of the regional GIS database. This scale is effective for city-level planning and mapping. It should be noted, however, that 1:24,000 (pixel size of 30 meters) may not be sufficiently detailed for project-level design objectives.

Data Selection

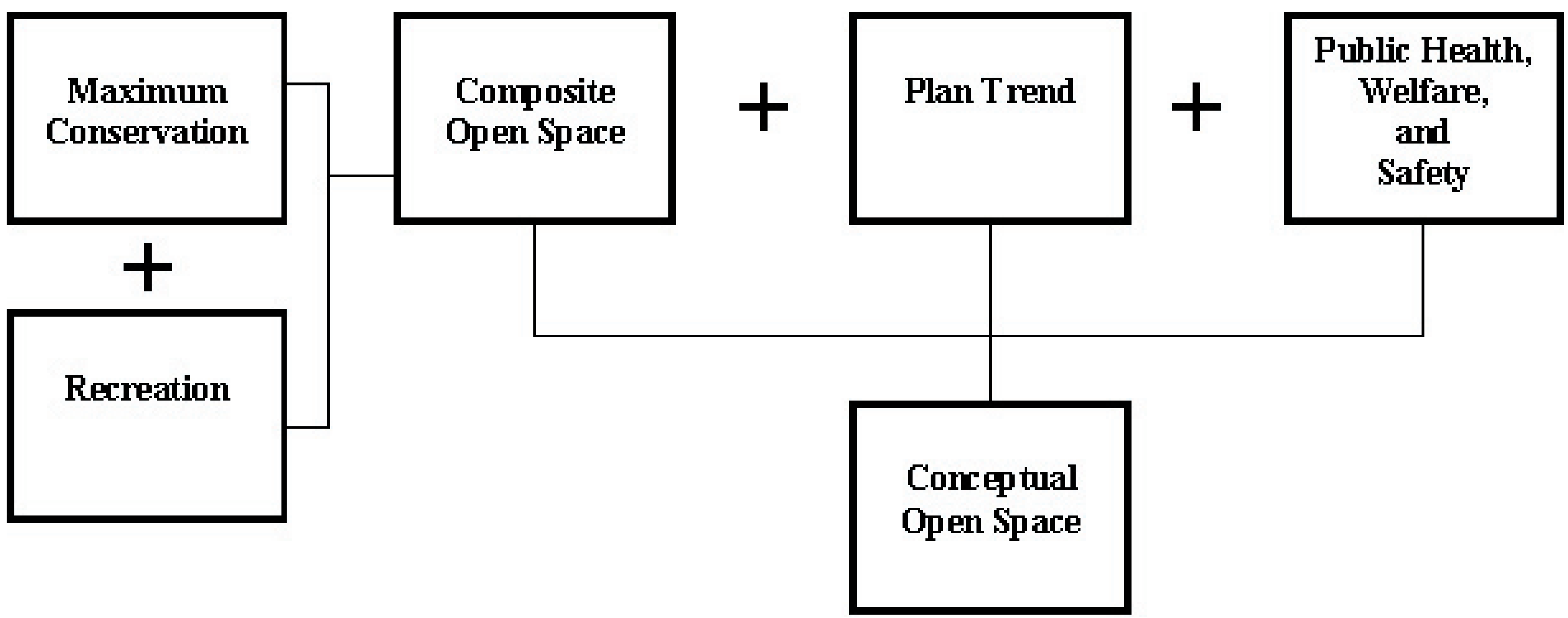
The next step in the data collection process prioritized data sets based on the recommendations of the study team and participating members of the MAG. A data matrix was created, and priority data sets identified. Most of the regional scale data were obtained from federal and state agencies. The Utah Automated Geographic Reference Center (AGRC) also contributed to GIS data collection.

By obtaining a comprehensive set of primary data layers, a versatile foundation was established for landscape analysis, modeling and planning activities. Data collection continued throughout the study when needed information was missing. Detailed information regarding the source, projection and scale of a particular attribute theme or location is beyond the scope of this report. This information can be accessed within the database by referencing the metadata text file associated with the data.

REGIONAL OPEN SPACE MODELS

The following models depict alternative future growth scenarios that protect regionally-significant open space. Although each scenario is based on similar data, they reflect different goals, emphases, and priorities. The different scenarios are eventually combined to create an overall open space plan (Composite Open Space, see diagram below), which is then compared to a growth and development model (Plan Trend) and public safety model (Public Health, Welfare, and Safety) to create the final Conceptual Open Space Model that shows where development and open space are compatible, and where they may conflict. This information allows planners and public officials to assess the relative suitability of various locations for regional open space and development.

Figure 20: Diagram of open space model configurations:



MAXIMUM CONSERVATION MODEL

The MAG region lies on the border of two distinct and large ecoregions: The Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow Province, and the Intermountain Semidesert and Desert Province (Bailey, 1995). These two areas are ecologically, economically, and culturally important, and both contain areas of high conservation value.

The Maximum Conservation Model relies upon various ecological criteria to identify areas that have high conservation value. The model identifies current open spaces that stakeholders may wish to remain as open space.

The Maximum Conservation Model includes landscape features that are critical for maintaining important ecological functions. It includes stream and river corridors, major water bodies, wetland areas, wildlife habitat, and watersheds. Together, these areas define a large amount of open space available in the study area. The model was constructed by examining each area individually and then collectively to identify open space that would protect those areas of the landscape that are important for flora and fauna as well as public enjoyment.

In developing the Maximum Conservation Model, buffer zones were applied to each side of the stream and river corridors (90m), wetlands (90m) and the major water bodies (90m). These buffers were selected using best professional judgment because the lands surrounding these areas are very important for conservation. Depending on the individual riparian system, these buffers may need to be expanded or reduced. The characteristics that should determine buffer zones include, but are not limited to, average channel dimensions (i.e., width/depth ratio, channel roughness, channel form, slope, and floodplain), flood frequency, drainage area, geological type, wildlife, vegetation, and current development (Toth et al., 2002).

The Maximum Conservation Model was limited to those areas that have a high risk of supporting land uses incompatible with conservation. Land that is currently developed was not included in the model. Also, land owned by public agencies such as the U.S. Forest Service (USFS) and Bureau of Land Management (BLM), or lands designated as wilderness, were not included in the model because of the limited management options available to stakeholders.

River and Stream Corridors and Corresponding Riparian Zones

In order to protect the integrity of river and stream corridors, a buffer zone of 90m on each side of the corridor was modelled. This allows bank stability and important riparian vegetation to remain intact, while also reducing the likelihood of flooding. Also, riparian zones are often important habitat for many types of wildlife, and buffer zones help protect these areas so both wildlife and the public can utilize and enjoy them.

Moreover, under natural conditions, rivers constantly change course. As a result, buffers will allow water corridors to respond to geologic, climatic, vegetative, and flow velocity changes without threatening nearby areas (Toth et al., 2002).

Finally, it is important to note that these buffers do not preclude land use changes. These zones allow stakeholders to understand that any proposed land use changes within these zones need to undergo careful review before they are approved by municipal or county officials. Such a review will allow these areas to retain their ecological function, while allowing compatible land use activities and development to occur.

Wetlands and Major Water Bodies

Wetlands include areas that lie between the extremes of open water and dry land. They are occasionally called "swamps," "wet meadows," or "marshes." Since water is oftentimes not visible year-round, wetlands may seem dry, making them difficult to identify (USGS, 2001). Wetlands are responsible for much of the biomass production that occurs in an ecosystem. This means more nutrients are captured and utilized by plants and animals in wetlands than in any other part of the ecosystem. Many different types of vegetation and wildlife rely on wetlands for survival. In fact, according to the Great Lakes Science Center, wetlands can be compared to tropical rain forests in the diversity of species they support (USGS, 2001).

Despite their importance, over half of the wetlands in the lower 48 States were developed between the late 1700s and the mid-1980s. This is what prompted the 1977 signing of Presidential Executive Order #11990: "Protection of Wetlands."

Wetlands should be protected from development due to their importance in protecting water resources, flood mitigation, biodiversity and groundwater infiltration (Toth et al., 2002). For this reason, a 90m buffer was included around all wetlands as well as the intersection between major water bodies and wetlands. Discouraging development within this buffer will help protect these sensitive and ecologically vital areas.

In the model, almost all wetlands were identified around existing major water bodies or stream and river corridors. Where these areas overlap in the final model, one can see that they are given a higher conservation priority. Despite this, where isolated wetlands occur alone, they are in need of special management that considers their high conservation value. They are too important to the ecosystem and the public to risk losing.

Figure 21: Jordanelle Reservior Photo by G. Busch

Wildlife Habitat Areas

The study area contains many critical habitat areas, all of which were included in the model. These areas include ungulate and bird migration corridors, forage and calving areas, and threatened and endangered species locations. While it is difficult to measure the exact impact these critical habitat areas have on the landscape, there is no doubt of their importance to the ecosystem as a whole.

Protecting these areas will benefit wildlife by providing areas for forage and shelter as well as establish migration routes between seasons. Also, for sensitive and endangered species, habitat protection allows the possibility of recovery, whereas development would almost certainly doom these species to extinction.

Critical wildlife habitat conservation also benefits the public through increased support for wildlife viewing, hunting and fishing, and increased revenue from licensing and the sale of sporting goods. Also, if wildlife habitat is protected, wildlife is less likely to enter urban areas where the potential for conflicts with humans is high (Toth et al., 2002).

These tables outline some principles to enhance habitat protection. The principles were developed by Duerksen et al. (1997) to help planners and citizens interact with ecologists in order to develop scientifically sound approaches to habitat protection.

Seven Operational Principles of Habitat Protection

Principle 1	Be willing to use rules of thumb based on scientific findings that may someday prove to be false
Principle 2	Understand that complex environmental problems do not have a single scientific solution based on "truth"
Principle 3	Begin all conservation plans with clearly stated, specific goals for wildlife protection
Principle 4	Insist that the analysis used for setting conservation priorities can be understood by everyone who is affected
Principle 5	Realize that all models are wrong, but some are useful
Principle 6	Make plans adaptive by evaluating the consequences of actions. Learn by doing.
Principle 7	Seize opportunities to enhance wildlife habitat by intelligent design of developments

Seven Biological Principles for Habitat Protection at the Landscape Scale

Principle 1	Maintain large, intact patches of native vegetation by preventing fragmentation of those patches by development
Principle 2	Establish priorities for species protection and protect habitats that constrain those species' distribution and abundance
Principle 3	Protect rare landscape elements by developing areas with "common" landscape features
Principle 4	Identify and protect corridors for wildlife movement
Principle 5	Maintain significant ecological processes in protected areas
Principle 6	Contribute to the regional persistence of rare species by protecting some of their habitat locally
Principle 7	Balance the opportunity for recreation by the public with the habitat needs of wildlife

Agricultural and Working Lands

Agricultural and other working lands in the study area are important for a number of reasons. For example, these lands provide excellent wildlife habitat, are important open spaces that break up monotonous landscapes, maintain an agricultural way of life for many Utahans, and provide general aesthetic value. Moreover, rural sociologists claim that agrarian practices within a society produce stronger community dynamics and greater social interaction (Toth et al., 2002).

Throughout the study area, there are a number of small- and medium-sized agricultural operations. Row crops and livestock are the most common and largest uses of working lands in the MAG region. Many of the dams in the region were initially constructed to provide water for farmers and ranchers, and are extremely important to the way of life of residents in the region.

The agricultural and working lands in the Maximum Conservation Model include current ag and working lands, as well as lands under private ownership that have the potential to become productive agricultural areas. These potential working lands were identified by their slope and soil characteristics (USDA, 1993), and by the fact that they are not currently developed. Preserving these working lands is important not only for the biodiversity and wildlife benefits they provide, but also for the economic, cultural and social benefits supplied.

Primary Watersheds

A watershed is a contiguous area that drains water to a common point or location. John Wesley Powell, an early scientist and explorer of the arid West, put it best when he said that a watershed is: "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community" (EPA, 2002).

Figure 22: Farmland around Payson, UT Photo by G. Busch

Primary watersheds are those which consist of first- and second-order streams and as such are invaluable for their contribution to water quality and quantity. Protecting these vital areas of the landscape is important for the maintenance of clean and safe water for human and livestock consumption. These areas support virtually every aspect of human, wildlife and vegetative existence.

The primary watersheds in the Maximum Conservation Model were identified and categorized as those occurring above 2390m. Because water flows from high elevation to lower elevation, we assumed that protecting areas of higher elevation would protect the source of much of the water in our study area. By comparing GIS layers of the water courses to the elevations of our area, we arrived at elevations that we believe encompass many of the primary sources of our water. Preserving these areas is important to maintaining high levels of water quality.

DECISION MATRIX	Rivers	Wetlands	Critical Habitat	Agricultural and Working Lands	Primary Watersheds
Surface Water	X	X	X		X
Ground Water	X		X		X
Water Quality	X	X	X	X	X
Water Quantity	X	X	X	X	X
Aquatic Organisms and Habitat	X	X	X		X
Terrestrial Wildlife and Habitat	X	X	X	X	X
Upland Vegetation			X	X	
Soil Preservation			X	X	
TES	X	X	X	X	X
Riparian and Wetland Vegetation	X	X	X		X
Recharge Zones	X	X			X
Recreation/Economic	X		X	X	
Scenic/Aesthetic	X	X	X	X	X
Total Designators	**11**	**9**	**12**	**8**	**10**

Theory of Evaluation

The areas most important for conservation are those that have the highest ecological importance. To aid in determining these lands, a decision matrix was developed that delineated critical ecological functions for different landscape features. When a positive correlation occurred between the ecological function and the landscape feature, a designator was placed. The decision matrix was adapted from Toth et al. (2002), and while it is not all-encompassing, it does successfully integrate important ecological functions and the landscape areas included in the Maximum Conservation Model.

The criteria described above were all included in the Maximum Conservation

Model in an effort to provide stakeholders with objective information about the importance of these different areas. In the Composite Model, where ecological data layers overlap, the conservation value increases. In interpreting the Composite Model, areas that have the darkest green have the highest conservation value and are thus more important for open space preservation.

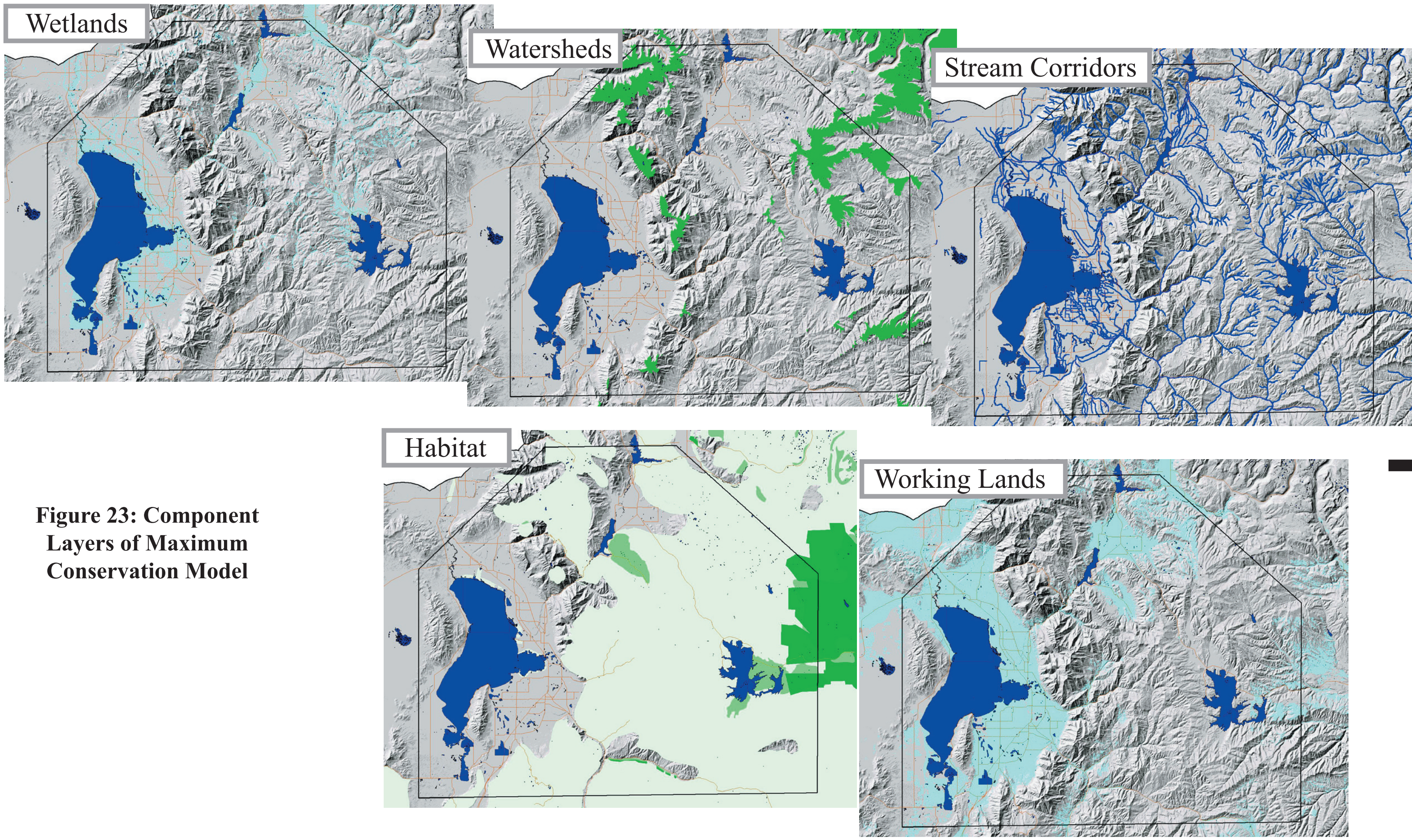


Figure 23: Component Layers of Maximum Conservation Model

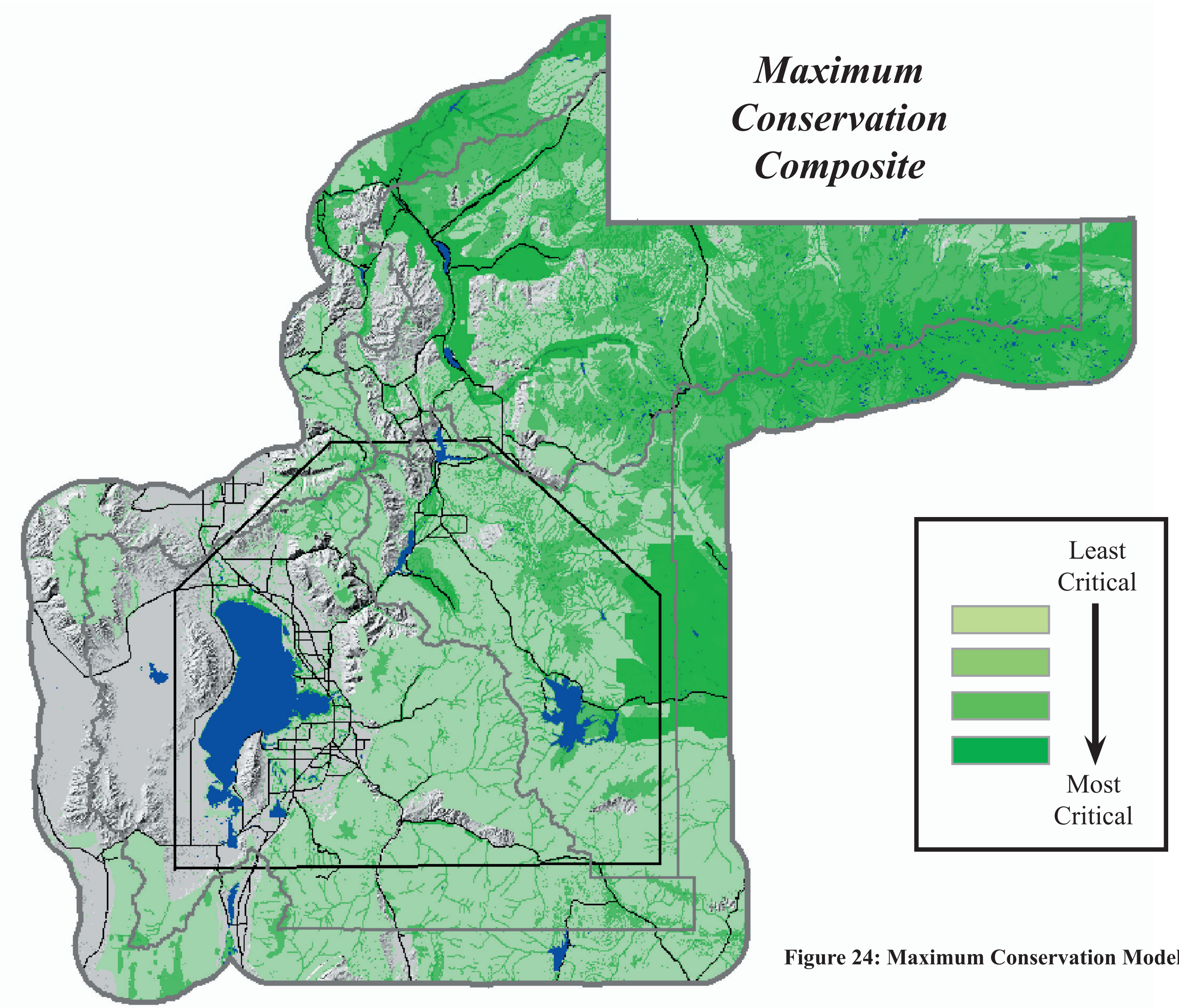


Figure 24: Maximum Conservation Model

RECREATION MODEL

The main goal of the Recreation Model is to identify potential areas for all-season recreation development. These areas would provide opportunities for winter recreation (e.g., skiing, sledding, cross-country skiing etc.), as well as summer recreation activities (e.g., walking, hiking, biking, horseback riding, fishing, etc.).

The final Recreation Model is constructed from separate winter recreation and summer recreation models. We segregated the search for summer and winter recreation sites because they have different requirements, such as aspect for skiing and proximity to water for many summer uses.

The final Recreation Model overlapped the seasonal models to identify areas that are suitable for all-season recreation. These areas present good opportunities for tourism development based on recreation and natural legacy.

REQUIREMENTS

Winter recreation

- appropriate slope (0-25%)
- shady slope
- adequate precipitation (8,000 feet elevation or higher)
- public land
- appropriate land use (forest, open space)
- visual quality
- natural/cultural legacy
- easy access

Summer recreation

- attractiveness
- proximity to water
- proximity to forest edge
- attractive views
- natural/cultural legacy
- appropriate land use (forest, open space)
- sunny sites
- public land
- easy access
- soil quality
- appropriate slope

Appropriate Slopes (0-25%)

0-25% slope is appropriate for a wide range of winter activities such as hiking, cross-country skiing, downhill skiing, sliding, etc. On the other hand, 25% slope is still considered safe and it does not expose humans to high risks.

Shady Slopes

Shady slopes are considered appropriate because they extend the timing of snow cover. Shady slopes allow snow cover to stay longer, which can extend winter activities into the spring. A longer season increases resort profitability.

Adequate Precipitation

Elevations above 8,000 feet are more likely to receive adequate snow for winter resorts.

Public Land

Nearly all large, high elevation areas are under public ownership.

Appropriate Land Use

Different winter activities have different needs that influence site suitability. For some activities such as hiking and cross-country skiing, both open space and forests are appropriate. Conversely, downhill skiing requires more open terrain to minimize risks to human safety.

On open space lands such as meadows and grasslands, we considered activities compatible with the site's original function and visual appearance.

Attractiveness

Recreation areas need to be visually attractive to people. Spending time outside not only satisfies physical needs, it can also have a relaxing influence. Visually appealing sites will attract more people, which is important for commercial development.

Proximity to Water

Water not only serves as a potential recreation site, but can also contribute to the visual richness of an area. Water can also influence local climate.

Figure 25: Jordanelle State Park and Marina Photo by G. Busch

Proximity to Forest Edge

Forested edges are oftentimes the most attractive part of a landscape because of the rich biological diversity they support. Edge combines the mystery of the forest with open space and provides shelter for many animals.

Attractive Views

Scenic vistas enrich the experience people have during outside activities. Views can serve as crucial points where people can rest while still enjoying the scenery. They can serve as a main orientation, a guide, or can be a location where recreational facilities are constructed.

Natural/Cultural Legacy

An area's natural and/or cultural legacy can also be an element that attracts people. If a recreation center includes these elements, it will likely attract more people and entice them to stay even after their activity ends. A variety of activities may provide a more diverse experience.

Access

Recreational facilities need to be readily accessible. Locating recreation centers near a main road enhances accessibility while lowering expenditures on new roads and infrastructure.

Figure 26: Park City Photo by C. Bagnes

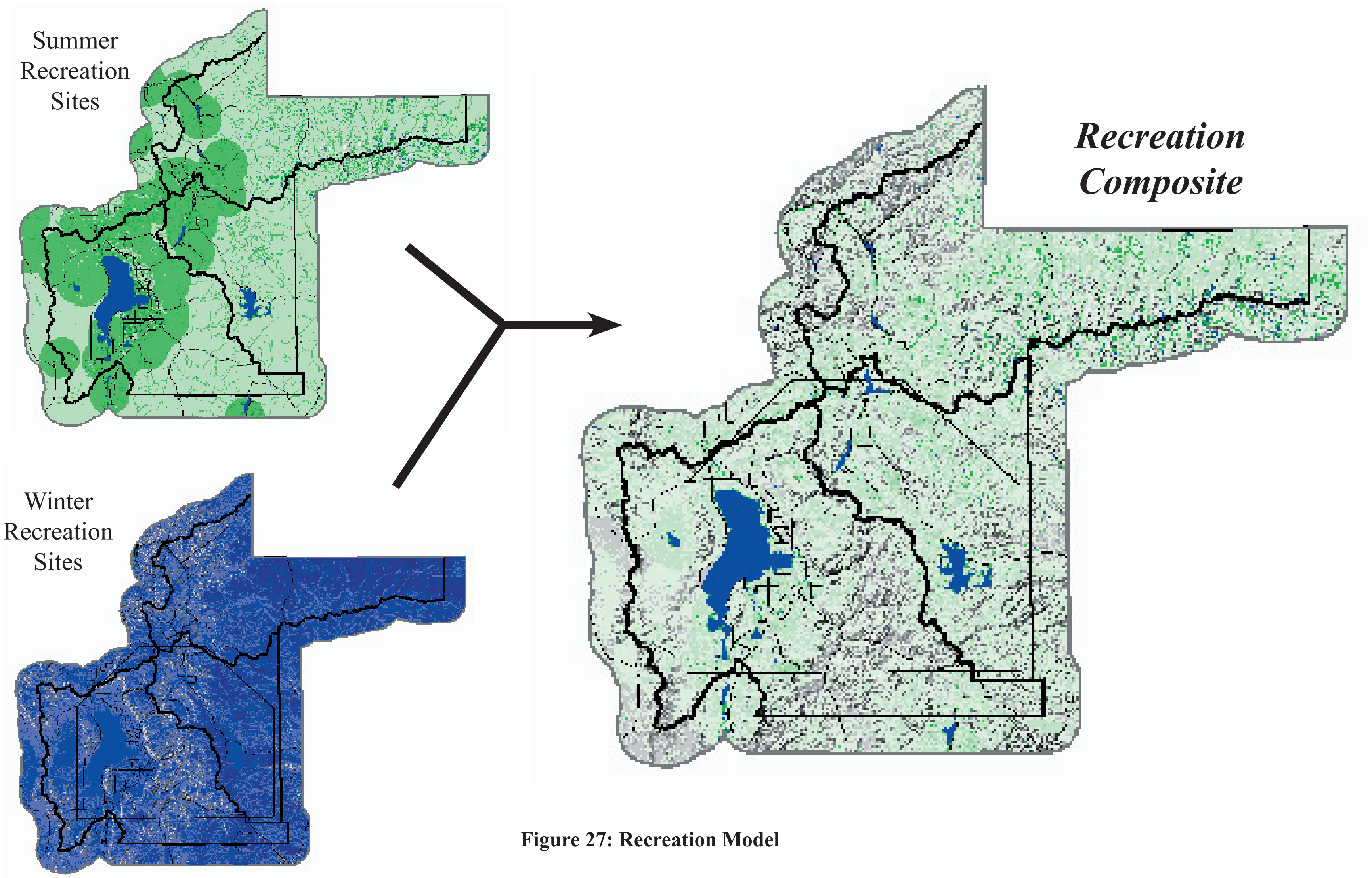


Figure 27: Recreation Model

COMPOSITE OPEN SPACE MODEL

This model identifies areas that are believed to have value as undeveloped open space. It is a combination of the Maximum Conservation and Recreation Models. In the Composite Model, private lands in red are most vulnerable to development.

Composite Open Space

- Open Space - Public Land
- Open Space - Private Land

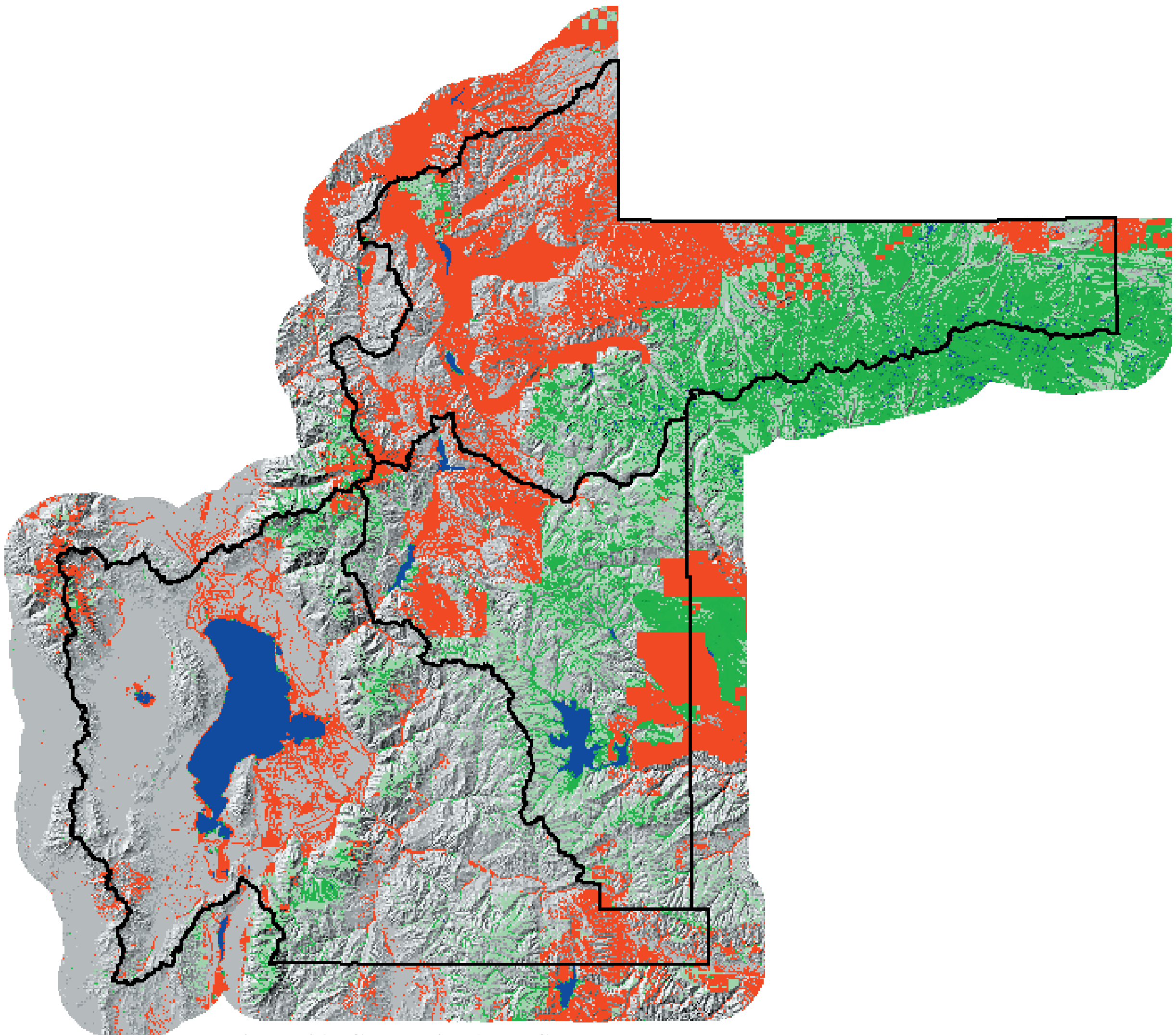


Figure 28: Composite Open Space Model

PUBLIC HEALTH, WELFARE AND SAFETY MODEL (PHWS)

The PHWS model identifies areas of the landscape that have the potential to negatively affect the health, welfare, and safety of people in the MAG region. The model seeks to maximize human health by giving stakeholders information on which areas may harm water quality and quantity, may cause structural damage, and may pose a threat to safety. Areas not suitable for human development present excellent opportunities for open space preservation.

Because of the diversity of the study area (Bailey, 1995), there are a number of different landscape features that are considered in the model. These features include: steep slopes, earthquake fault lines, mudslide areas, areas with shallow groundwater, high shrink and swell soils, floodplains, and areas with high wildfire danger.

Each of the features listed above was located on the landscape. When examined separately, these areas represent sites that could pose a substantial threat to human health, welfare, and safety. Examined together, the areas show where human development should be avoided in the MAG region.

A risk assessment matrix was developed by Toth et al. (2002) in their analysis of a five-county area along Utah's Wasatch Front. The following matrix was adapted from that study to show stakeholders how different areas have the potential to affect various aspects of public health, welfare and safety. The matrix provides a basis for discussing the different landscape features that could potentially affect public health, welfare, and safety. In this section of the report, each of the features is examined separately and then combined into a final map showing the areas that pose the largest threat. Development should be avoided in these areas, if at all possible. This will help stakeholders and planners mitigate the negative effects of these potentially damaging landscape features.

It should be emphasized that this model is not all-inclusive. There are other landscape features that can potentially affect resources important to humans. The landscape features included represent those that have affected public health, welfare and safety in the past. The likelihood of some of these landscape features affecting resources again is higher than for others.

Figure 29: Saratoga Springs Photo by G. Busch

Avalanche/Steep Slope

The Wasatch Mountains in the MAG region receive high annual snowfall, with some locales receiving more than 25 feet of snow during the winter months (Utah, 2002). Plentiful snowfall gives an increasing number of backcountry recreationists excellent opportunities to ski, snowboard, and snowmobile. Unfortunately, if the snow pack becomes unstable on steep slopes, it can slough off and cause avalanches. These avalanches have the ability to affect human health, cause structural damage, and increase health-care and insurance costs. This portion of the model was designed to identify those areas of the landscape that are more prone to avalanches and/or have slope characteristics that are detrimental to public welfare.

Four characteristics must be present for an avalanche to occur: (1) accumulation of a critical mass of snow, (2) structural changes within the snow that affect the snow's stability, (3) slope angle that permits flow, and (4) a trigger (Ebert, 1988). The mechanism of an avalanche is simple. When the snow falls, it forms layers on the ground. These layers are often distinct from each other, and have distinct characteristics. Some layers are stable because they are made of small, tightly packed snowflakes. Others are more loosely packed. If this layering effect occurs on a slope of 30-45 degrees, loose layers covered by heavier snow may cause the bottom layer to give way and lead to an avalanche (Tremper, 2001). Besides avalanche risk, some areas may be too steep for snow to accumulate in deep layers, but still not be good places for human habitation or development. Based on these considerations, we included areas with slope angles greater than 30 degrees. This would then include both avalanche-prone areas, and areas with steep slopes.

In 2002, three people were killed by avalanches in Utah (USFS, 2002). Each year, a growing number of people are injured by avalanches. Steep slopes also pose a falling hazard for hikers and skiers. Most Utah ski resorts have active avalanche patrol, and are constantly on the lookout for avalanche conditions. Often these patrols trigger avalanches before they become too dangerous. Also, backcountry recreationists increasingly wear locating beacons, and avalanche education, prediction and mitigation efforts are on the rise.

Avalanches may also damage or destroy infrastructure like homes, businesses, roads and railroads. Since a single major roadway connects many areas within MAG, avalanche blockage could prove costly to many small, rural communities and hamper relief efforts. As a result, restricting or reducing development in these areas would greatly reduce the costs incurred if an avalanche occurs. Avalanches also affect health insurance and medical costs. The bills associated with hospital stays greatly affect individuals, and society typically pays some of the cost. Moreover, rescue personnel sent to save avalanche victims are often volunteers or employees who work for public agencies. Such work is time intensive, risky, and extremely expensive for communities.

Fault Lines

Utah's densely populated Wasatch Front lies along an active fault system. Deep underground, the earth's geologic plates slowly move the Wasatch Mountains to the west (Morisawa, 1972). As these plates stretch along the normal fault type (Ebert, 1988), the reduced stress pushes the mountains higher, resulting in the 7,000- to 12,000-foot peaks we see today (Morisawa, 1972). If this motion occurs slowly, it is called creep and is imperceptible. If it occurs quickly, however, earthquakes can result (Morisawa, 1972). While few large-scale earthquakes have occurred on the Wasatch Fault over the last 300 years, there is evidence that the fault is still active, that it has been active within the last few thousand years, and that large earthquakes can be expected in the future (Morisawa, 1972).

The purpose of this part of the PHWS model is to identify fault lines and delineate a one-kilometer buffer on each side around them. The buffer width could be increased or decreased, depending upon local seismic conditions, building codes, and future occurrences of earthquakes.

More than 600 earthquakes occur in Utah every year. Approximately 2% of the earthquakes are felt. An average of about 13 earthquakes of magnitude 3.0 or larger occur in the region every year (UUSS, 1996). Most often, these earthquakes occur on faults running under the western edge of the Wasatch Mountains. According to the University of Utah Seismograph Station's web page, the Wasatch Fault is overdue for a magnitude 7 to 7.5 earthquake. If this happens, the earthquake could break segments of the fault about 20 - 40 miles long and produce displacements at the surface of 10 to 20 feet (UUSS, 1996).

Of all natural disasters that affect public health, welfare and safety, earthquakes send out the largest and longest range of associated phenomena that can be used to foreshadow the impending catastrophe (Bryant, 1991). Still, predicting an earthquake's exact timing and location is nearly impossible (Eubank, 1996, Ebert, 1988). In fact, it is often the post-quake hazards that cause the greatest damage (Ebert, 1988), so even if prediction was available, development along active faults has great potential for harming people and structures. Reducing and/or strengthening development along fault lines is an effective way of mitigating potential damage by earthquakes (Steinberg, 2000).

Earthquakes all negatively affect human health, medical costs, and structural and infrastructure integrity. Between 1850 and 1995, earthquakes of magnitude 5.5 or greater occurred in Utah 16 times. Earthquakes this large are likely to cause surface ruptures and damage homes, work places, and highways. Health insurance and medical costs will almost certainly increase in an area following an earthquake. The relief and emergency personnel and equipment needed to repair damage would be expensive. Extensive damage to structures, especially schools, hospitals, apartment buildings and other large structures, can also occur during and after earthquakes

Mudslides

Although mudslides are not historically recognized as causing as large a death toll as earthquakes, the damage to property is just as extensive, and the loss of life associated with some earthquakes is due to landslides that occur after the quake (Bryant, 1991). Mudslides result from a massive failure within a large body of earth materials (Ebert, 1988). Mudslides occur because the shear strength of the earth materials is not sufficient enough to resist the pull of gravity (Bryant, 1991). When earth materials are not covered by vegetation, the shear strength of the materials is greatly reduced (Ebert, 1988).

Due to increased wildfires, the vegetative cover in and around the mountains of the Wasatch Front has been reduced. This has increased the amount of erosion that takes place. When the rain falls on these landscapes, mudslides can occur (Chapman, 1994). The purpose of this part of the PHWS Model is to identify locations that are historic or potential sites for mudslides.

While mudslides are a normal part of nature, there can be catastrophic consequences when people's homes or other structures lie in the way. This was observed in Santaquin and Spring Lake, Utah, in September of 2002, when more than 40 homes were damaged (Canham, 2002).

Mudslides have the potential to negatively affect human health, cause structural damage, and increase medical insurance and health care costs. When mudslides affect residential or commercial areas, people are often injured in the slides. Homes and other structures are damaged by the weight and speed of the moving earth. Power lines can be knocked down, and bridges can collapse under the weight. Because roads are often impassable following a slide, evacuation of the injured is risky and expensive.

Shrink/Swell Soils

Much of the soil in the MAG region is suitable for agricultural and building uses. However, there are a few soil types in the area that contain a high percentage of clay. Clay soils are also known as expansive soils because of their tendency to shrink and swell. Each year, expansive soils cause more than $3 billion worth of damage to structures and roads in the U.S (Bryant, 1991). The process works slowly, so the damage is often not as obvious as that associated with other natural disturbances. Of all the homes built on expansive soils in the study area, 10 percent will undergo significant damage and 60 percent will have minor damage (Bryant, 1991).

The purpose of this part of the PHWS Model is to identify locations in the study area that have high percentages of clay, and therefore classify as expansive soils.

Expansive soils can crack foundations, floors, and walls. Many large buildings do not receive much damage because the weight of the building prevents expansion. The most effective way to prevent damage by expansive soils is to avoid them altogether (Bryant, 1991).

Shallow Ground Water

This part of the model identifies areas of the MAG region that had shallow ground-

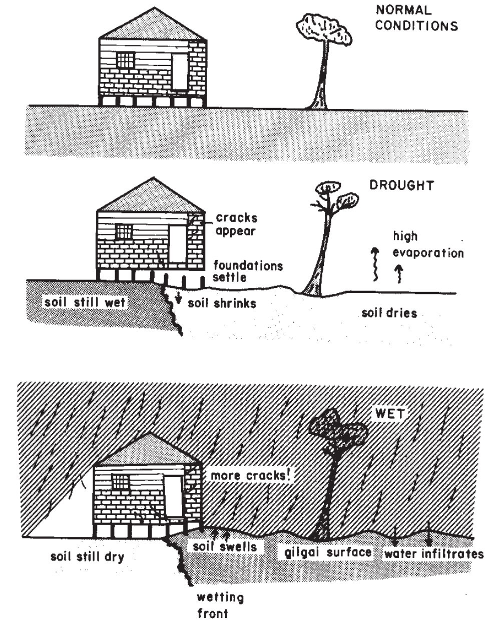


Figure 30: Mechanism of soil expansion/contraction (Bryant, 1991)**.**

water. Groundwater close to the surface is highly susceptible to contamination from point and non-point source pollution. As contaminants leach into the soil, the static charges of soil particles may retain the contaminants. If water, however, is present before all the contaminants can be immobilized by the soil particles, the water can become polluted (Hecker et al., 1988). GIS data describing shallow groundwater in the study area contains two categories: 10 feet below the surface and 30 feet below the surface. In the model, both depths of groundwater were included, with the 10-foot depth being weighted as more risky than the 30-foot depth.

Shallow groundwater can also affect groundwater recharge, water quality and quantity, human health, and structural integrity. Groundwater recharge is the replenishment of an aquifer with water from the land surface (Toth, 2002). Recharge rate is usually defined in terms of acre-feet per year. Often this water comes from rain or snow, but may be present in streams, lakes, irrigation return, inter-aquifer flows, and sewers (Toth, 2002).

If any of the sources of groundwater recharge are contaminated, then there is a high possibility shallow groundwater will also become contaminated. This is especially true when septic systems are present. Water quality is often poor in shallow groundwater areas located near septic systems. Many other potential point pollution sources were established decades ago before their effect on water quality was fully understood, and unfortunately have been grandfathered in areas where current regulations would make them illegal (Toth, 2002). Non-point sources are often more widespread, but when taken collectively can still have damaging effects on water quality. Other sources of contamination include small businesses like dry cleaners, automotive repair shops, and restaurants (Toth, 2002).

Water quantity can also be adversely affected in areas with shallow groundwater. Due to a rapidly increasing population, water is sometimes taken out of underground aquifers more rapidly than recharge can replace it. Sometimes, subsidence can result if water is taken out too quickly. This happens when the vapor pressure in an aquifer is reduced and the land above the aquifer begins to sink–sometimes from a few inches to several feet (Bryant, 1991). These sinkholes can cause damage to infrastructure like roads, commercial buildings, agricultural fields, and homes.

Human health can also be affected by shallow groundwater. Since contamination is more likely in these areas, the potential for humans to ingest polluted water is greatly increased. Dysentery, nausea, or other gastro-intestinal diseases can become widespread in areas where shallow groundwater has become contaminated by surface sources.

Floodplains

The purpose of this portion of the PHWS Model is to identify areas that lie in floodplains and are hence more susceptible to damage from flooding.
According to Wijkman and Timberlake (1988), damage from floods is increasing faster than that caused by any other natural disaster. Predicting when a flood will occur is difficult, but predicting where it will affect people is not as difficult (Turcotte and Haselton, 1996). In 1993, much of the Mississippi River basin experienced just such a flood (Steinberg, 2000). The levees and other structures designed to keep water within channels were unable to prevent the flooding of low-lying fields and towns. Often times, floodplain land is less expensive, so the poor are disproportionately the victims of flooding (Wijkman and Timberlake, 1988). In the MAG region, there are also low-lying areas that are susceptible to

flooding if water levels in lakes and rivers rise beyond their banks. However, unlike the regional flood that affected the Mississippi Valley in 1993, the floods likely to affect the study area are flash floods, resulting from intense precipitation or rapid snow melt (Bryant, 1991).

Just like many other landscape features that can affect the public, floodplains have the potential to threaten human health, damage structures and infrastructure, and increase health care costs. Thousands of people perish each year by drowning or other injuries incurred during flooding, and billions of dollars in property damage. Property insurance and special flood insurance premiums rise when flooding occurs, and since mainly the poor are affected (Steinberg, 2000), this can cause financial difficulty for many families. When people become stranded, special rescue personnel must be called in to save them, which is extremely costly.

High Fire Risk

Decades of fire suppression, coupled with prolonged drought, make many parts of the study area prime candidates for wildfire (Bryant, 1991). As populations increase, areas previously uninhabited become more densely settled. In the study area, the wildland/urban interface is of primary concern since these areas typically have high fuel loads which can ignite and easily burn (Bryant, 1991).

This part of the model locates parts of the study area that have high fire risk based on fuel load, slope, and average annual precipitation. The Utah Department of Forestry, Fire, and State Lands produced these data in 1998. Since these data are five years old, the area indicated as high fire risk may actually be larger today.

Fires can affect water quality, human health, buildings and infrastructure, and health care costs. When fires burn, they can degrade soil quality to the point that it becomes sterile and cannot support vegetation. This can increase erosion and siltation of water courses. Also, ash introduced into riparian systems can degrade water quality and reduce recreation opportunities (Toth et al., 2002).

Particulate matter from fires ingested into respiratory tracts can be dangerous. Small particles can be inhaled and lodge deep within the lungs, where they can remain for long periods of time. The particles may affect human health by their inherent toxicity, interfering with normal physiological processes in the lungs, or carrying toxins from other materials into the body.

Buildings and infrastructure like power lines are extremely susceptible to wildfires. In the summer of 2000, nearly 2,000 fires covering 227,825 acres burned in Utah (Utah Bureau of Land Management, 2003). In almost all of these fires, structures were not involved, but the danger to buildings is still high.

Since the Clean Air Act was passed in 1970, some counties in Utah have had to increase efforts to prevent airborne pollutants. When fires burn, they release volatile organic compounds into the atmosphere. In addition to increases in direct health care costs, reduced visibility along the Wasatch Front could affect the welfare of people living in the area (Toth et al., 2002). Indeed, maintaining aesthetic qualities has been recognized as a positive factor in human perceptions of well being.

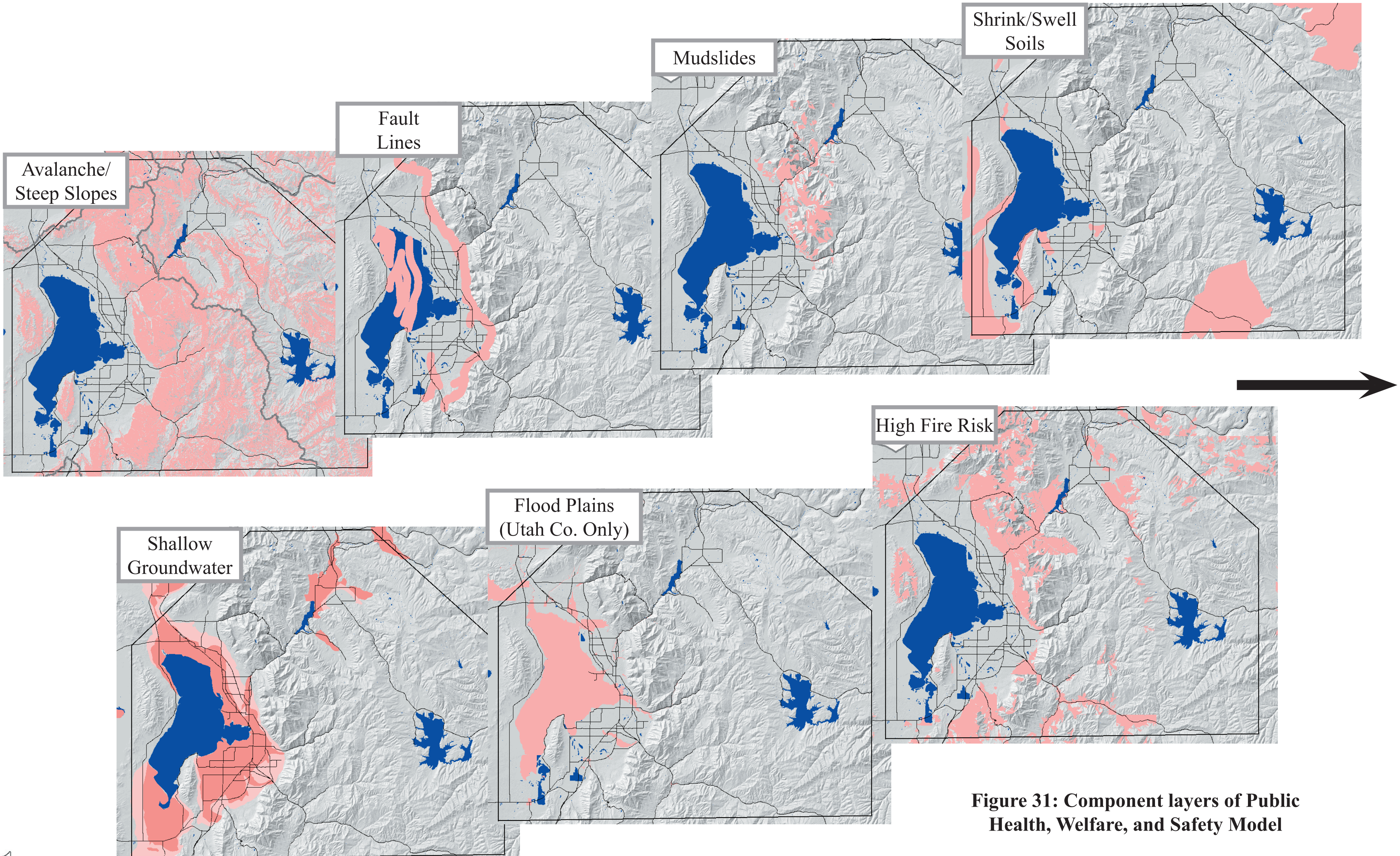


Figure 31: Component layers of Public Health, Welfare, and Safety Model

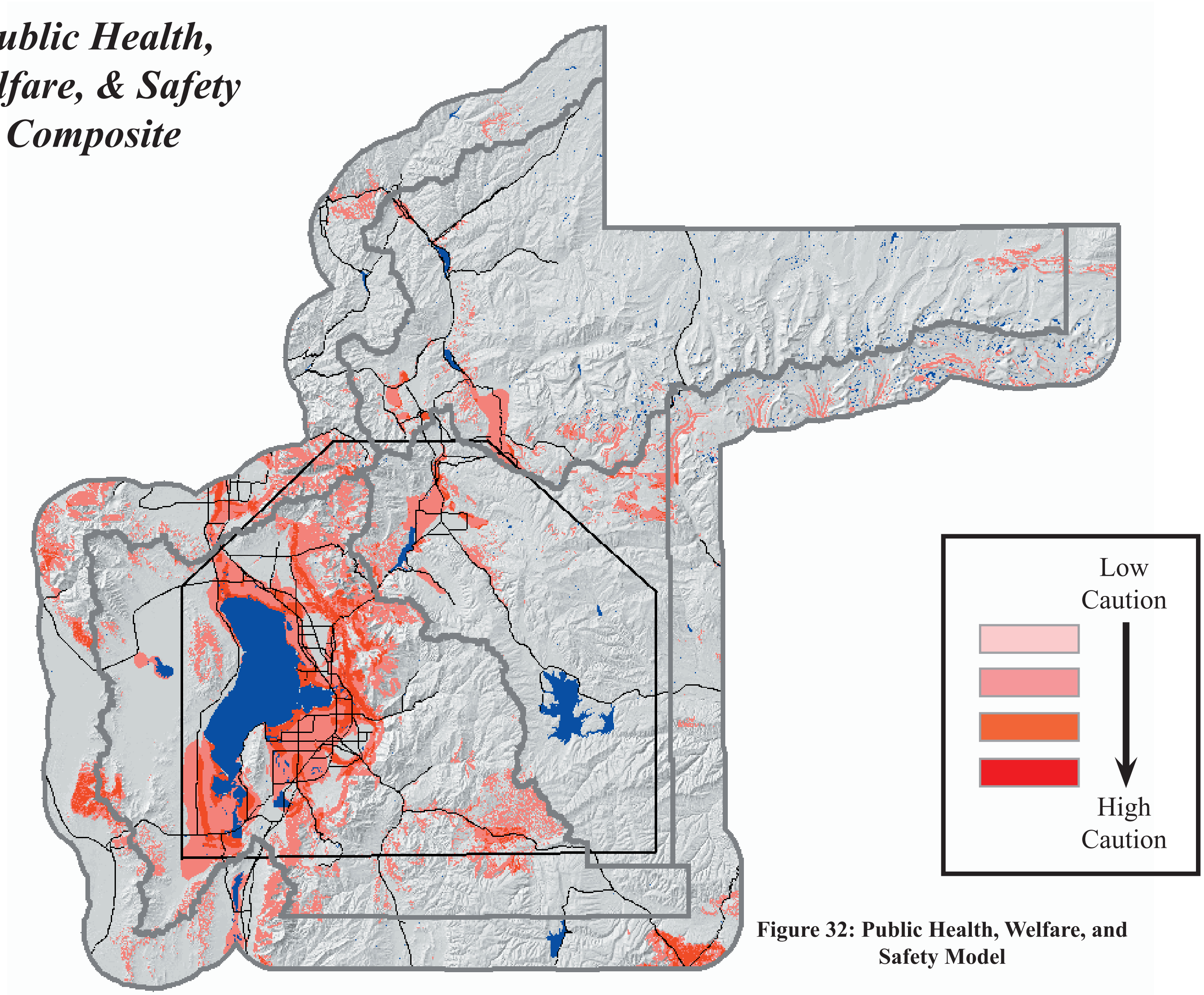


Figure 32: Public Health, Welfare, and Safety Model

PLAN TREND MODEL

According to the Governor's Office of Planning and Budget, Wasatch, Utah, and Summit counties will experience a population increase of 300,000 people by 2030. Among other things, these people will require homes, infrastructure, and jobs.

The Plan Trend Model tries to predict where this future development is likely to occur. It does not recommend where development should occur, or seek to protect areas from being developed.

The model is comprised of elements that are believed to be attractive for development, and excludes areas that are not believed to be attractive.

The following elements are believed to be attractive and are combined to show where development pressure will be greatest.

Proximity to Existing Development

New development tends to occur around areas of existing development. This concept is embodied by urban sprawl. For this reason, a 120-meter buffer was created around all areas of existing development, to illustrate greater development pressure within this buffer.

Proximity to Roads

Development depends greatly on the existence of roads. A 120-meter buffer was created around all major roads to show greater development pressure within the buffer.

Municipal Boundary

The model assumes that areas within a municipal boundary are more desirable than those outside boundaries. This assumption is based on the accessibility of infrastructure, such as water and sewer.

Figure 33: Homes in Deer Valley Photo by K. Wells

EXCLUSION LAYERS

Exclusion layers are layers of information that are subtracted from the model. They consist of elements of the environment that would not be suitable for development.

Slope > 25%

Although building on a slope greater that 25% is possible, design requirements such as cut and fill operations may make it prohibitively expensive. For this reason, all landscapes with slope greater than 25% have been excluded from the model.

Public Land

Building on public lands is restricted, and acquisition of these lands by private developers is expensive or unrealistic. Therefore, areas which are owned by the public, such as National Parks and Forest Service lands, have been excluded.

Water Bodies

The physical bodies of water—but not the areas surrounding them—have been excluded.

Figure 34: Wildland/Urban Fringe Photo by: G.Busch

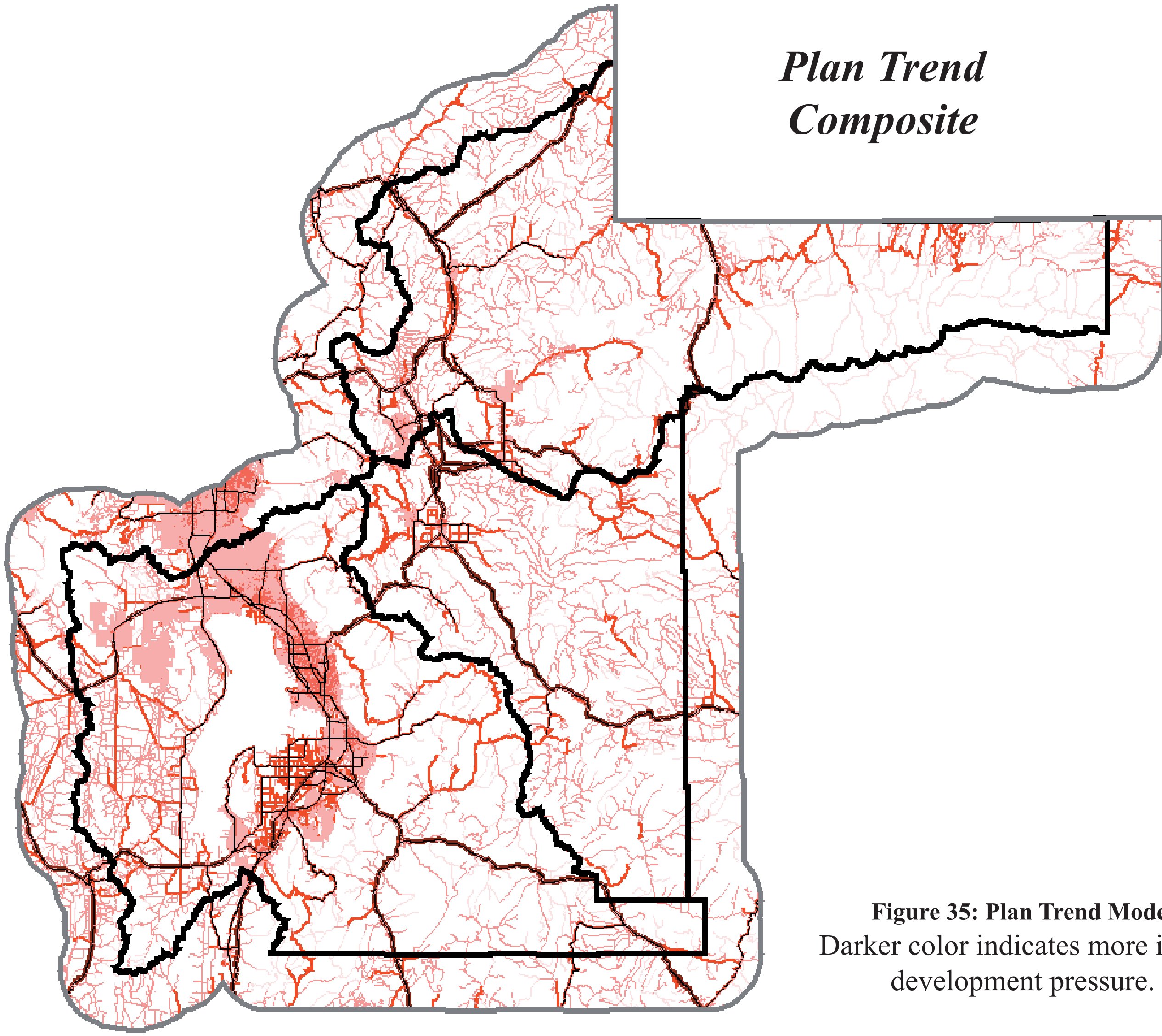


Figure 35: Plan Trend Model
Darker color indicates more intense development pressure.

CONCEPTUAL OPEN SPACE MODEL

This model illustrates where development pressure will occur in relation to maximum conservation and public health, welfare, and safety. It was created by combining the Maximum Conservation and Health, Welfare, and Safety Models, then comparing that model to the Plan Trend. It identifies where different degrees of conservation and development pressure will overlap.

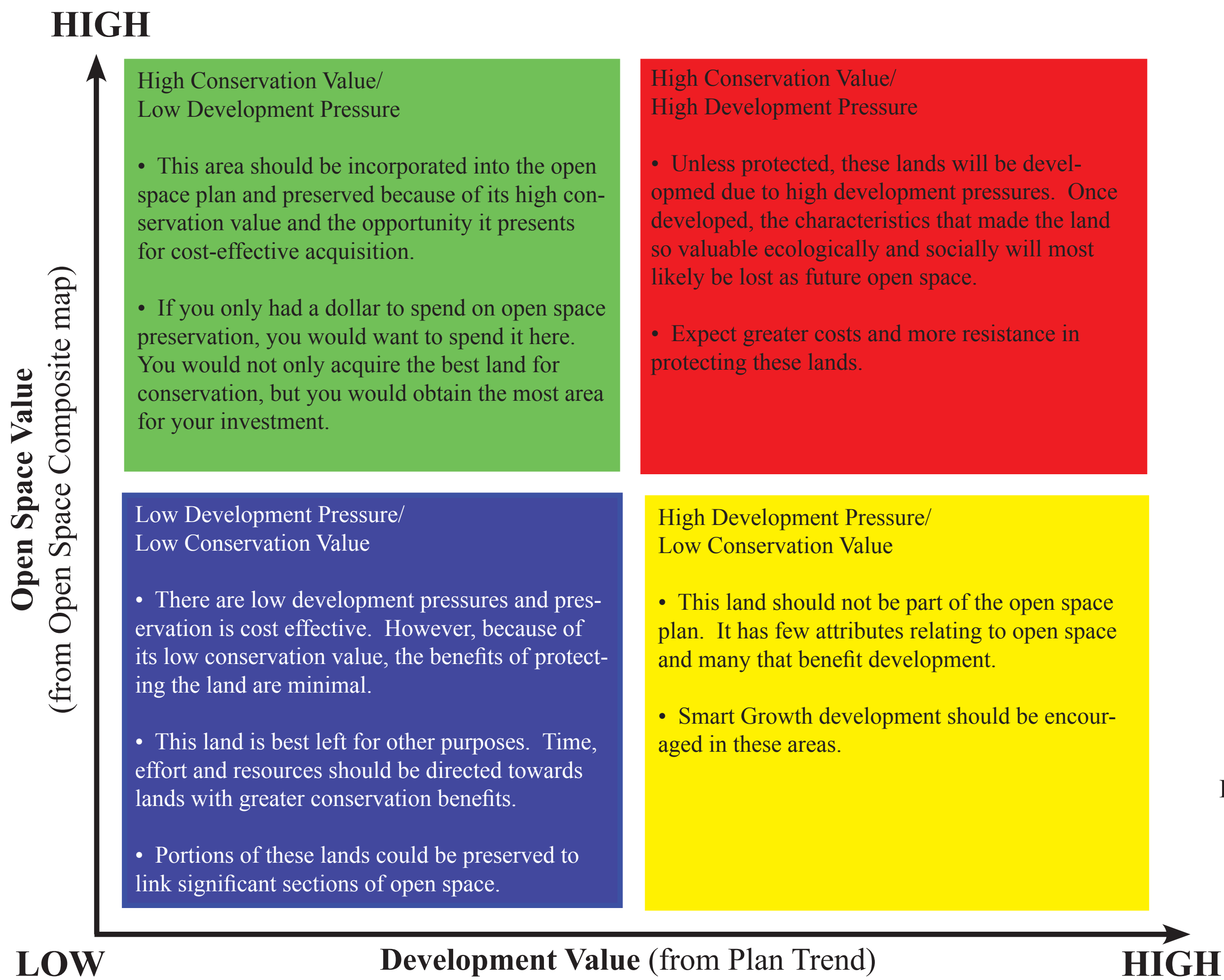
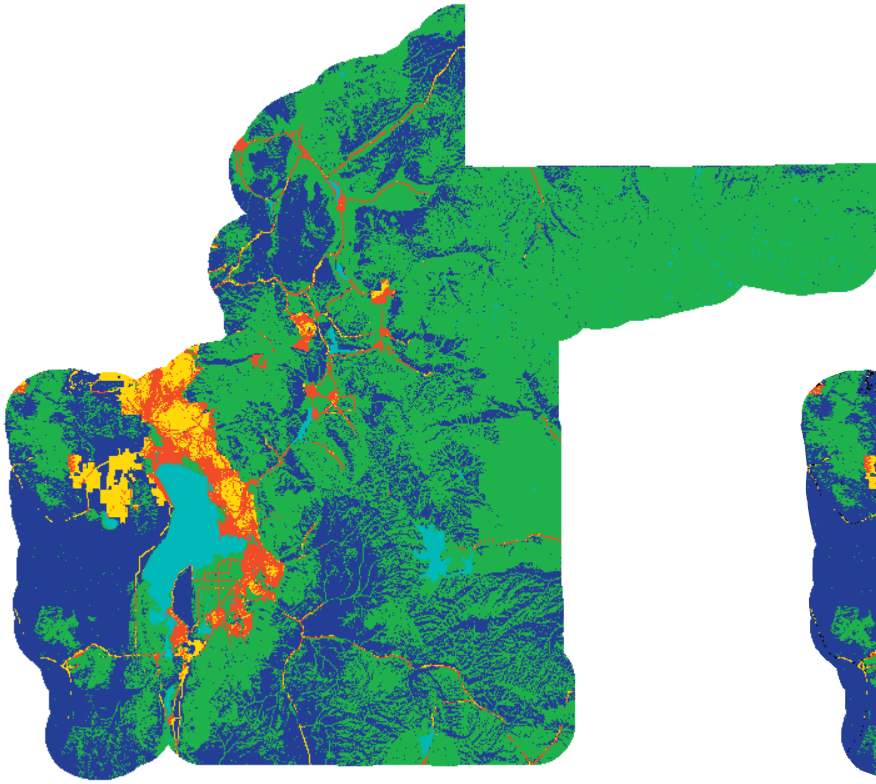
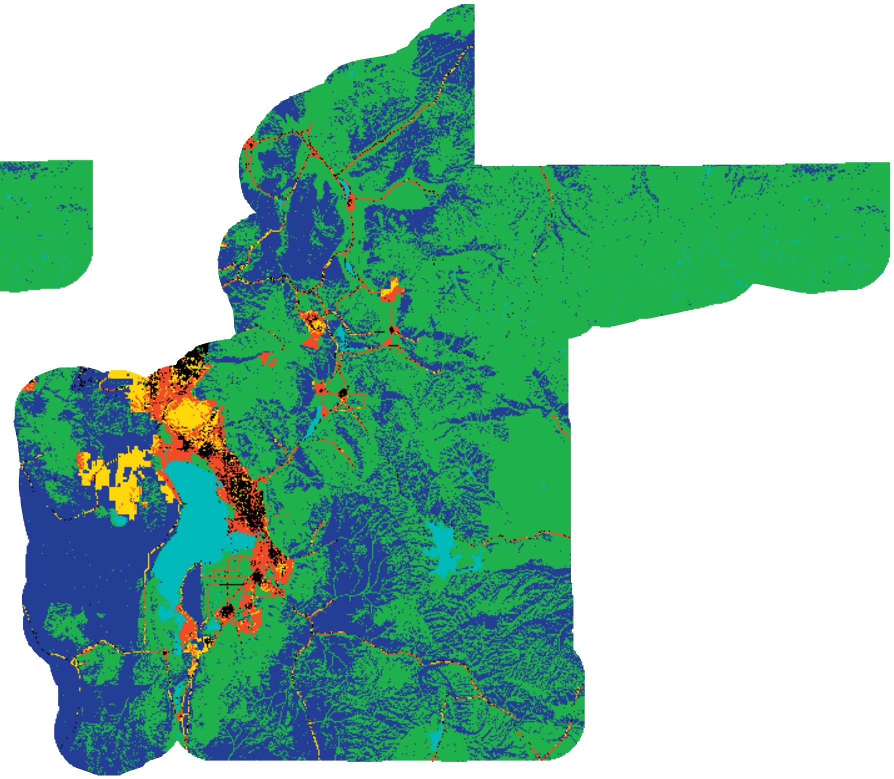


Figure 36: Color guide for Conceptual Open Space Model



Conceptual Open Space



Conceptual Open Space with Current Development in Black

High Conservation Value/ Low Development Pressure	Low Conservation Value/ High Development Pressure
Low Conservation Value/ Low Development Pressure	High Conservation Value/ High Development Pressure

Figure 37: Conceptual Open Space Model

BASE MODELS

The study team developed a number of base models that were not incorporated into the Conceptual Open Space Model. These base models are still useful for planners and stakeholders to examine.

The models provide unique insights into the MAG landscape that are not currently available to decision makers.

Even though these models were not included in the open space modeling, they could be incorporated into those models at a later date.

We believe these models should be utilized for the information and insight they provide about a number of unique landscape features.

Figure 38: Heber Valley, Deer Creek Reservoir - looking Southwest Photo by: G. Busch

COMMERCIAL DEVELOPMENT MODEL

Desirable Land

The Commercial Development Model was designed to recognize areas that would be suitable for the development of residential infrastructure, such as schools and hospitals, as well shopping areas and businesses.

To begin we used state soil data to identify suitable soil, namely mollisol soils, and land with less than 10 degree slope within our study area. Mollisol soils are well suited for development of large structures since they have a desirably low level of clay and sand. While small units of development can exist on steeper slopes, we felt that flatter areas, those having less than 10 degrees of slope, were the best choice for building large structures such as hospitals, schools, and shopping areas.

Next, we identified land within the study area that had herbaceous growth, such as agricultural areas or grasslands. These lands are the least costly to develop because they require less clearing prior to building. Finally, we identified all private lands within the MAG study area. Private lands are the quickest and easiest lands to acquire, with simple deeds and transactions needed to obtain ownership.

Combining these four criteria, we created a “desirable lands” layer. Desirable lands incorporated all four-development criteria.

Our map of desirable locations does not take into account land that may be critical to protected species. It also does not consider wetland areas, developmental infrastructure such as utilities, or roads providing access.

Residential Locations

Most commercial development occurs within close proximity to residential development. Therefore, vacant areas close to residences will be the most valuable.

Figure 39: Mouth of Provo Canyon showing residential development.
Photo by K. Wells

AGRC data was used to identify existing land uses in Utah, and thereby extracted the locations of existing residences in our study area. We determined that the most desirable commercial location would be within 1 mile of a residential location. This is a convenient distance to drive to schools, grocery stores, and other commercial establishments. We created a 1-mile band around residential areas to identify these highly desirable locations.

While a one-mile drive is convenient, we determined that most people would drive 2 miles to a shopping area such as a mall or grocery store. Therefore, we also created a 2-mile band around existing residential areas to identify these lands. Additionally, most residential growth results from the expansion of existing residential locations. Therefore, these 1- and 2-mile bands depict where future residential growth is likely to occur.

Our residential bands do not take into account protected areas, such as public lands or critical wildlife habitat. The bands also do not take into account soil, slope or land ownership.

Development Along Roads

While access to development is restricted to nodes on interstate highways, most other major and large minor roads provide easy access. Additionally, businesses that ship and receive products often desire quick and easy access to main roads.

In order to examine the impact of roads on commercial development, we identified the location of all major roads (class 1 and 2) and large minor roads (class 3) within the study area using AGRC data.

We then created a 1/4-mile (500 meter) band along each side of our selected roads (Figure 4) to identify locations desirable as shopping areas, offices, or convenience stores. We chose this distance because it is attractive for travelers wishing to stop quickly and easily return to their travelling route.

Roadway intersections are prime locations for commercial enterprises due to heavy traffic use. Indeed, intersections often contain restaurants, gas stations, hotels and other such conveniences. Consequently, we used ArcView to identify these points where major roads intersect within the study area.

Incorporation of All Components

By combining all of the factors discussed above, we can identify areas most desirable for different types of commercial and institutional development.

For example, selecting the best location for a school would utilize data from all three models to identify suitable land with ready access within close proximity to residential locations. In contrast, a new convenience store would be best located along a main road near an intersection. In this second example, proximity to residential areas may or may not be important.

Considering Locations for New Municipalities

The MAG region is expected to grow by 300,000 residents over the next 30 years. To accommodate such growth, existing residential areas will expand and new development may be needed. In anticipation of this projection, we considered the possible locations of new towns. These potential locations require enough suitable land to support a town infrastructure, as well as a proximity to a main road which will take residents to an interstate highway, facilitating travel to and from work. The following maps are examples of the availability of commercial land in two of the locations considered for commercial development.

The first, Heber Valley, has a small numnrt of existing residences, shown in red. However, there are adequate roads, shown in bright yellow and orange, to support travel in the event of further growth. The dark green (within the lighter green and lighter orange bands of residential growth) illuminates the availability of suitable land for commercial development and residential infrastructure.

The second example, located north of Utah Lake, shows an area with a large amount of existing residential development. Additionally, there are numerous road intersections within the residential growth bands that would attract convenience stores as well as shopping centers. A large amount of suitable land is available for development within the bands surrounding existing residential areas.

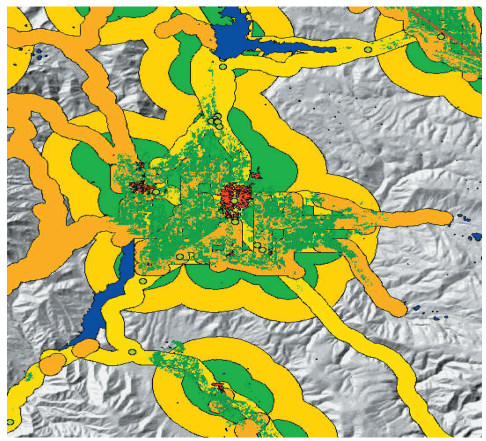


Figure 40: Heber Valley: Overlapping criteria with existing residences in red

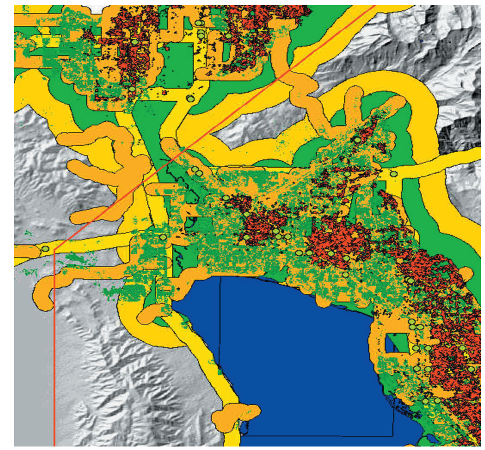


Figure 41: Northern Utah Lake: Overlapping criteria with existing residences in red

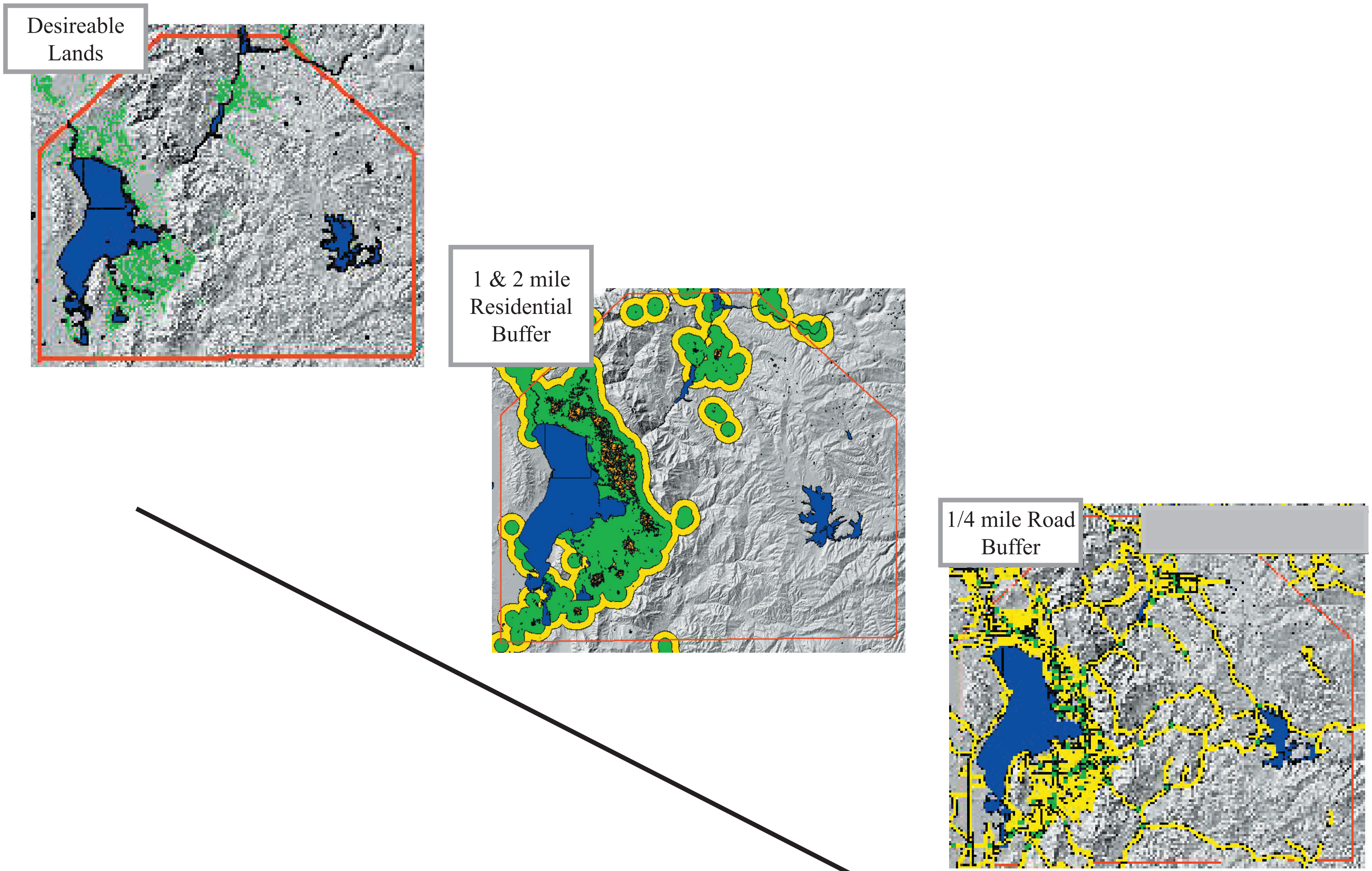


Figure 42: Components of Commercial Development Model

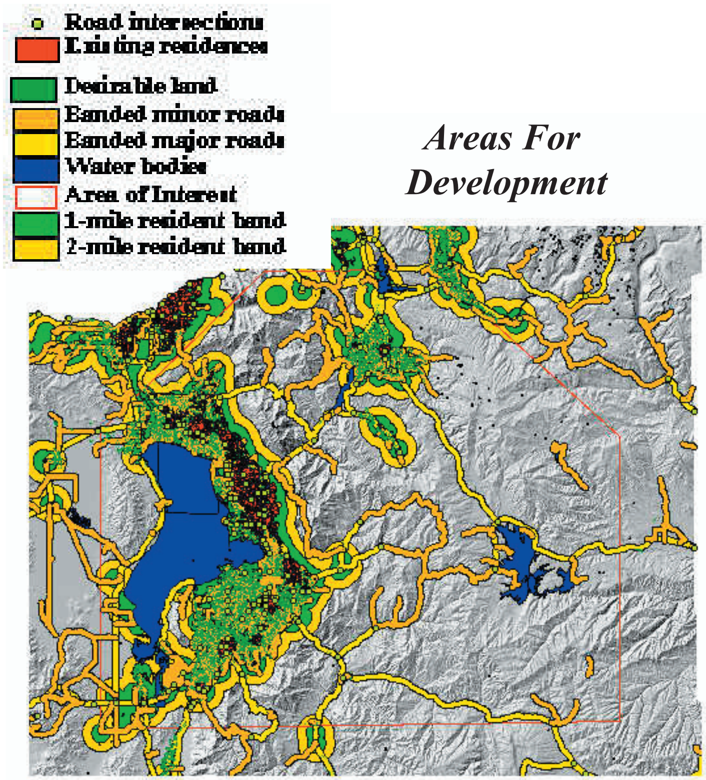


Figure 43: Areas for Development

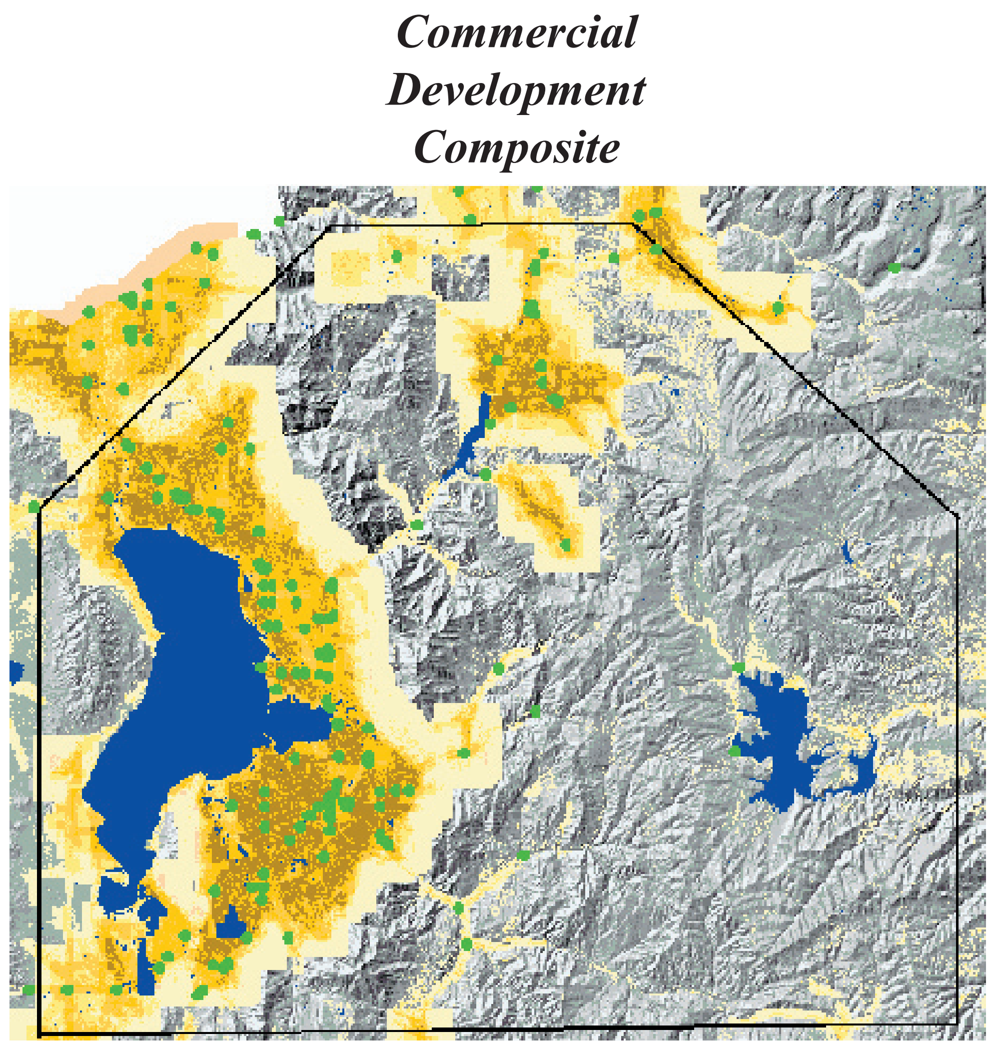


Figure 44: Commercial Development Composite Model - darker color indicates land more suitable for commercial development

VISUAL QUALITY MODEL

The MAG region contains some of the most scenic areas in Utah. Visual quality is an important and highly valued aspect of living in this region. Visual quality is also one of the most threatened resources due to uncontrolled development. By using Geographical Information System (GIS) programs to visually and statistically analyze the MAG region, we can better understand how future development will affect visual quality.

The process used to analyze visual quality for the MAG region involved locating visually-sensitive points of interest. These points of interest were identified along road corridors and other important locations. Another set of visually sensitive points are located on major water bodies since land visible from important water bodies could be areas where planners might want to favor unobtrusive development. Once delineated, the two sets of points were entered into the GIS database.

Figure 45: Mt. Timpanogos reflected in Deer Creek Reservoir Photo By: C. Wood

The next step involved making a visual viewshed model (areas visible from the points of interest). A digital elevation model of the area (similar to a topographic map, but in digital form sectioned in 30-meter increments) was used to provide topographical elevation data. The GIS software was used to scan 180 degrees around each land and water point of interest, creating the following elevation-based visual quality models.

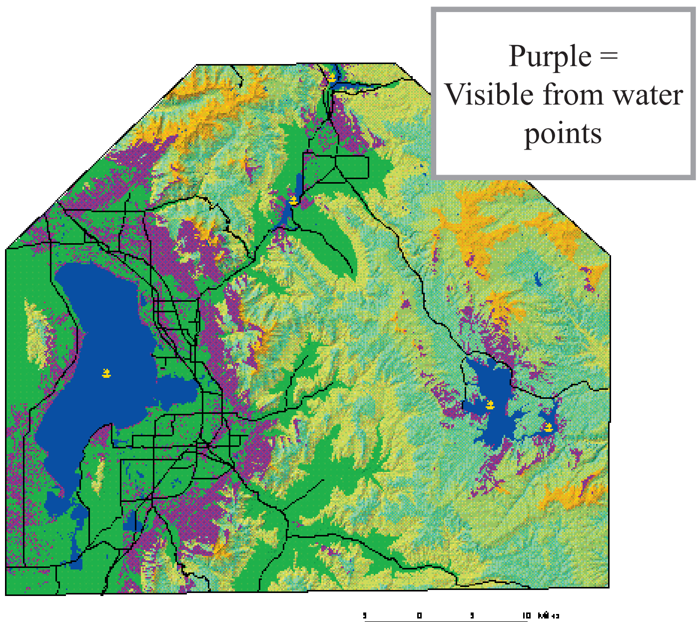


Figure 46: Area visible from water points

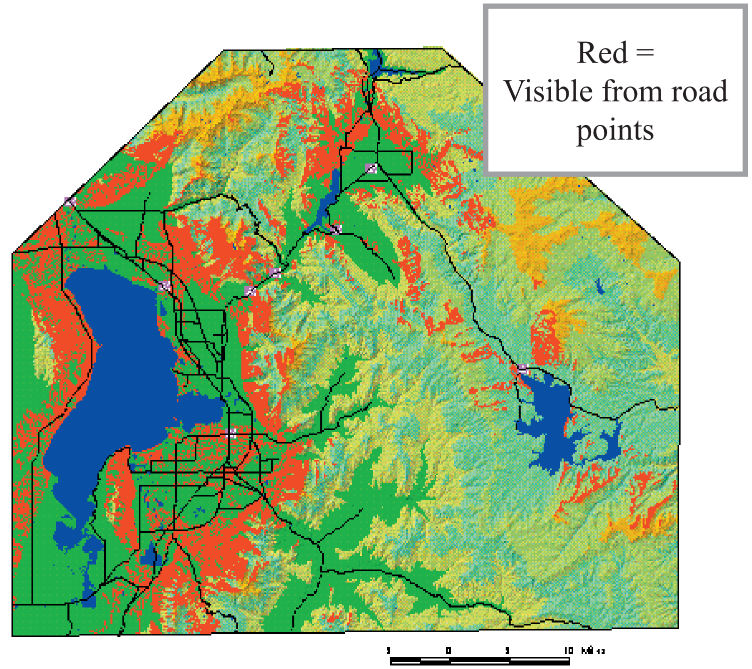


Figure 47: Area visible from road points

Viewshed Composite

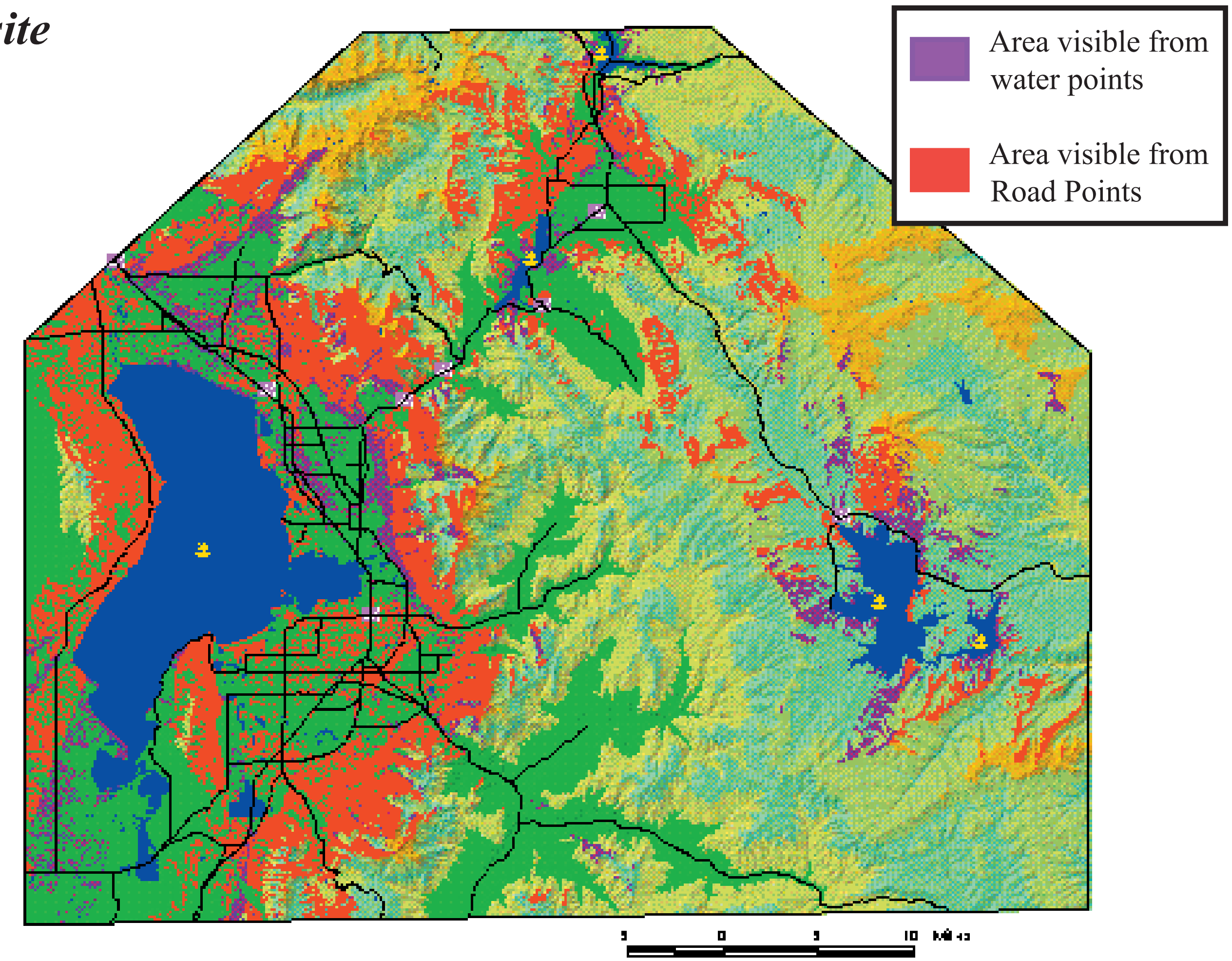


Figure 48: Visual Quality Model, Viewshed Composite

RECREATION ACCESS MODEL

As growth continues along the Wasatch Front, specifically within Summit, Wasatch and Utah counties, recreation access to public lands will become more important. Each municipality and county will need to carefully review new development adjacent to public lands to insure future public access for all citizens. Once new development is in place it will be almost impossible to retrofit public access through private lots or developments.

The Recreation Access Model is comprised of each municipality within the MAG jurisdiction and a 5-mile buffer around each municipality. The buffer represents an easy walk or ride to public lands, as well as areas of likely future annexation. Areas where the buffer and public lands overlap are defined as possible future access areas. Existing trailheads have also been identified to help assess future trailhead needs in response to possible future access areas. Planning for these areas should be conducted by the appropriate county or municipality to ensure future public access to public lands.

Figure 49: Jordanelle Reservoir Photo by K. Wells

WATER RECREATION MODEL

Trails are and will continue to be an important aspect of living in Utah. Citizens utilize trails for walking, hiking and biking. Waterways seem to naturally create trail corridors. They provide aesthetic value by supplying wildlife habitat, vegetation and natural cooling affect. With growth and development on the rise, municipalities and counties will need to plan accordingly.

The Water Recreation Model is comprised of each municipality within MAG jurisdiction and a 5-mile buffer around each municipality. The buffer represents an easy walk or ride along waterways and likely future annexation of lands adjacent to public lands. Rivers, water bodies, and canals that intercept these buffers are highlighted in red.

Existing trailheads have also been identified to help assess future trailhead needs in relation to waterways. Planning for these areas should be conducted by the appropriate county or municipality to ensure future access to trails for all citizens.

Recreation Access

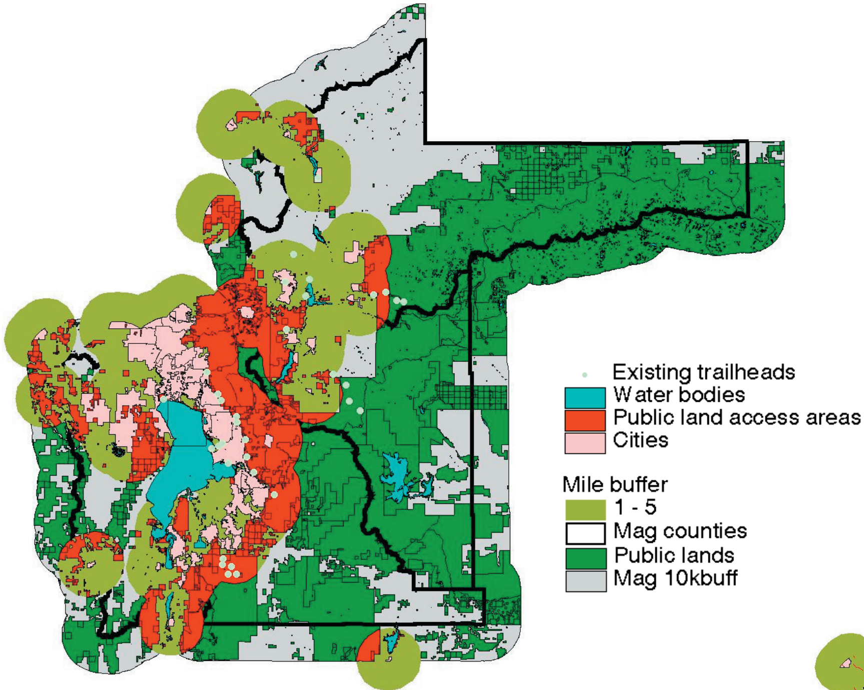


Figure 50: Recreation Access Model

Water Recreation

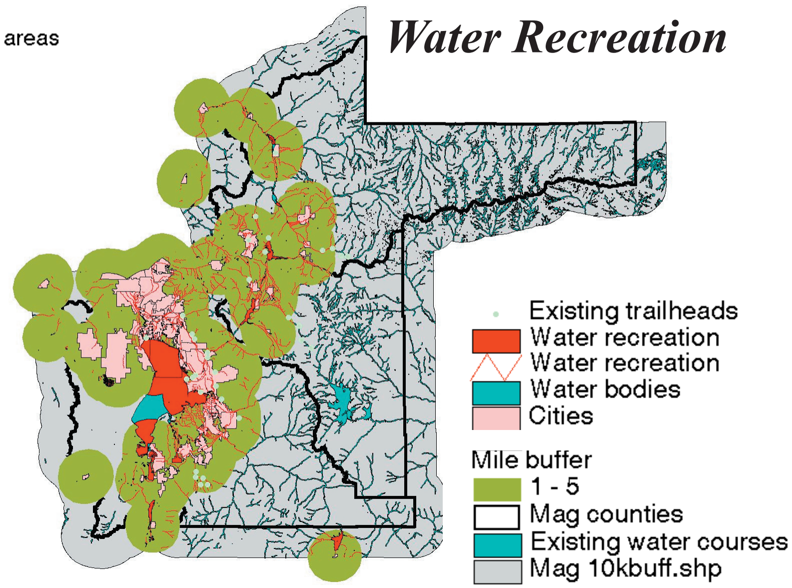


Figure 51: Water Recreation Mode

POPULATION TREND

ArcView was initially used to calculate the available developable land within each MAG municipality. Individual layers of water, public land, industrial land, commercial land, and currently developed land were subtracted from the original available land mass within the borders. This remaining area was converted into acres and used within Excel spreadsheets to compare available land with predicted population growth. Since municipalities are able to expand their borders through annexation, the following models were constructed to "raise a flag" to the large influx of likely new residents to the region.

Average household size data were supplied by the Utah Governor's web site (Governor's Office of Planning and Budget, 2003), and the predicted municipality populations were supplied by MAG.

The first spreadsheet model (shown to the right) calculates the acreage required for each municipality under various "housing mixes" required to house the predicted populations for the years 2010, 2020, and

Average Household Size

	2010	2020	2030
Summit:	2.66	2.55	2.47
Utah:	3.48	3.37	3.24
Wasatch:	2.94	2.81	2.69

Housing Mix Scenario

Housing Mix (H/M/L density):

High Density:	**0.25** acres/house	50/30/20	47.5 acres/100 houses required
Medium Density:	**0.50** acres/house	60/30/10	40 acres/100 houses required
Low Density:	**1.00** acres/house	80/15/05	32.5 acres/100 houses required
New Commercial Dvlpmt:	**15%**		

Municipality	2000 Census	2010	Scenario	2020	Scenario	2030	Scenario	Remaining Acreage
	Summit County:							
Coalville	1,382	1,807	50/30/20	2,519	50/30/20	3,236	50/30/20	1,023
Francis	698	1,119	50/30/20	1,560	50/30/20	2,004	50/30/20	881
Henefer	684	860	50/30/20	1,164	50/30/20	1,451	50/30/20	351
Kamas	1,274	1,952	50/30/20	2,641	50/30/20	3,294	50/30/20	162
Oakley	945	1,465	50/30/20	2,059	50/30/20	2,668	50/30/20	3,521
Park City	7,371	9,124	50/30/20	12,712	50/30/20	16,312	50/30/20	2,267
	12,354	**16,327**		**22,655**		**28,965**		**8,203**
	Utah County:							
Alpine	7,146	9,874	50/30/20	11,752	50/30/20	15,675	50/30/20	2,249
American Fork	21,941	27,787	50/30/20	32,573	50/30/20	35,583	60/30/10	142
Cedar Fort	341	500	50/30/20	632	50/30/20	738	50/30/20	7,778
Cedar Hills	3,094	6,807	50/30/20	9,663	50/30/20	10,133	60/30/10	153
Draper	0	4,758	50/30/20	7,833	50/30/20	10,448	50/30/20	2,239
Eagle Mountain	2,157	9,758	50/30/20	16,756	50/30/20	22,770	50/30/20	17,788
Elk Ridge	1,838	3,093	50/30/20	4,391	50/30/20	5,024	50/30/20	837
Genola	965	1,565	50/30/20	2,392	50/30/20	4,744	50/30/20	5,114
Goshen	874	1,250	50/30/20	1,682	50/30/20	1,970	50/30/20	113
Highland	8,172	14,940	50/30/20	20,120	50/30/20	23,564	50/30/20	975
Lehi	19,028	31,302	50/30/20	44,437	50/30/20	48,975	50/30/20	5,861
Lindon	8,363	10,711	50/30/20	11,918	50/30/20	13,020	50/30/20	2,051
Mapleton	5,809	9,403	50/30/20	14,928	50/30/20	20,990	50/30/20	2,042
Orem	84,324	96,039	50/30/20	100,020	50/30/20	103,000	60/30/10	449
Payson	12,716	20,606	50/30/20	27,750	50/30/20	30,583	60/30/10	312
Pleasant Grove	23,468	27,334	50/30/20	30,415	50/30/20	33,226	50/30/20	1,413
Provo	105,166	118,607	50/30/20	130,814	50/30/20	134,687	50/30/20	2,012
Salem	4,372	7,351	50/30/20	12,101	50/30/20	17,016	50/30/20	1,811
Santaquin	4,834	9,822	50/30/20	16,865	50/30/20	24,263	60/30/10	250
Saratoga Springs	1,003	8,993	50/30/20	18,005	50/30/20	23,450	50/30/20	5,558
Spanish Fork	20,246	27,693	50/30/20	32,745	50/30/20	35,771	50/30/20	3,540
Springville	20,424	28,866	50/30/20	34,132	50/30/20	37,286	50/30/20	1,471
Vineyard	150	968	50/30/20	4,056	50/30/20	5,703	50/30/20	835
Woodland Hills	941	1,891	50/30/20	3,247	50/30/20	4,014	50/30/20	998
	357,372	**479,918**		**589,227**		**662,633**		**65,989**
	Wasatch County:							
Charleston	501	871	50/30/20	1,354	50/30/20	2,106	50/30/20	456
Heber City	6,232	8,552	50/30/20	10,496	50/30/20	12,880	80/15/05	115
Midway	2,548	3,681	50/30/20	4,755	50/30/20	6,143	50/30/20	1,077
Park City	24	42	50/30/20	66	50/30/20	103	50/30/20	4
Wallsburg	362	524	50/30/20	676	50/30/20	874	50/30/20	141
	9,667	**13,670**		**17,347**		**22,106**		**1,793**

Figure 52: Housing Mix

2030. The population differences were calculated using the 2000 Census as a baseline. Then, using the average household size and the least dense housing mix such as a 50/30/20 (being 50% high density, 30% medium density, and 20% low density), the remaining land available was calculated. If this was determined to be a deficit, the next housing mix of 60/30/10 was calculated, and so on. As can be seen, the community of Heber City would require an 80/15/05 housing mix to be able to house all of its expected growth in the year 2030. Other communities, such as American Fork, Cedar Hills, Orem, Payson, and Santaquin, would require a 60/30/10 housing mix to meet their expected growth by 2030.

The model assumes that a high density residential housing mix would consist of one ¼-acre lot per family. A medium density would be ½-acre, while a low density would be 1-acre. A percentage of new commercial development was also factored into the equations. All of these factors can be altered by the user.

A second model (shown below) was run, using demographic data on six communities received from MAG. Available acreage was obtained through the USU GIS system and MAG. This model shows that the community of Highland will run out of available land by the year 2010 if the current land uses continue. Kamas, Lehi, Orem, and Midway will encounter spatial constraints by 2020, and Heber City may encounter spatial constraints by

Current Housing Trend

Municipality	Persons per Res. Acre	Percent Comm. Acres	2000 Census	2010	Acres Required	(GIS)	(MAG)	2020	Acres Required	(GIS)	(MAG)	2030	Acres Required	(GIS)	(MAG)
			Summit County:												
Kamas	2.03	38.00%	1,274	1,952	460.9	OK	OK	2,641	929.3	over	over	3,294	1373.2	over	over
			1,274	**1,952**				**2,641**				**3,294**			
			Utah County:												
Highland	1.90	11.48%	8,172	14,940	3971.0	over	over	20,120	8122.3	over	over	23,564	10463.5	over	over
Lehi	2.84	50.98%	19,028	31,302	6525.1	OK	OK	44,437	17273.1	over	over	48,975	20358.1	over	over
Orem	9.99	26.88%	84,324	96,039	1487.9	OK	OK	100,020	10670.2	over	over	103,000	12696.0	over	over
			111,524	**142,281**				**164,577**				**175,539**			
			Wasatch County:												
Heber City	4.63	36.94%	6,232	8,552	686.2	OK	OK	10,496	2898.7	over	over	12,880	4519.3	over	over
Midway	0.68	3.25%	2,548	3,681	1720.3	OK	OK	4,755	1500.3	OK	OK	6,143	2443.9	over	OK
			2,548	**3,681**				**4,755**				**6,143**			

Figure 53: Housing Trend

2030. Again, this assumes that the current density trends continue.

In sum, these models are intended to alert community planners and developers to the fact that current density trends must be considered if open space is to be conserved. Many options exist, one being the implementation of Urban Growth Boundaries (UGBs).

Portland, Oregon, has become a recent model for the use of UGBs. The goal is to determine an outer-most boundary to the municipality and encourage in-fill within that boundary. "Need factors" must first be determined by planners, which deal with the question of how much land should be brought into the UGB. Then "locational factors" must be established as to where the boundary should be placed.

The county and city must work together in establishing the UGB since this additional area, which typically encircles the city, is usually under county jurisdiction. Coordinated planning and zoning through "urban growth management agreements" help to lay out the rules and regulations as to how this venture is to be managed.

In order to make higher density living more attractive, planning should incorporate transit and landscape layout design. As was done in Portland, public transit can be designed to reduce car dependence, thereby opening more space for open plazas, parks, and other areas where people can congregate. Easy bicycle access is provided on the city's trains, and 85% of new development must be within a five-minute walk of a transit stop.

Mixed use zoning allows people to live closer to their work, schools, shopping, or cultural life. In comparison, Cleveland, Ohio, has followed a more traditional route and has sprawled into the surrounding countryside. Between 1970 and 1990, Cleveland's land use expanded by 33%, even though its population decreased by 11%. During the same period, Portland remained fixed in size even though its population increased by 50% (Ayers, 1999).

NEW COMMUNITIES MODEL

Rapid population growth along the Wasatch Front—especially in Utah County—forces many problems to the forefront. Two of these problems which can become opportunities are transportation and housing. The status quo with housing development centers around single family housing at a density of 1/3- to 1/2-acre. Transportation planning for this density is forced to accommodate the automobile because of the large land mass required for development. In response, planners must look to new ideas for development. With opportunities for new concepts in mind, two future growth models were created to identify areas for new communities and transportation options for these and existing municipalities.

New Communities

Past efforts in community development provide useful concepts for today's changing landscape. Three ideas examined here include high density development, mixed-use development, and multi-modal transportation options. In detailing these concepts and examples, the communities of Radburn, NJ, and Kentlands, MD will be highlighted.

Alternatives

Three alternative development scenarios are presented for the study area:

1. A compact community of 5,000 people within the existing urban fabric based on walkable community concepts and in proximity to mass transit options. This development can be replicated in several situations to accommodate growing populations.

2. A larger city with approximately 40,000 residents that is self sufficient in education, employment, and recreational offerings.

3. A recreational community catering to weekend escapes and acting as a tourist destination. This scenario is intended to control second home sprawl on sensitive lands in Utah's scenic backcountry.

Alternative 1. The lure of this alternative is walk-ability based on high density development and New Urbanist principles. These principles center around such design considerations as: street grids which offer more path options instead of cul-de-sacs; narrow street widths with minimal housing setbacks; mixed use neighborhoods with apartments, single family, commercial, and public open spaces; and transit options within easy walking distance. Radburn, NJ exemlifies the size of this alternative type. It has a few differences from the New Urbanists idea, but is a walkable community of 5,000 residents encompasing 150 acres. The success of this development depends upon the organization of pedestrian walkways to connect common destinations, and public open space within higher density development.

Alternative 2. Lands to the east of the Wasatch Front provide many opportunities for siting new communities. The success of this development concept will lie in the technological capacities offered in the infrastructure.

The new community would cater to white collar businesses such as sales and service, and would accommodate residents who work from home via fiber optics.

Amenities include a reservoir for water sports and fishing, access to a major ski resort, backcountry hiking, a sense of seclusion, and proximity to Provo—a 20-minute drive. All of this would be offered within easy reach while living in a high-density development.

Alternative 3. The third option provides an alternative to extensive second home development on visually sensitive areas such as ridge tops and the shorelines of lakes, reservoirs and streams. The first step in constructing this alternative was to identify prime recreational areas, whether they are developed or not. Once these sites are identified, new community principles can be used to create small hamlets of clustered housing. Care will have to be taken to preserve the feeling of seclusion while ensuring views from individual homes. This alternative can also offer tourist hamlets while still preserving the seclusion and ruggedness of the backcountry.

New Community Details

The New Community Model identifies areas for further study by flagging potential developments within a 5-mile radius of a central node. Within the circle exist opportunities to implement one or more of the alternatives described above. These sites were selected based on quality-of-life issues and open space preservation. This model is an extension of the transportation model. The following describes the criteria used in the model.

Model Criteria

Light Rail Extension. This criterion considers a site's suitability for commercial development based on proximity to an existing or future light rail proposal. The transportation model identifies nodes for future east/west expansion routes based on planned commuter rail.

Existing Rail Bed. This criterion identifies areas with existing rail beds and right-of-ways that could be acquired for light rail expansion.

Public Land. This criterion was established to identify areas where developments could abut public lands to provide recreational opportunities close to home.

Existing Infrastructure. The existence of major roads and multi-modal transit options reduces capital expenditures needed for new development. This falls under the category of infill.

Slope and Soil. Topographic slope and soil characteristics suitable for development were identified. New communities will take advantage of this and target these areas for development.

Recreational Opportunities. New communities should be sited in areas with a high proportion of open space and recreational choices. The proximity to open space will reduce automobile trips to recreate.

Health, Welfare and Safety. This criterion seems self-explanatory but is often ignored. New community sites should be minimally affected by flooding, earthquakes, etc.

Visibility. This criterion primarily affects areas in the backcountry. To preserve the feeling of wilderness, sites that cannot be seen from various viewpoints have been identified for hamlets and villages.

Multi-Modal Options. This criterion is important in preserving open space and easing automobile dependence. Options include: bus, train, biking, walking, and ferry transport. Areas with high concentrations of these options will be favorable for new development, as well as infill projects. The matrix identifies new community sites and ranks them based on the criteria described. The total scores depict areas of higher suitability for development. Scores can be changed based on criteria set forth by governing bodies. Scores here are for example and based on the group's direction.

	Light Rail Extension	Rail Bed Exists	Public Land	Major Roads	Recreational Opportunities	Safety and Welfare	Sight	Slope and Soil	Multi Modal Options	Total
Lehi/Saratoga Springs	6	6	5	6	3	3	3	5	6	43
Santaquin/ Goshen	6	6	4	6	4	3	3	6	6	44
Kamas/ Jordanellle	3	3	5	4	6	6	4	6	2	39
Wallsburg/ Deer Creek	2	2	6	3	5	4	6	5	2	35
Strawberry Reservoir	0	0	6	3	4	6	5	5	0	29
Soldier Summit	1	6	4	6	5	5	4	6	0	37

Figure 54: Matrix for prioritizing new community locations. The higher the value the better the site.

Radburn, N.J. Vs. Kentlands, M.D.

Area
Radburn: 149 acres
Kentlands: 356 acres

Population density
Radburn: 19 persons/acre
Kentlands: 14 persons/acre

Population at Build-out
Radburn: 2900 persons
Kentlands: 5000 persons

Dwelling units
Radburn: 674 du
Kentlands: 1600 du

Dwelling unit density
Radburn: 4.52 du/acre
Kentlands: 4.49 du/acre

Open space percentage:
Radburn: 16% or 23 acres
Kentlands: 28% or 100 acres
(Lee et al., 2003)

The above descriptions of Radburn and Kentlands can be used as design guideline starting points. Both of these developments have been successful in their own right. The success comes from the walkability of the communities and the sense of community created. A drawback to both is the lack of sufficient employment. Both have become bedroom communities. Another detail to consider is the market for these developments. As a result, special care will be needed in creating these communities.

Conclusions

In order to preserve open space along the Wasatch Front, new concepts in home development will have to be considered. Higher densities, fiber optic connected communities, and recreation hamlets are proposals that can achieve open space preservation. The New Communities Model identifies areas that can be further analyzed based on specific criteria set forth by county governing bodies. In selecting sites from the New Communities Model, it will be beneficial to select existing continuous sites and set aside land for new development. Once the land is acquired, weights will have to be given to the importance of various features associated with development alternatives. To determine weighting systems, public opinion surveys and the availability of suitable housing will need to be researched.

Example

As an example, consider the area around Lehi and Saratoga Springs. In the matrix scoring it ranked favorably for primary development. The new communities map, however, identifies a large area with many options for development. For example, should the community emphasize proximity to light rail extensions and a ferry system to carry people to Provo and Orem, or should new development occur next to public land and recreation opportunities? How the community weighs the criteria is essential to the identification of lands for development. The New Communities Model provides a starting point for such discussions.

New Communities Model

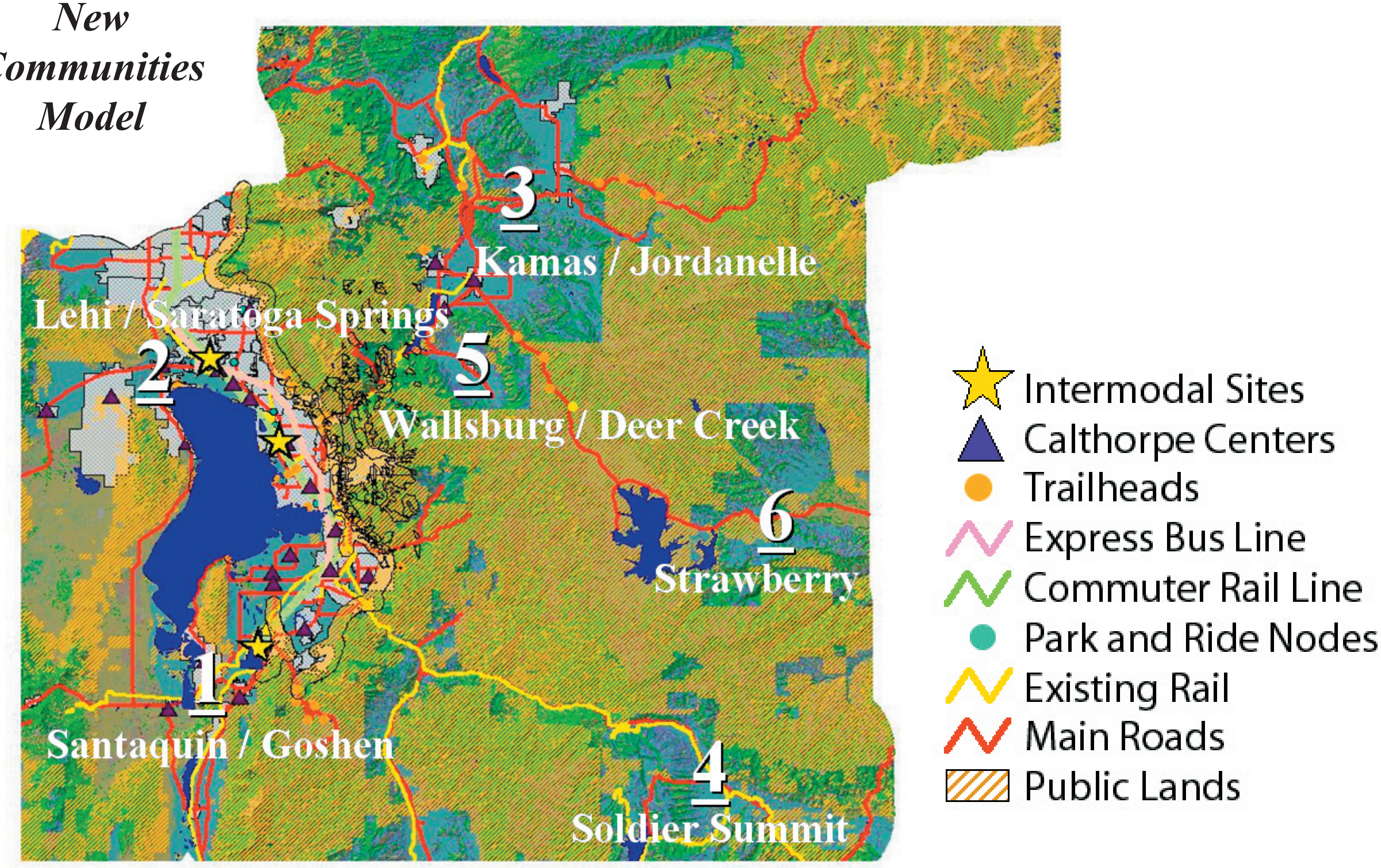


Figure 55: New Communities Model

TRANSPORTATION PLANNING MODEL

This model assesses the viability of east/west light rail expansion lines. Indeed, the planned future construction of a commuter rail line from Brigham City to Payson provides an excellent opportunity for east/west expansion in order to serve a greater portion of the population. These expansion lines will serve high-density nodes and reduce commute time and daily automobile trips. Nodes should be sited to allow development clusters nearby. This suggests a need for open land suitable for development and not slated for conservation. For areas already developed, a multi-modal system similar to the one recently developed in Ogden should be considered. With such a system in place, commuters could have a five-minute drive to the station, a short light rail ride to the commuter rail, and then a quick ride to Salt Lake or elsewhere. This method includes only two changes to get to downtown, and could greatly reduce automobile traffic.

Transportation Model

The Transportation Model primarily identifies transit for future transit-oriented developments—especially light rail extensions. The nodes were identified using criteria based on existing methods of mass transit. These were chosen assuming that nodes would become multi-modal stations with new community clusters nearby.
The criteria chosen for analysis were:

1. existing rail lines
2. major road intersections
3. recreational trailheads
4. express bus routes
5. park and ride lots
6. proposed commuter rail lines
7. potential developments proposed by Envision Utah (Calthorpe, 2002)

The Transportation Model identifies locations where a majority of the criteria were in proximity to each other. A 2-½ mile radius was located around the nodes. The diameter was based on Governor Leavitt's desire to see development occur where everyone can be within a 15-minute drive of a trailhead. The model takes this into account, and areas within the circle are within a short drive or, ideally, a short walk of a transit option, which was substituted for a trailhead. From this point, further criteria were added and the New Communities Model was created. The New Communities Model is based on the nodes identified in this model, but adds additional criteria to identify new areas for development.

Light/Heavy Rail Planning Model

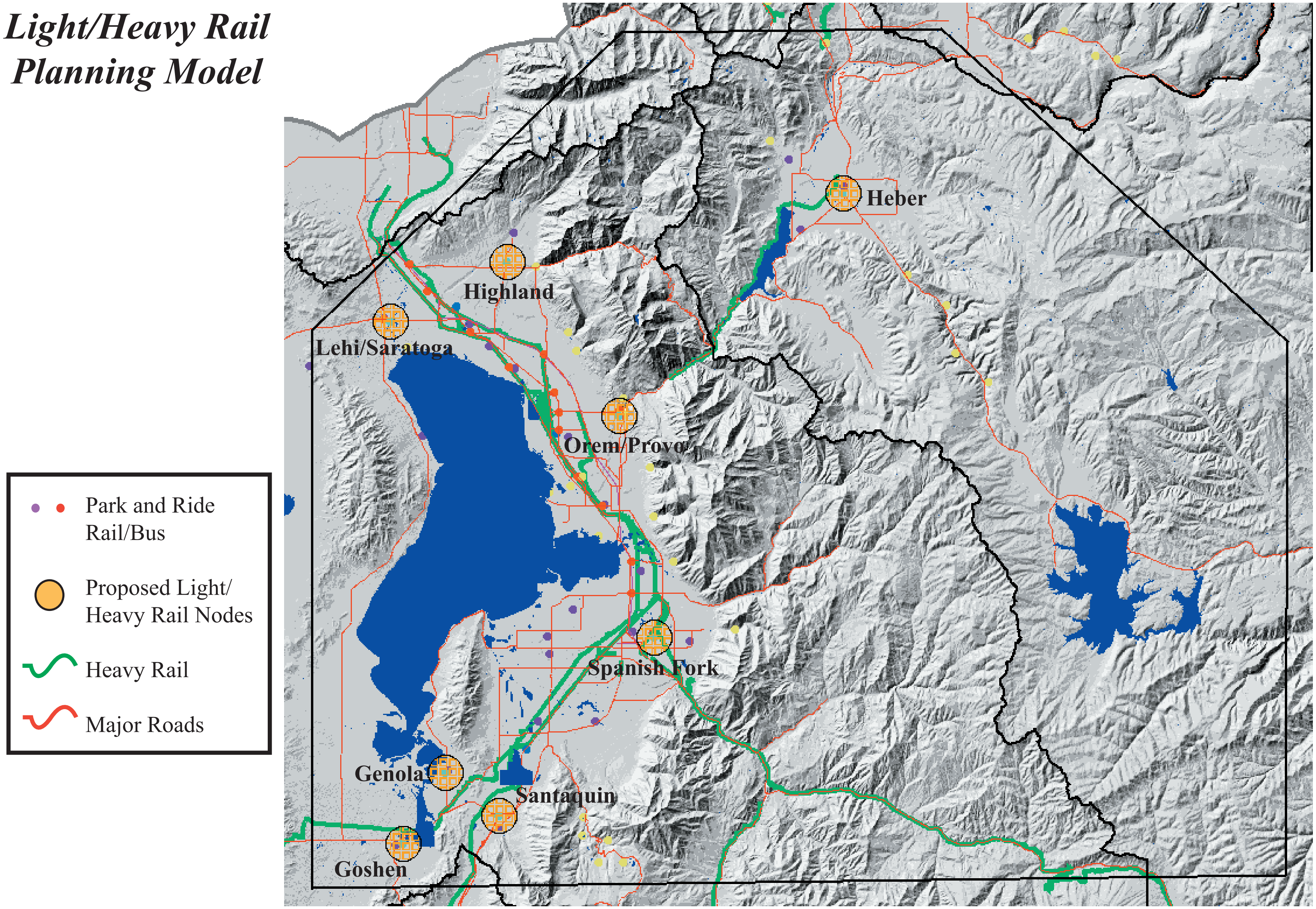


Figure 56: Transportation Planning Model

IMPLEMENTATION TOOLS BY AGENCY TYPE

This section of the report is taken directly from Alternative Future's for Utah's Wasatch Front. (Toth et al., 2002). The reason for this is that the two study areas are physically and politically adjacent to each other. Consequently, the implementation tools and strategies apply similarly to both. There are numerous tools for preserving open space. Not all are useful in any given situation, but it is felt that specific tools can be identified as needed for a particular site or feature.

Implementation Tools Available to Individuals, Governmental Agencies and Non-Governmental
Agencies

Conservation Easements

A conservation easement or restriction is a legal agreement between a landowner and a land trust (see OSU Extension Fact Sheet CDFS 1262-98, for information on Land Trusts) or government agency that permanently limits uses of the land in order to protect its conservation values. It allows the land owner to continue to own and use the land, and to sell it or pass it on to heirs. When someone donates a conservation easement to a land trust, he or she gives up some of the rights associated with the land. For example, one might give up the right to build additional structures, while retaining the right to grow crops. Future owners will also be bound by the easement's terms. The land trust is responsible for making sure the easement's terms are followed.

Conservation easements offer great flexibility. An easement on property containing rare wildlife habitat might prohibit any development, for example, while one on a farm might allow continued farming and the building of additional agricultural structures. An easement may apply to just a portion of the property, and need not require public access.

Landowners sometimes sell conservation easements, but usually easements are donated. If the donation benefits the public by permanently protecting important conservation resources and meets other federal tax code requirements, it can qualify as a tax-deductible charitable donation. The amount of the donation is the difference between the land's value with the easement and its value without the easement.

Placing an easement on property may also result in property tax savings. Perhaps most important, a conservation easement can be essential for passing land on to the next generation. By removing the land's development potential, the easement lowers its market value, which, in turn, lowers estate taxes. Whether the easement is donated during life or by will, it can make a critical difference in the heirs' ability to keep land intact (Land Trust Alliance, 2002). See the Utah State code for further details.

Purchase of Development Rights (PDR)

PDR is a voluntary program where a land trust or some other agency or institution makes an offer to a landowner to buy the development rights on the parcel. The landowner is free to turn down the offer, or to try to negotiate a higher price. Once an agreement is made, a permanent deed restriction is placed on the property, which restricts the type of activities that may take place on the land in perpetuity. In this way, a legally-binding guarantee is achieved to ensure that the parcel will remain agricultural, or as open (green) space forever.

The deed restriction may also be referred to as a conservation easement, or, since most PDR programs are designed to preserve agricultural use, an agricultural conservation easement (See The Ohio State University, 2002).

Right of First Refusal

A landowner may grant or sell a right of first refusal. The holder of such a right is given the opportunity to purchase the property when it becomes available. This right may or may not specify a time limit. When the property is offered for sale, the holder either buys or declines, at which point the property is placed on the open market.

Fee Simple Acquisitions

While simply purchasing land for conservation seems to be the simplest option, it is not without problems. If the land is purchased by a government agency, it is removed from the tax rolls. The agency is also responsible for maintenance and management of the property. Fee simple acquisition is expensive because the agency is purchasing all the rights to the land including those that are not in the public interest. The development rights to the land are still available and at some future time, the owner may decide to develop or sell the land. However, for lands of high development potential and high conservation value, this may well be the best option.

Purchase Options

Similar to right of first refusal, this option allows an interested agency to raise the funds to purchase land that has become available. The option is usually for a specified time period, and if not exercised, may expire with any monies spent being lost.

Bargain Sale

A bargain sale represents a middle ground between outright donation and fee simple acquistion. For example, after negotiation with the landowner, an agency or organization buys the land or perhaps just the development rights at less than "full market value." The difference between full market value and the purchase price is a tax-deductible donation by the owner.

Often times the tax deduction returns the same net financial gain to the seller as if they had sold the property at full market value yet the buying organization gains the land for conservation purposes. As with all of these tools, counsel is recommended.

Purchase and Sell-Back

After a government or conservation group purchases a property, it may sever certain development rights and then sell the land. This removes the development potential of the land and avoids the on-going costs of land management.

Purchase and Lease-Back

Similar to purchase and sell-back, this option allows the owner to draw rent as income on the property. These methods are subject to many provisions of the tax code and the advice of professionals is strongly encouraged.

TOOLS AVAILABLE ONLY TO LOCAL GOVERNMENTS

Special Areas Preservation/Mitigation Programs

These are used in some states to identify important natural resource areas like watersheds. Mitigation measures are then specified to ensure that land uses are compatible with the area's ecological function. In Alberta Canada, local volunteer committees examine candidate crown lands for suitable sites to preserve. They help draft management plans including boundary options, management objectives, and appropriate land uses for the minister's approval to ensure ecosystem protection (Alberta Special Places, 2002).

Sensitive Land Overlays

Zoning overlays are used to implement specialized standards for unique areas. The purpose of these zoning regulations is the mitigation of natural hazards that may cause loss of life or property. Natural phenomena which could threaten new development include: flooding, ground rupture, slope failure, rock fall, earthquake, compaction/consolidation, liquefaction, groundwater interception, and fires. Natural phenomena which could be aggravated by new development include: groundwater recharge problems, flooding, soil erosion, wildlife/fisheries habitat reduction, fires, losses of visual quality, and impediments of public access to public resources (Governor's Office of Planning and Budget, 2002).

Exactions and Dedications

Local governments can require land dedications or assess impact fees for the purpose of land conservation. These requirements need to meet certain legal standards such as proportionality and reasonableness. These terms have been through the courts in some detail and the advice of legal professionals required. For a more complete discussion, see Exactions, Dedications And Impact Fees: Applicability of Nollan-Dolan Rough Proportionality Requirements to Non-Possessory Exactions and Exactions Imposed by Legislative Enactment (Delaney, 2000).

Intergovernmental Agreements

Some states allow jurisdictions to join together to plan and protect open spaces. In Utah, cross-county planning is restricted to the activities of the state's Association of Governments (Lilieholm and Fausold, 1999). Other states recognize that land use planning and open space preservation frequently cross local jurisdictional boundaries and require local government cooperation.

Cluster Zoning and Conservation Subdivisions

Cluster zoning sets a maximum per-acre density for dwellings but allows for closer spacing between homes to encourage open space in other parts of the development. This can reduce infrastructure and maintenance costs as well as increase home value due to proximity to open space (Lilieholm and Fausold, 1999; Trust for Public Land, 1999).

Agriculture Land/Open Space Zoning

Open space zoning and exclusive agricultural zoning are two of the most promising methods for preserving agricultural land. Open space zoning relies on the principal of cluster development, whereby new homes are clustered onto part of the parcel to be developed. Clustering allows the remaining land to be preserved as productive farmland or unbuilt open space.

Since housing density—not number—is changed, open space zoning can permanently protect a substantial portion of every development tract's agricultural productivity without decreasing the development profitability or the local tax base.

Exclusive agricultural zoning prohibits nonagricultural land uses within a district and is less frequently used than nonexclusive zoning. The main advantage is that it avoids conflicts between residential and agricultural uses. However, the ordinances are more difficult to adopt because farmland owners must forego (often reluctantly) the option to sell their land to residential developers.

A more landowner friendly form of exclusive agricultural zoning is the voluntary creation of agricultural districts. The benefits that farmers obtain by voluntarily joining an agricultural district may include preferential assessment, protection against nuisance ordinances, and limits on public investments for nonfarm improvements. Basic standards for reviewing district petitions should be outlined in the local zoning ordinance, if not at the state level. Like any zoning ordinance, however, its effectiveness can be undermined by a zoning authority's lax supervision of rezoning and variance requests (Carver and Yahner, 1996).

The state of Utah has provisions for creating agricultural districts. See http://www.le.state.ut.us/~code/TITLE17/17_21.htm for details.

Impact Fees

Impact fees are gaining popularity with local governments as a way to finance infrastructure without placing a large burden on existing taxpayers. Impact fees can be used to fund basic services such as water, roads, and sewers directly connected with a development, or less obvious needs such as fire stations, parks and other recreational facilities. The fees must meet several standards including reasonableness, fairness and appropriateness (Kolo and Dicker, 1993).

Agriculture Protection Areas

See the discussion for agriculture land/open space zoning. The primary difference is that protection areas include protection for farmers from nuisance suits by local residents resulting from farm activities. Protection is not absolute, however, and farmers still need to use best management practices as well as good judgment in their farming operations.

Limited Development

Limited development is usually associated with a conservation easement. Here, the property owner works together with the holder of the easement to develop plans for the property that will allow limited use compatible with the purpose of the easement. This process has the potential for both income and tax benefits to the property owner (San Isabel Foundation, 2002; Brandywine Conservancy, 2002).

Land and Mitigation Banking

Land banking is a way to comply with federal regulations requiring "no net loss" of wetlands or historical function lands.

Developers or government agencies purchase land in advance of development projects, construct the necessary wetlands, and then use the land as an acre-for-acre exchange with wetlands lost as they develop. The land banks should be in a similar ecosystem as the areas they are replacing. The process is subject to a wide range of federal regulations (NCSU Water Quality Group, 2002).

Transfer of Development Rights

Transfer of development rights uses market incentives to help protect land. The process requires a governmental agency to identify land desired for protection (the sending area) as well as land suitable for development at higher densities (the receiving area) than would normally be allowed. Property owners in the sending area are assigned development rights that can be sold to developers for use in receiving areas. The process is complex and requires significant expertise by the administering agency as well as educating developers and property owners. Colorado, Maryland, and New Jersey have working TDR programs that have protected over 45,000 acres since 1980 (One Thousand Friends of Minnesota, 2001).

Urban Growth Boundaries

Urban growth boundaries (UGB) establish a line around a municipality within which growth is permitted, and outside of which development is prohibited or severely restricted. UGBs are used to channel growth into existing areas when loss of open space will be minimized and infrastructure costs reduced. UGBs can be established by state legislatures (e.g., Oregon, Tennessee and Washington) or by local governments (e.g., California) (Staley and Milder, 1999; Ecotrust, 2002).

Like any tool used to control growth, the boundaries need to be revised from time to time as development occurs. UGBs can be implemented through conservation easements or by zoning, which is reversible.

Performance Zoning

Performance zoning seeks to specify the intensity of land use rather than the actual uses of a parcel. The intent is to preserve community vision while allowing developers to be innovative in how the vision is carried out. The process is more flexible and subjective than other protection mechanisms. (Eastern Michigan University, 2002).

Preferential Tax Assessments

Preferential tax assessments base tax levies on current use rather than "highest and best" use. This encourages maintaining land in agriculture or open space, rather than developing it to pay for taxes. Iowa began such a program in 1955. As experience accumulated, they noticed that while farmers did receive the tax break, land conversion to development did not slow.

After some experimentation, a new process was developed where land is placed in restrictive agreements with owners agreeing not to develop the land for 10 years. Each year the land remains in the agreement, the time period is automatically extended another year. The result is that if a developer buys the land, they must hold it for 10 years before developing it, a generally prohibitive arrangement. Under this program, farmland conversion has slowed substantially in Iowa (Edelman, 1998).

Building Moratorium

Building moratoriums are frequently used to allow planners to "catch up" with growth. Local governments generally impose the moratoriums when the current building permit process is inadequate to control development, or when general plans for the area are being created or revised.

Unfortunately, moratoriums do nothing to prevent previously issued building permits or approved plans. Developers will frequently rush through a mass of projects if they anticipate that a moratorium is planned. The Supreme Court (U.S. Supreme Court, 2001) recently ruled that moratoriums do not constitute a "taking" under the Constitution, and are a legal and sometimes appropriate means of controlling growth. Utah limits moratoriums to six months, whereas other states have limits that vary.

Transfer Development Taxes/Conversion Taxes

This type of tax is focused on land conversion and development. Taxes are assessed and paid when open space land is developed. They are intended to discourage land conversion and can be used to pay for the increased municipal cost of development. They are not currently available in Utah (Lilieholm and Fausold, 1999).

IMPLEMENTATION TOOL BOX

The following describes some of the better-suited implementation tools that are likely to prove useful in Utah's unique political climate The discussion is followed by other tools used throughout the country.

Conservation Easements

Description. A major reason for the conversion of working lands to non-agriculture uses is property and estate taxes. These inheritance taxes are based on fair market value of the property's "highest and best" use, which can significantly increase the value of land based on its potential development. Heirs are often forced to divide property and sell some or all of it to pay taxes, regardless of whether or not they intend on developing (American Farmland Trust, 2001).

One option to prevent property from being assessed at its highest and best use is a conservation easement. This type of easement allows for the separation of the development rights from a given piece of land, so that the remaining value of the land is the actual use of the land. These rights can be voluntarily sold or donated using a conservation easement, but the property remains in private ownership and the land can still be sold and leased. Often an easement can bring along significant tax benefits because the land is taxed on its actual use instead of highest and best use (Davis County Shorelands, 2001).

When to Use. Conservation easements are voluntary and undertaken by the landowner when conservation of the land is desired for perpetuity. They are often used by ranching operations or farms that face some kind of developmental or sub-division pressure, as well as by families who are concerned about passing the property along to the next generation. It should be noted that a conservation easement does not necessarily remove all future development from the property. By working with a trust it is possible to select a few home sites that can be built upon in the future.

Who to Contact. In Utah there are several trusts that can accept these easements. There are national land trusts like the Nature Conservancy or American Farmland Trust, or local land trusts such as Utah Open Lands. The following websites offer more comprehensive descriptions of conservation easements and the process through which they can be sold or donated
• Land Trust Alliance http://www.lta.org
• The Trust for Public Land http://www.tpl.org
• Utah Open Lands http://www.utahopenlands.org

Purchase of Development Rights

Description. Purchase of development rights (PDR) is similar to conservation easements in that the rights to development are permanently separated from the land (American Farmland Trust, 1998). However, in this case the rights are purchased instead of donated.

This method is incentive-based in that landowners are compensated for the development rights at the market value of potential development.

When to Use. This method is of use when the landowner wants to maintain current land uses, but cash is needed instead of tax benefits. Securing funds for the purchase of the development rights can be difficult with this method, however. PDR most often occurs in areas of significant conservation value facing serious development pressure.

Who to Contact. The following websites offer more comprehensive descriptions of the purchase of development rights option,
• Land Trust Alliance http://www.tla.org
• The Trust for Public Land http://www.tpl.org
• Utah Open Lands http://www.utahopenlands.org

Transfer of Development Rights

Description. Transfer of development rights (TDR) is a method for land conservation that attempts to direct new growth from areas of environmental concern into areas of existing development. The development rights on the land of environmental concern (sending area) are traded or sold for development rights within a city (receiving zone) (Lilieholm and Fausold, 1999).

When to Use. A transfer occurs when a landowner within a sending zone sells their rights to a buyer wishing to build higher densities in the receiving zone. Ideally, the receiving zone is an existing urban location that can accommodate additional densities (Davis County Shorelands, 2001) although this is not necessary. City ordinances must be in place before TDRs can occur.

Who to Contact. Davis County's Shorelands Master Plan contains a sample ordinance to guide municipalities interested in enacting a TDR program.
• Davis County Shorelands Master Plan (2001) (see pages 25 through 28).

Agriculture Protection Areas

Description. As urban and residential development spreads from existing municipalities into the surrounding countryside, conflicts often arise over differing land uses. Farms produce noise, dust, odors, and pesticide over-sprays that may become bothersome to nearby residents. Regardless of the fact that new residents settled near farms, they often file complaints. If enough complaints are filed, the farm can be legally restrained in its operations.

Agriculture protection areas (APA) are implemented at the county level to protect farmer's rights to continue productive agricultural practices within a developing area.

Enabled by the Utah Legislature in 1994, APAs protect farm owners from unreasonable nuisance lawsuits, and prevent zoning changes within the APA unless the farmers allow the change that would compromise farming. An APA also makes potential nearby homebuyers aware that they are near a protected farm. Finally, farm owners in a protection area can remove their land from the agreement at any time for any reason (USDA, 1999).

When to Use. Agricultural protection areas are most useful in areas with large tracts of contiguous farmland, and areas that are currently zoned for agriculture. If excessive residential development exists in a given area, the county may not create an APA.

Who to Contact. For more information, please refer to the following websites.
• The American Farmland Trust http://www.farmland.org
• Western Rural Development Center http://extension.usu.edu/wrdc/

Agricultural Zoning

Description. Agricultural Zoning is used to protect farmland by preventing the subdivision of farms into unsustainably small units. Lot size limits are usually set at a minimum practical farming area (often 160 acres or greater). The agriculture zone can restrict the number of dwellings on a farm, or exclude non-farm development. These zones are intended to protect the viability of farmlands for the future, not as holding areas for future development (Davis County Masterplan, 2001). However, they are not permanent solutions, as zoning can be changed in a city or county plan.

When to Use. Cities and counties interested in protecting agricultural lands away from existing developments often use this tool. It is not well received near urban areas where land values have been inflated because of development potential.

Who to Contact.
• Western Rural Development Center http://extension.usu.edu/wrdc/
• The American Farmland Trust http://www.farmland.org

Cluster/ Conservation Development

Description. The following descriptions are based on the Conservation Development chapter from the Davis County Shorelands Plan (2001). This type of zoning discourages development near critical environmental areas. In comparison to normal zoning, which results in houses on even-sized lots over the entire parcel, cluster zoning may allow the same number of units, but groups them together. Essentially, the number of houses that would have been built on a sensitive area are transferred to another area of the development. The remaining land can then be protected as open space using a variety of conservation techniques.

Cluster Zoning may increase the value of the new development because of its proximity to permanent open space. Cluster zoning also has the potential to reduce the costs of development because roads and sewers are not spread in a grid across the entire landscape.

When to Use. This strategy is useful when a particular piece of property has both developmental and conservation value, such as a wetland or trail corridor. Both the city and the developer must be willing to work together to create a successful project.

Since conservation development works on a parcel-by-parcel basis, the resulting open space will be localized. Largescale open space protection requires a different strategy.

For images describing different types of cluster zoning see the Davis County Shorelands Comprehensive Land Use Master Plan (2001, pp. 26, 30).

Who to Contact.
• The American Farmland Trust http://www.farmland.org
• Davis County Shorelands Master Plan (2001) Pages 29 through 30.

Fee Simple Acquisition

This method involves the actual purchase of the desired land and all of the associated rights by a municipality, agency or organization (Lilieholm and Fausold, 1999). This is one of the most expensive methods of land protection and it may be controversial in a state like Utah that has a high percentage of public land.

Deferential Assessment

Deferential assessment reassesses property taxes for farm or ranch lands based on its agricultural value rather than its highest and best use as indicated by fair market value.

Deferential assessment usually involves a contract period in which the land cannot be developed so as to avoid speculation.

Urban Growth Boundaries

An urban growth boundary (UGB) is a line drawn around a city that marks the outer limit to which residential development will be allow to expand. The UGB should be large enough to accommodate predicted population growth for the near future, but still provide public services efficiently.

Infill and Redevelopment

Infill is the process of encouraging development of land inside a city before outward development is allowed. A positive infill strategy encourages higher density, which in turn, keeps housing costs down. Redevelopment provides new affordable housing and the infrastructure necessary for higher densities.

Palm Beach County, Florida, formed a public-private partnership to reduce blight and provide affordable housing. The organization would acquire funds from various sources, buy land, and sell land to developers at reduced prices.

Additional incentives are also offered to developers such as zoning changes, low-interest loans, and the waiving of development fees.

Conclusions

Successful programs combine a variety of tools that incorporate both incentives and controls. On one hand, they make farming more profitable by reducing taxes, and on the other, they prevent development near existing farmlands.

There is not a one-size-fits-all solution to protection of open space, but there are usually lots of tools that can be applied to any given situation.

Proper tools are only the first part of the solution. Critical to the implementation of any working land or open space plan is political will. These tools require support and enforcement from government officials in order to be of any value. A wonderful plan is ineffective if it sits on the shelf of the planner. Zoning is just as useless if variances are systematically granted to all who apply.

Sticking to the goals of the open space or working land plan can be difficult when facing the opposition of a few individuals or businesses. It is important to remember that though there may be a few unhappy voices, the open space plan is for the benefit of the entire community. In fact, many surveys in Utah show widespread public support for open space (Envision Utah, 2000a).

Many organizations throughout the country have been assisting local and county governments to develop and effectively implement these tools. Below is a resource list of several governmental and non-governmental organizations that can assist with questions. Following the resources is a list of publications that describe in greater detail the many benefits and drawbacks of the programs discussed in this report. There are also many tools not mentioned in our short summary that could also prove useful for land protection.

Resources

American Farmland Trust
Jeff Jones, Rocky Mountain Field Director
P.O. Box 328
320 S Main
Palisades, CO 80526
(970) 464-4963

Envision Utah
254 South 600 East, Suite 201
Salt Lake City, Utah 84102
kthompson@cuf-envision.org
(801) 303-1450

Governor's Office of Planning and Budget
Kort Utley
116 State Capitol
Salt Lake City, UT 84114
(801) 538-1556
kutely@gov.state.ut.us

The Nature Conservancy
Moab Project Office
Anne Wilson
P.O. Box 1329
Moab, UT 84532
(435) 259-4629

Rocky Mountain Elk Foundation
Division of Wildlife Resources, Utah
Dwight Bunnell
1146 Lampton Road
South Jordon, UT 84095
(801) 254-1960

Utah Department of Conservation Districts
Sherri Einfeldt, Education Specialist
1670 West 200 North
Kaysville, UT 84037
(801) 547-9430

Gordon Younker, Executive Vice President
1860 North 100 East
Logan, UT 84341
(435) 753-6029
Gordon-yonker@ut.nacdnet.org

Utah Department of Agriculture and Food
Larry Lewis, Public Information Officer
P.O. Box 146500
Salt Lake City, UT 84114-6500
(810) 538-7104

Utah Department of Natural Resources
Dana Dolsen, Wildlife Planning Manager
1594 West North Temple, Suite #2110
Salt Lake City, UT 84114-6301
(801) 538-4790

Utah Open Lands
Wendy Fisher, Executive Director
P.O. Box 680921
Park City, UT 84068
(801) 463-6156
wendy@utahopenlands.org

Development and Conservation Planning
Adair Bosnal, Director
PO Box 68092
Park City, UT 84068
(801) 463-6156
adair@utahopenlands.org

Utah Quality Growth Commission
Salt Lake City Council Member, Carlton Christensen
451 South State Street
Salt Lake City, UT 84111
(801) 535-7600

Department of Natural Resources
Kathleen Clarke, Executive Director
1594 West Temple, Suite 3710
Salt Lake City, UT
(801) 538-7200

SUMMARY

We have provided open space models, other models, and new communities models that should help planners develop cohesive, long-term plans for the Mountainland region. The models are not all-inclusive and our intent is not to limit planning to only those models presented. Instead, we intend that this document be a tool for planners to use when developing areas within the Mountainland region.

In 1999, the Utah Legislature demonstrated its commitment to open space by passing the Quality Growth Act. Through that act the Quality Growth Commission was formed. However, even though four sessions have been held by the commission, no statutory recommendations have been made. The McAllister Open Space Fund has also fallen from a $3,000,000 funding level to less than $500,000 in the past two years. It seems that a full commitment by the Governor's Office needs to be made before any of these recommendations can be implemented (Baird, 2003).

Figure 57: Francis, Summit County Photo by: G. Busch

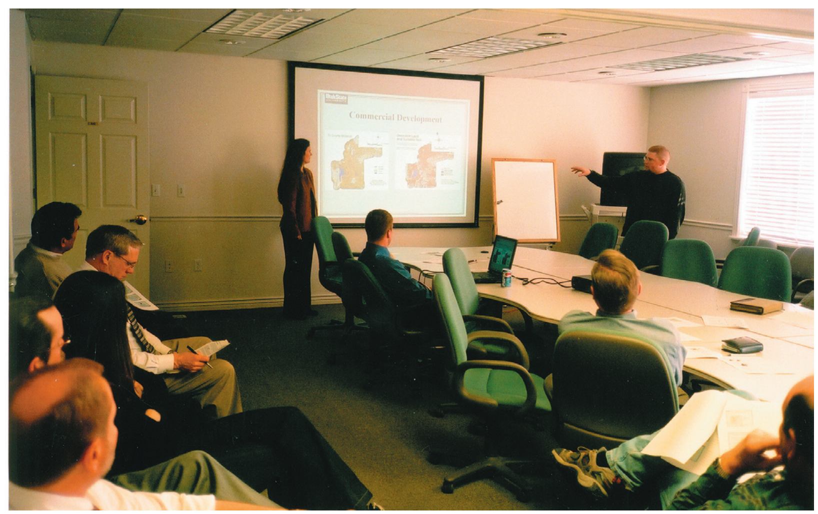


Figure 58: Final presentation to MAG staff Photo by: R.E. Toth

Case Study of
Possible Futures for the Muddy Creek Watershed,
Benton County, Oregon
Institute for a Sustainable Environment,
University of Oregon, Eugene, OR.
Hulse et al., 1997.

Abstract

This project sought to show a method that could be used to create possible development futures and analyze them to ascertain their impacts upon natural processes. The four-step methodology was: first, choose a study area; second, characterize the study area; third, depict possible futures; and fourth, evaluate possible futures. Each step of the project is clearly described in the report.

Existing data were used to select a study area (phase one) and as an input for characterizing the study area (phase two). Also, new data were generated through extensive local stakeholder participation to help characterize the study area. New data were also gathered about water quality and biodiversity to use as benchmarks in the analysis of the futures (phase four). The stakeholders not only provided data about the community, they were allowed to create the future scenarios (phase three). The stakeholders' involvement in the project was considered very valuable by the research team. GIS maps of data and of the futures proved to be good fodder for discussions and tended to keep deliberations focused and productive.

The analysis of the futures concludes that development-oriented futures degrade water quality and risk loss of species habitat.

The project goals are revisited at the end of the report (pp. 68-71), and seem to have been met. Recommendations for future studies following this methodology are given, improvements to the models suggested, and the benefits of more specific data in some categories stated. The suggestions for improvements are based upon the limitations found within the case study.

Background of Project

From the 1930s to the 1990s, the Willamette River Basin has had numerous planning efforts to guide development. While these past planning efforts tended to emphasize quality of life issues, rapid population growth and increasing demands upon natural resources has brought to light the need for planning that considers environmental quality (pp. 7-8).

This project was designed to illustrate a framework that local communities could follow to help create different future scenarios for land conservation and development. The project was a two-year interdisciplinary effort led by the Institute for a Sustainable Environment at the University of Oregon and funded through four contributing agencies. The 125 sq. mi. Muddy Creek Watershed within the Willamette River Basin was selected as a case study area to illustrate the framework.

***Goals and Objective**s

The project has four goals (p.11):

- to improve understanding of the relationship between human use of land and its effects on ecological resources;
- to use this improved understand-

ing to enhance the ability to predict the effects people's activities have on water quality and biodiversity functions of these resources;
- to provide products useful to local communities in their efforts to create, evaluate, implement, and monitor land conservation and development plans; and
- to clarify which aspects of this approach are locally specific and which are transferable to other communities, landscapes and regions.

To accomplish these goals the project team identified four objectives. Each objective related to a phase of the project. The work of each phase (objective) built upon the previous phase. Briefly stated they are:

- select a case study area within the Willamette River Basin;
- characterize the study area, including information about community concerns for the future, cultural factors affecting possible futures, and natural factors affecting possible futures;
- based on stakeholders input create a spectrum of possible futures; and
- evaluate each future for its effect upon biodiversity and water quality.

Research Teams, Stakeholders, and Local Experts

The eleven reporting authors are individuals from four organizations: five individuals from the University of Oregon, one from Environment Canada, three from Oregon State University, and two from E & S Environmental Chemistry, Inc. The research team consisted of 10 of the authors plus seven students from the University of Oregon and one additional person from E & S Environmental Chemistry, Inc.

Members of the community within the Muddy Creek watershed, called stakeholders, participated extensively during phases two and three of the project. Not only did they provide data about the area and community concerns, they were allowed to decide and create the spectrum of possible futures.

Local experts were consulted to help compile species breeding lists to be used as a benchmark of biodiversity.

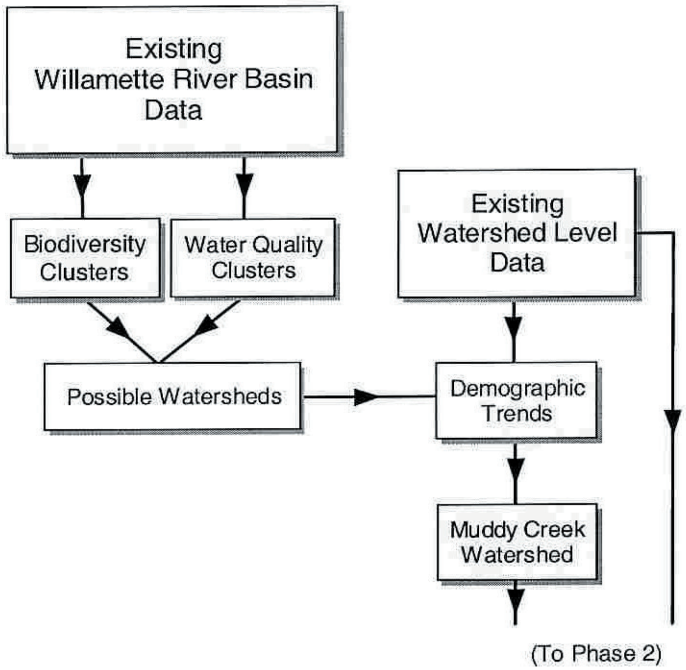
Key Terms

Futures: The scenarios of possible development levels in the year 2025, thirty-five years into the future.

Biodiversity: As used in this project, diversity within the environment was represented by changes in wildlife populations.

Methods

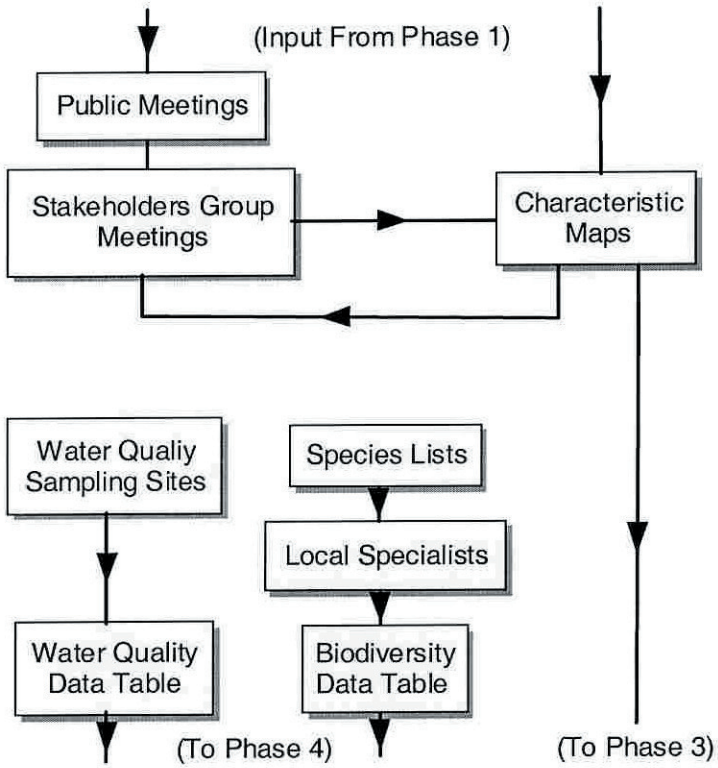
The following diagrams are box-line diagrams of the methodology of the project. Following each diagram the phase is briefly described.



Select Case Study Area
Phase 1

Phase 1

The first phase was to select a study area within the Willamette River Basin. The research team felt that a watershed, with its natural boundaries, would be appropriate to use as the study area. The team used existing data covering the Willamette River Basin and analyzed it to map biodiversity clusters, based upon species lists and vegetation patterns. Clusters of water quality data were also created. The combining of these clusters revealed possible watersheds for the case study. Local watershed level data were then considered to identify those watersheds likely to experience land use changes, and the current level of community involvement in planning processes. From this analysis the Muddy Creek Watershed in Benton County was selected for the case study.

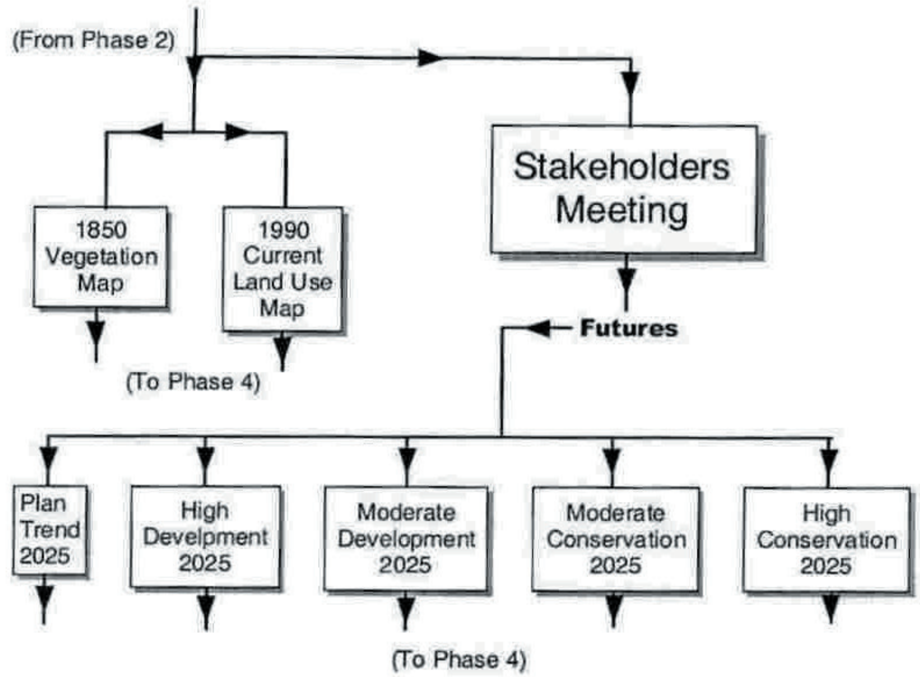


Characterize the Study Area
Phase 2

Phase 2

With the case study area selected, the next phase was to characterize the watershed by natural factors affecting land use, community concerns for the future, and cultural factors affecting land use. Natural factors affecting land use (e.g., slope, wetlands, hydrology, etc.) were mapped in GIS layers. Two public meetings were held to gather data about community concerns. This was followed by a stakeholders' group comprised of individuals selected from the community, which met several times with the research team to refine community concerns. The stakeholders also helped the research team create and refine maps that reflected community concerns and the cultural factors affecting land use.

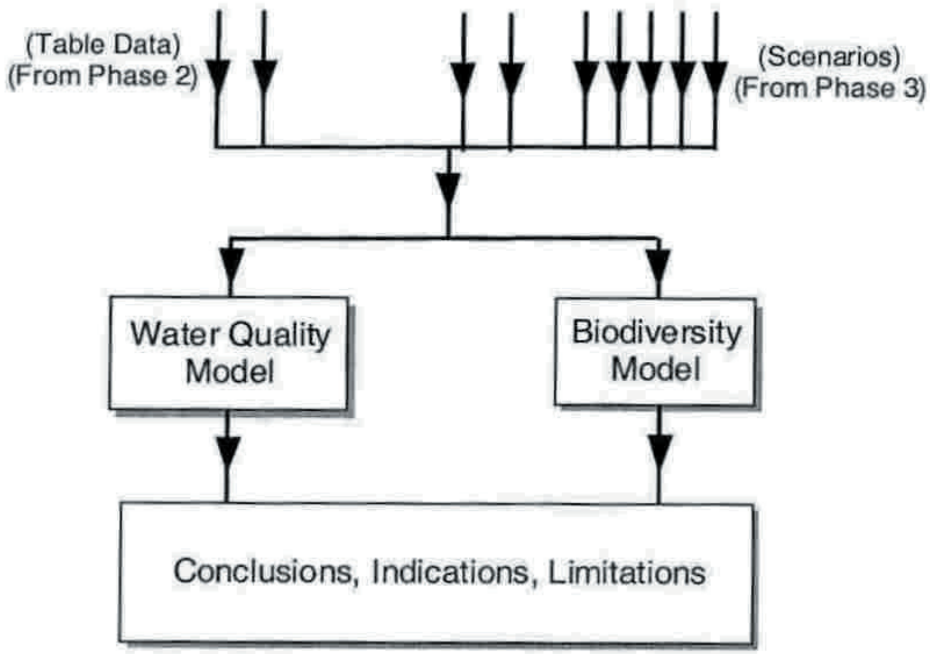
Water quality and biodiversity were chosen as benchmarks that would be used to analyze the future scenarios. Relevant, data were gathered and compiled in tables. Data about water quality came from 10 stream sampling sites established by the research team. Biodiversity data included breeding lists of various wildlife species. Local experts revised the lists and assigned each species into a category: amphibians, reptiles, birds, or mammals.



Create Futures Scenarios
Phase 3

Phase 3

The task now was to create a scenario of possible futures for the study area. The stakeholders met with team members over a five-month period and used the information in the maps of phase 2 to determine plausible futures. Along with an 1850 vegetation map and a current 1990 land use map, maps of five futures depicting land use in the year 2025 were created. The five future scenarios are: plan trend, high development, moderate development, moderate conservation, and high conservation.



Analyze Futures
Phase 4

Phase 4

The final phase was to evaluate the five futures to predict their effects upon biodiversity and water quality. The data gathered in phase 2 along with the futures were run through two existing models to predict the effects. Visuals of the futures were also created.

Project Conclusions and Indications

The project summary lists conclusions and indications of the project's findings (pp. 64-67). Conclusions are directly supported by the project's findings. Indications are professional judgments by the research team that correlate with the project's findings. Both are listed here.

Conclusions:

- To maintain biodiversity, seek a land use/land cover pattern between the Plan Trend and Moderate Conservation futures;
- The High Development future puts species habitat at risk;
- Current water quality is high;
- Significant levels of sediment in the upper elevations of the watershed are not leaving the watershed;
- Under the Plan Trend, future water quality would degrade: water quality would significantly degrade with the Moderate and High Development futures, and slightly improve under the High Conservation future.
- To maintain water quality, seek a

land use/land cover pattern between the Moderate and High Conservation futures.

Indications:

- The development-oriented futures shift the risk to species from one species to another;
- The riparian flood plain is a sediment trap; and,
- The network of logging roads in the upper elevations of the watershed may be the source of sediment.

Implementation

The project report states that others can follow their four phase process. A recommended fifth phase is responding to the planning process, meaning the use of an evaluation model to refine and enhance future visions.

One of the project's goals was to identify those aspects of the project that are transferable to other communities, landscapes, and regions. Throughout the report the sidebars of the text are used to identify transferable aspects of the project, making them easily located by the reader.

The project report states that using public involvement for comments and creation and refinement of data and futures, links humans with the environment by increasing understanding about how stakeholders' decisions affect ecological functions.

In the project summary several limitations are mentioned. Most of these are considered recommendations for future projects.

Summary

The project methodology was clearly presented in the report, along with the criteria and data analysis techniques used for each task. Efforts to spread knowledge of the project and its findings continues. The project is presented on the Institute for a Sustainable Environment's web page, and the data maps created by the project can be downloaded. Clearly, it is the desire of the Institute that this project be used and its process followed and improved upon by others.

Cindy Bagnes
Kevin Wells

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