Mountain Accord

Draft Existing Conditions & Future Trendlines of the Environment System

System Group Recommendation

April 2014

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1. EXECUTIVE SUMMARY

This report presents the existing conditions and future trendlines for the Mountain Accord Environment System Group. This group has identified four sub-systems to define the environment system: water, air, ecosystems, and land. A bulleted summary of key points is provided below. This summary is followed by an introduction to the environment system with a discussion on the area's background and history along with a brief discussion on perceived stressors to the environment. The bulk of the report focuses on the existing conditions of each of the four sub-systems. Finally, future trendlines are presented in terms of baseline projections and effects on the environment system.

SUMMARY OF ENVIRONMENT SYSTEM EXISTING CONDITIONS & FUTURE TRENDLINES

Water:

- *Project area watersheds are critical sources of drinking water for the Central Wasatch communities and are carefully managed to protect this important resource. These water sources will become more critical, and more in need of protection, as demands increase in response to population growth and climate change.*
- *Past efforts to protect the health of project area watersheds for their ecological and social values have been effective, although some watershed areas are degraded. Numerous stressors threaten future watershed health, including urban encroachment and mountain development, wildfire, water development, and climate change.*
- *A key component of the Salt Lake City Watershed Ordinance (§17.04) is to not allow new uses of water, beyond what existed in 1991 in the Wasatch Front watersheds, and to not extend geographically, or in volume, existing water agreements for the use of "surplus" water. Areas within the Central Wasatch Mountains that benefit from "surplus" water agreements with Salt Lake City include the Town of Alta, Snowbird, Solitude, and Brighton. Each agreement establishes a volume of water available, and the geographic area in which the water can be used. These interruptible agreements cannot be expanded pursuant to §17.04.*
- *Several stream segments in the project area are classified as impaired by the State of Utah, with generally degraded water quality conditions in the lower portions of the watersheds. Any further degradation of water quality may further impact aquatic habitat and require drinking water treatment plant upgrades.*
- *Groundwater quantity and quality in Salt Lake County support current needs. However, declining groundwater levels and climate change impacts threaten water supply, and water quality is threatened by industrial contamination, road de-icing chemicals, and other factors.*

SUMMARY OF ENVIRONMENT SYSTEM EXISTING CONDITIONS & FUTURE TRENDLINES (CONTINUED)

Water (continued):

- *Water quality regulations require implementation of best management practices to minimize pollution from stormwater runoff from new urban areas, construction sites, industrial sites, and transportation facilities. Nonetheless, as urban and mountain development increase, stormwater runoff will be an increasing threat to receiving water quality.*

Air:

- *Davis and Salt Lake counties are considered air quality maintenance areas for ozone; ongoing measurements in nonmetropolitan areas may show that Summit and Wasatch counties are potential nonattainment areas for ozone.*
- *Potential for a new lower ozone standard may result in new nonattainment areas for ozone.*
- *Salt Lake and Utah counties are nonattainment areas for PM_{10}.*
- *Davis County, Salt Lake County, and portions of Utah County are nonattainment areas for $PM_{2.5}$.*
- *Although pollutant levels are declining based on historical monitoring, ozone and particulate matter continue to be problematic. Ozone is highest during the summer, while particulate matter is highest during winter temperature inversions. Ozone and the majority of the particulate matter are formed in the atmosphere from precursor air pollutants.*
- *Future emissions from industrial sources are expected to remain unchanged; emissions from area sources are expected to grow with population; and emissions from cars and trucks will be declining largely due to new vehicle standards.*

Ecosystems:

The streams, wetlands, and plants of the Central Wasatch provide the backbone for all other uses. Despite this key role, comprehensive studies of ecosystem health and function in the Wasatch Mountains have not been conducted. What is known is that:

- *Much of the vegetation in the project area has a moderate to high level of departure from reference (potential natural vegetation in a healthy system) conditions. Primary factors that negatively affect forest health include drought-aided infestations of insects, like pine beetles, and decades of fire suppression.*
- *The quality of aquatic and riparian habitats in urban and suburban areas is low. In mountain areas, aquatic systems have been negatively affected near developments and from stream dewatering, recreation, effects of historical mining, and stocking of non-native fish.*
- *Widespread changes in terrestrial and aquatic health have been observed, and can be represented in part by the decline of indicator species such as Bonneville cutthroat trout (for the aquatic system) and Northern goshawks (for overall forest health).*

SUMMARY OF ENVIRONMENT SYSTEM EXISTING CONDITIONS & FUTURE TRENDLINES (CONTINUED)

Ecosystems (continued):

- *Climate change and drought will exacerbate existing stressors.*
- *Mountain development can make ecosystem management more difficult; for example, fire as a management tool is more difficult to use where lives and property may be at risk.*
- *While there have been many restoration efforts and remediation of some past human-caused changes, further active management and restoration will be important. Avoidance of irreplaceable systems, such as wetlands, streams, rare plants, and alpine meadows will also be important.*

Land:

- *There are similar amounts of protected open space in the Wasatch Front and Wasatch Back within the project area (42 percent and 36 percent, respectively) with little protection in the urbanized areas. There is increasing development pressure on remaining open space that may also be available for protection in both the Wasatch Front and Wasatch Back.*
- *The Central Wasatch Mountains contain world-class viewsheds and open space. Increasing development pressure correlates with increasing threats to open space, public land access, and viewsheds. Views are compromised on bad air quality days.*
- *Soil contamination from historic mining is a concern, especially on the Wasatch Back.*
- *Future development will result in increased pressure on those lands not currently afforded protection as open space and will be particularly evident in Summit County as growth spreads into undeveloped areas.*
- *Funding for future acquisition of open space or protection of sensitive lands will need to meet or exceed current levels.*
- *Not all undeveloped lands are suitable for development.*

2. INTRODUCTION

2.1 Report Introduction and Status

This is an interim version of the Environment System Existing Conditions and Future Trendlines report for Mountain Accord. This report will be finalized after the Environment System Group meeting on April 29, 2014, and following public and stakeholder input. The intended audience for this report is the public and the four Mountain Accord system groups. Note that the key takeaway points are compiled in the executive summary for readers interested in a quick overview.

This report references detailed information and analyses, but is not meant to be a comprehensive description of all that is known about the environment system. It is meant to concisely present available information that will help the Environment System Group focus on key considerations for an idealized system. The intent is to help identify the key needs and opportunities for this system; inform the development of a vision, goals, and metrics; and establish a baseline against which to compare options for a future idealized system. If later steps in the process identify the need for additional information regarding existing conditions or future trendlines, that information can be added at that time.

A parallel report is being developed for each system group—environment, transportation, recreation, and economy. The purpose of these reports is to inform the Mountain Accord process and inform an agreement, by January 2015, on this region's direction for optimizing the future performance of the environment, recreation, transportation, and economic systems in the Central Wasatch. To reach that goal, Mountain Accord will be implementing a process to develop the following:

- Existing Conditions and Future Trendlines report
- Agreement on the future vision and metrics for each system
- Agreement on idealized systems
- Agreement on a preferred scenario (that combines and optimizes the four idealized systems)

Each of these reports will be developed through the following actions:

- Develop draft information
- Solicit system group input
- Poll the system groups on their level of concurrence with the report
- Revise the information
- Invite public and stakeholder input
- Finalize the report for Executive Board review and adoption

Table 1, below, summarizes the key information regarding existing conditions and future trendlines that has been developed to date. If later steps in the process identify the need for additional information, that information can be added at that time. More information is included on the Mountain Accord website at www.mountainaccord.com.

Table 1. Status of Report Development

Milestone Development Steps	Incorporated in this Report?
Group Meeting #1 on Existing Conditions	X
Group Meeting #2 on Existing Conditions	X
Group Poll on Existing Conditions	
Group Meeting #1 on Future Trendlines	X
Group Meeting #2 on Future Trendlines	
Group Poll on Future Trendlines	
Public Review of Interim Report	
Stakeholder Meeting Input	
Other	

2.2 Project Area

The project area (where proposed actions are anticipated) is bounded on the north by Parleys Canyon, on the south by Little Cottonwood Canyon, and on the west generally by Interstate 15 (I-15) in Salt Lake County. This project area extends north of Interstate 80 (I-80) in the Salt Lake Valley to include the University of Utah and the Salt Lake International Airport. The project area also extends into Summit County and Wasatch County, bounded on the east by U.S. Highway 40 (U.S. 40). It is recognized that the environment system extends beyond the project area boundary; for instance, the project area includes a small area of the Provo River Watershed, as well as portions of sub-watersheds associated with the Silver Creek, East Canyon, and Weber River drainage. Therefore, while the Mountain Accord analysis focuses on the project area, it is important to identify the interconnected environment systems that extend beyond the project area.

2.3 System Introduction

> *"Men and nature must work hand in hand. The throwing out of balance of the resources of nature throws out of balance also the lives of men."*
>
> *— Franklin Delano Roosevelt*

A critical correlation exists between the health of the environment system and the ability of Mountain Accord communities to maintain public health, quality of life, and a sustainable economy. It is because of the surrounding mountains and natural areas that communities have clean water, areas to recreate, and ways to attract businesses and grow the economy in Utah's most populous region. One of the goals of Mountain Accord is to make growth and development decisions with a clear understanding of the area's dependence on a sustainable and healthy natural system.

This document provides a high-level overview of the environment system, describes how the system is currently performing, and provides insight into how the system has changed over time. The environment system includes a series of interdependencies between the natural and built environment, and between the environment's major sub-systems: water, air, ecosystems, and land. This report is organized around these major sub-systems. Stressors to the health of the environment system (e.g., population growth and climate change) are also included in this discussion.

The Mountain Accord project area overlaps the boundary between two distinct regions—the Basin and Range (desert) to the west and the Rocky Mountains (alpine) to the east. The Wasatch Mountains—the westernmost portion of the Rocky Mountain chain—are the first major barrier encountered by atmospheric currents flowing eastward across the desert. This barrier results in orographic lifting, which produces precipitation and snowpack in the mountains, as well as influences inversions by helping to trap cold, heavy air in the valleys. The water supply from the snowpack released during spring and summer supports life in the valley as well as the mountains. Referring to the environment as a "system" emphasizes the importance of the relationship among water, air, ecosystems, and land.

Background / History

Since the mid-1800s Utah's Wasatch Range has provided residents along the Wasatch Front and Park City with water, recreation, and economic opportunities. While the importance of watershed protection was recognized by city founders, pressure from timber and mining industries conflicted with efforts to do so. By the mid-1860s, prospecting and mining settlements existed throughout the Wasatch. Coincidentally, population and economic growth became increasingly reliant on clean water from sources such as Parleys Creek and Big and Little Cottonwood Creeks.

By 1870 mining towns like Alta and Park City were negatively affecting the environment. A decision to refuse a mining settlement at the headwaters of City Creek in 1873 would be the first in a long history of refusals to allow unsustainable development in the watersheds by Salt Lake City (Garber 2012). While mining in the canyons continued through the 1960s, operations would reach their peak during the early 1920s. Similarly, Park City's silver mining operations languished until approximately 1950.

Beginning in the early 1900s, Salt Lake City began completing sanitary surveys, watershed ordinances, and canyon patrols (U.S. Environmental Protection Agency [EPA] 1999). In 1906, the Wasatch-Cache National Forest was established under the newly created U.S. Forest Service (USFS) (the Wasatch watersheds are currently comprised of about 60 percent National Forest System lands). Gifford Pinchot, President Theodore Roosevelt's first Chief of the National Forest, was reported to have traveled to Salt Lake City on at least two occasions in the first decade of the 20th century to speak to Salt Lake City leaders about the importance of protecting the city's watersheds and to begin watershed restoration activities in areas of the Cottonwood Canyon watersheds that had been impacted by mining and logging (EPA 1999).

Today, the Wasatch Mountain watersheds encompass 185 square miles. Salt Lake City has extraterritorial jurisdiction over its extended watershed. This authority, along with the federal authority granted by Public Law 101 of 1914 and 1934, allows for the establishment of regulations and ordinances to protect the water supply (EPA 2010). Under this state authority, ordinances have been passed and enforced by the city to manage the watershed lands that are not municipally owned. Salt Lake City regulates uses in the surrounding canyons including Big and Little Cottonwood, City Creek, and Parleys.

The effects of Park City's silver mining operations still remain approximately 70 years after the demise of the mining industry. Today, mine-related wastes are an ongoing focus of Park City's environmental efforts. Mine-related waste is managed through Park City's Soil Ordinance and Environmental Management System, created in partnership with the EPA (Park City 2014).

Environmental protections of these watersheds are now in place and environmental cleanup from a by-gone era continues. Bold actions, conservation, and ongoing land management have protected critical lands, enabling the protection of our watersheds resulting in the protection of ecosystems.

Stressors

Environmental stressors are factors that place stress on the environment system. Three major stressors—population growth, development, and climate change—affect the major sub-systems of the environment (water, air, ecosystems, and land). These stressors are introduced briefly here and are discussed in more detail for each sub-system in Section 3, Existing Conditions, and Section 4, Draft Future Trendlines, of this report.

Population Growth

Population growth and changing recreation demographics stress the environment system through additional demand for resources and additional impacts from development, recreation, and traffic. From 1990 to 2010, the population in Salt Lake County increased by 42 percent (729,000 to 1 million), in Summit County by 133 percent (16,000 to 36,000), and in Wasatch County by 134 percent (10,000 to 24,000). Development is shown on Figures 1, 10, 13, and 14 (labeled as "disturbed areas").

Development and Increased Use

Stressors to the environment system also include increasing development and use. Habitat fragmentation, sanitation, impermeable areas (such as buildings, roads, and parking lots), invasive species proliferation, and other concerns caused by more development and increasing uses of the Wasatch Mountains can negatively impact overall ecosystem function, as well as the ecosystem services we depend upon (such as water). These stressors can also make it more difficult for environment systems to adapt to climate change impacts over time. Small incremental development and use increases over time can create large cumulative impacts that are difficult, if not impossible, to reverse.

Climate Change

Climate change is a stressor for the hydrologic cycle, including water resources, and ecosystems. Several significant long-term climate trends have been observed over most of the western United States during the past 50 years, including:

- Increase in the frost-free growing season
- An earlier and warmer spring
- Earlier flower blooms and tree leaf-out for many plant species
- Earlier spring snowmelt and runoff
- Greater portion of spring precipitation falling as rain instead of snow

Climate trends likely to emerge in Utah during the 21st century include a reduction in natural snowpack and snowfall in the early to late winter (particularly in lower to mid-elevation areas, with trends in the high elevation areas unclear), an earlier and reduced snowmelt-driven spring runoff, and increased demand for agricultural and residential irrigation due to more rapid drying of soils. Utah is forecasted to warm in excess of the projected global average temperature increases, which are 3°F to 7°F globally by 2100. Increased temperatures will likely result in a longer growing season, more heat waves, and warming of lakes and rivers with associated changes in aquatic life. Utah is in a transition zone for precipitation projections, and it is uncertain whether precipitation will increase or decrease (Blue Ribbon Advisory Council on Climate Change 2007).

3. EXISTING CONDITIONS

3.1 Introduction

The following is a second draft summary of the existing conditions information that could be relevant to Mountain Accord. This draft has been reviewed by the Environment System Group once, and comments have been incorporated. The public has not reviewed this draft yet.

The discussion is organized by the four major environment sub-systems: water, air, ecosystems, and land. A summary of comments on the existing conditions report is provided at the end of this section.

3.2 Water

The Wasatch Mountains and their streams are of extraordinary importance to the area's public water supplies and the community's well-being. The good health of the natural systems of the Wasatch—the land, vegetation, snow, riparian areas, habitats, and ecosystems—facilitates the water cycle and ultimately connects these mountains to faucets throughout the project area and beyond. Water sustains our communities, and connects us directly with our natural environment.

The mountains of the Central Wasatch capture storm systems tracking through northern Utah in the winter, resulting in bountiful snows. The water released during spring and summer snowmelts supports life in the terrestrial, riparian, and aquatic environments of the mountains and downstream valleys. This water also constitutes the majority of the drinking water supply for the communities in the project area, and is therefore critical to the health and economic prosperity of our communities.

The sustainment of the watersheds and ecosystems of the Wasatch Mountains is inextricably connected to the surrounding communities' well-being. The Wasatch watersheds we depend upon for water also feed our collective desires for recreation, beauty, and fresh air.

Water is a critical topic for the Mountain Accord environment system. Key water-related components include:

- Watershed protection and health
- Water supply and demand
- Surface water and groundwater quality and quantity
- Stormwater quality

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Water is also a key element for ecosystems, as discussed further in Section 3.4, Ecosystems, of this document.

Watershed Protection and Health

Watershed Jurisdictions

Maintaining the critical water supply for a large population along the Wasatch Front is dependent on watersheds located in the project area. Salt Lake City relies on watersheds in the Jordan River Basin portion of the project area as a primary source of water for municipal and industrial purposes (see the following section for a discussion on water supply and demand). Within the Provo/Jordan River Basin, Salt Lake City has extraterritorial authority to enforce watershed protection ordinances in City Creek, Parleys, Big Cottonwood, and Little Cottonwood canyons to protect its water resources (Figure 1). Sandy City has similar authority for Little Cottonwood Canyon and Bell Canyon. These watersheds are regulated as drinking water source protection areas, and the streams are regulated under state anti-degradation standards. Ordinances have not been adopted or implemented specifically for the Provo River Basin.

Salt Lake City and Sandy City have developed and implemented watershed management plans that provide policy and management strategies to maintain high-quality water in those streams used for culinary purposes. Plan management strategies include ecosystem maintenance, stream and riparian area protections, land protection, environmental education, environmental monitoring, and participation in development review and decision-making processes. The plans emphasize water quality as the first priority, and multiple-use of the watershed second. Watershed conditions in these source water areas are closely monitored, and under existing conditions with vigilant protection they are adequate to meet the source water quantity and quality needs of the water users that depend on them (based on the conditions that exist today).

Water resources in Park City and the Snyderville Basin provide water to a rapidly growing population. Park City has established source water protection zones in the Silver Creek and Kimball Creek watersheds (Figure 1) to safeguard the quality of water intercepted by the Spiro and Judge tunnels, which were formerly used for mineral extraction. Park City also benefits from Salt Lake City's watershed protection efforts because the tunnels intercept water emanating from Salt Lake City's watersheds as well.

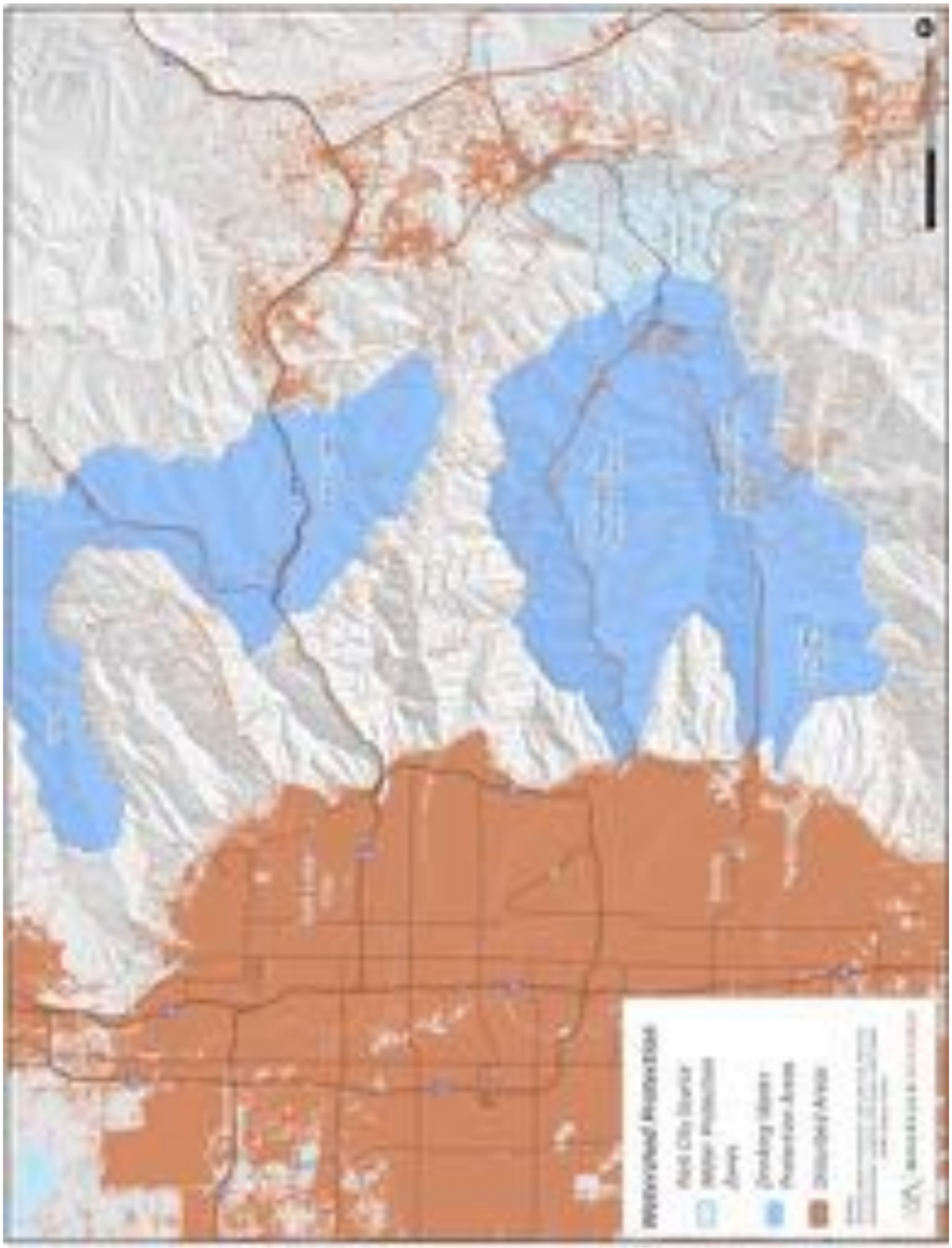


Figure 1. Watershed Protection Areas

In addition to water providers, a number of natural resource government agencies and organizations share the mission of watershed protection in the project area. Examples include USFS, which has jurisdiction and multiple-use and natural resource mandates under the Multiple-Use Sustained Yield Act and through its Forest Planning Rule, and local watershed organizations such as the Provo River Watershed Council (www.provoriverwatershed.org). Also, the EPA and the Utah Department of Environmental Quality are currently overseeing cleanup efforts in the lower Silver Creek watershed to improve water quality and habitat.

Source Water Protection

The project area lies within the Provo/Jordan River Basin and Weber River Basin watersheds. These watersheds support a vast array of important ecological and social functions, including water supply, aquatic and terrestrial habitat, recreation, and aesthetics. It is globally recognized that watershed protection provides many ecosystem and economic benefits (Postel et al. 2005). Because of their proximity to the Wasatch Front urban area and other factors, these watersheds are subject to numerous stressors and threats to their overall health, i.e., their ability to maintain sustainable ecological functions and to provide the desired environmental and human benefits. These stressors and threats include:

- Fragmentation and urban encroachment
- Increased water demand
- Recreation pressures and over-use of sensitive areas
- Catastrophic wildfire
- Invasive species
- Roads and trails
- Inadequate sanitary systems
- Historical (grazing, mining) and current land use practices
- Development in sensitive areas
- Climate change impacts

As a result of these stressors and threats, monitoring and protecting the health of watersheds in the project area are important objectives of many different agencies and groups. For purposes of this report, emphasis is placed on water-related issues that affect watershed protection and health. Additional watershed issues are discussed in subsequent sections of this report.

Key watershed functions include water quality, water quantity (collection, storage, and discharge), channel stability, habitat (aquatic and terrestrial), and social/recreation (i.e., wildlife viewing and education). Watershed health can be gauged in part by evaluating if the watershed is providing these anticipated functions at the level expected.

Watershed Health

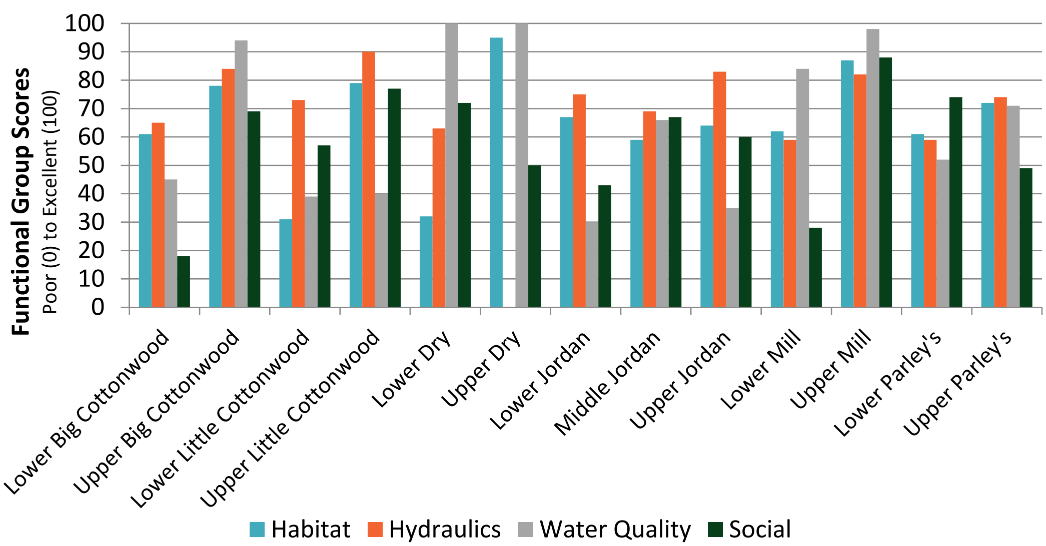
To better understand the effectiveness of watershed management as well as the chemical, physical, and biological health of the waterways, two sources of systematic assessment developed by Salt Lake County and USFS provide useful information. Salt Lake County developed the Water Quality Stewardship Plan (WaQSP), and USFS developed the Watershed Condition Framework. In summary, the upper watersheds in the Central Wasatch range are functioning well to impaired, based on a number of different criteria developed by Salt Lake County and USFS. While watershed health is relatively good in the upper watersheds, the ratings reflect degradation based on historical mining activities and current land and recreational uses. This implies there are opportunities to improve conditions, and that vulnerabilities could lead to additional decline.

Stream Function Index: A monitoring tool called the Stream Function Index was designed and presented in the 2009 Salt Lake Countywide WaQSP. The WaQSP is the update to Salt Lake County's *1978 Area-Wide Water Quality Management Plan* required under Section 208 of the Federal Clean Water Act. The WaQSP Stream Function Index is computed by breaking streams into segments (Figure 2) and assigning scores from 0 (poor) to 100 (excellent) to each segment. The scores summarize the biological, physical, and chemical parameters of river and stream corridors using habitat, hydraulics, and water quality metrics. A social parameter is also included, which includes aesthetics and recreation metrics. Habitat, hydraulics, water quality, and social metric scores for the streams within the project area are shown on Figure 3. The upper watersheds located in the mountain areas score higher for most parameters compared to the lower watersheds located in urban areas. Adverse impacts from activities in the watershed tend to accumulate and cause greater impairments in the lower stream segments. Additional details pertaining to this plan can be found online at http://www.slco.org/watershed/wtrQualSteward/index.html. Stream Function Index data are available on the interactive Mountain Accord water map at http://bit.ly/1jDZyjc.

Although the Stream Function Index focuses on streams and not the surrounding land features, the streams are good indicators of the overall health of the watershed areas that contribute to them. Cities that are dependent on watersheds in the project area have used the Stream Function Index to develop stream and watershed management plans.

No similar stream assessment studies have been completed for streams along the Wasatch Back. Completing a study with a similar methodology within Summit and Wasatch counties would be valuable to provide a consistent assessment of watershed health.

Figure 2. Stream Segments Selected for Evaluation in the WaQSP



Source: 2009 Salt Lake Countywide Water Quality Stewardship Plan

Figure 3. Stream Function Index Scores for the Jordan River and Salt Lake County Streams

Watershed Condition Framework: USFS conducted a systematic assessment of watersheds through its Watershed Condition Framework in 2011 to assist in prioritizing watershed restoration activities. The USFS Watershed Condition Framework consists of criteria such as aquatic biota, soils condition, aquatic life, forest health, road and trail condition, and other metrics to rate watershed health. In the project area along the Wasatch Front, the headwaters of Big Cottonwood Canyon, Mill Creek, and Parleys Creek received a moderate "functioning at risk" rating, while the headwaters of Little Cottonwood Canyon received the lowest rating, "impaired function" watershed condition. The main reason for Little Cottonwood Canyon's low rating is elevated levels of zinc in reaches of the stream that exceed trout toxicity levels. The watersheds also are rated based on the condition of roads and trails as they pertain to mass wasting, or the contribution of sediment to the stream system. In the project area along the Wasatch Back, the Kimball Creek and Snake Creek watersheds received a "functioning properly" condition classification. It should be noted that USFS has not yet completed a planned Terrestrial Condition Framework for the watersheds, which would be helpful for future evaluation of these watersheds and ecosystems. More information and an interactive map can be found at http://www.fs.fed.us/publications/watershed/.

Wildfires represent a significant threat to watershed health and source water quality. As urbanization and mountain development push further into natural areas, and as the health of forests declines due to climate, invasive species, and other factors, the threat of wildfires increases. Burned areas generate much higher loads of sediment than undisturbed areas, affecting downstream waterways and water infrastructure. In addition, runoff from burned areas contains higher concentrations of pollutants that are not typically removed in standard water treatment processes. This issue is discussed in more detail in the Ecosystems section of this report.

Water Demand and Supply

Water demand and supply represent significant interdependencies between the natural environment systems of the Wasatch and the built urban environment. In essence, water supply is dependent upon the natural function and ability of the Wasatch Mountains to capture, store, and release high-quality water; the ability of built infrastructure to reliably capture, treat and distribute clean water to the public; and the needs, behaviors, and water-use practices of consumers. The water infrastructure in the project area provides water and public health benefits to more than one million people.

Wasatch Front

The existing condition of water demand and supply along the Wasatch Front can best be described as well managed, but balancing demand and supply can be tenuous when stressors of drought, water quality degradation, infrastructure failure, increasingly stringent regulations, climate change, and increased demand due to population growth are present. Balancing demand and supply now and in the future depends on water conservation, maintaining watershed health, maintaining infrastructure, and ensuring resiliency and redundancy of the entire water system.

The current condition of water demand and supply along the Wasatch Front is the result of more than 150 years of complex and interdependent water resource planning and decisions, land use policies, development and implementation of a water rights framework, and investment of natural and built infrastructure (e.g., watershed investment, treatment plants, and distribution systems). Developing water in Utah has always been a challenge, and given population increases and climate change, water resources management is not anticipated to get any easier.

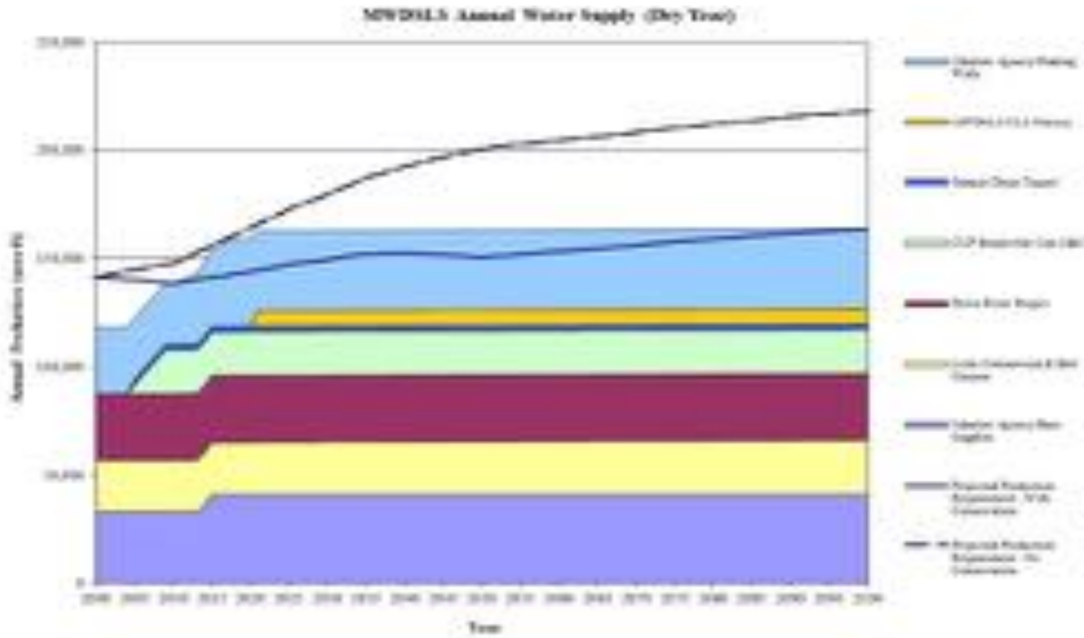
The 2007 *Salt Lake County Demand and Supply Study Report* provides insight into the overall water availability and needs throughout Salt Lake County. The purpose of the study was to complete a countywide evaluation of demand and supply that jointly considered the needs and supplies of all major public water suppliers in Salt Lake County (i.e., Metropolitan Water District of Salt Lake & Sandy [MWDSLS], Salt Lake City, Sandy City, Jordan Valley Water Conservancy District [JVWCD], Holliday Water Company, and Murray City Water). Supply and demand projections for Salt Lake County to the year 2100 are available in the 2007 report, though note that significant assumptions related to weather, climate, redundancy needs, conservation practices, and the future political and physical feasibility of obtaining new sources were made. In the context of Mountain Accord, the most significant factor related to water demand and supply is the considerable and necessary reliance on surface water sources emanating from the Central Wasatch Mountains and the groundwater recharge provided by those mountain sources.

Salt Lake City's water service area and the areas of the Wasatch Mountains from which a significant portion of the water supply emanates are shown in Figure 4.

Figures 5 and 6 illustrate the mix of water resources currently used and those projected to meet water demand for the MWDSLS and Salt Lake City systems, respectively. It is important to underscore the critical importance of surface water sources (the Wasatch watersheds) in the mix of water supply. MWDSLS supplies originate from surface water sources within and beyond the project area. Salt Lake City relies on a combination of surface and ground water sources, with more groundwater being used in dry years to compensate for lower surface water runoff. Sandy City has a similar mix of surface water and groundwater supplies. Future water supply and demand projections are discussed in the Future Trendlines section of this report.

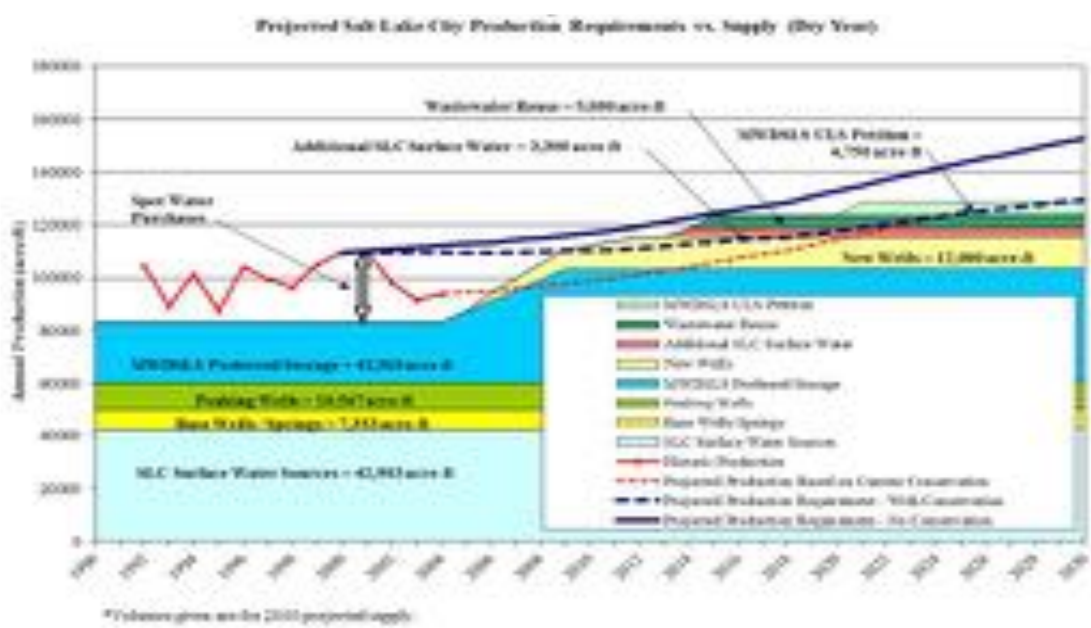
Source: Bardsley et al, Planning for an uncertain future: Climate change sensitivity assessment toward adaptation planning for public water supply, 2013

Figure 4. Salt Lake City Water Supply Basins and Delivery Area



Source: Bowen, Collins & Associates 2007. Salt Lake County Demand and Supply Study Report)

Figure 5. MWDSLS Annual Water Supply (Dry Year)



Source: Bowen, Collins & Associates, 2007a. Salt Lake City Major Conveyance Study

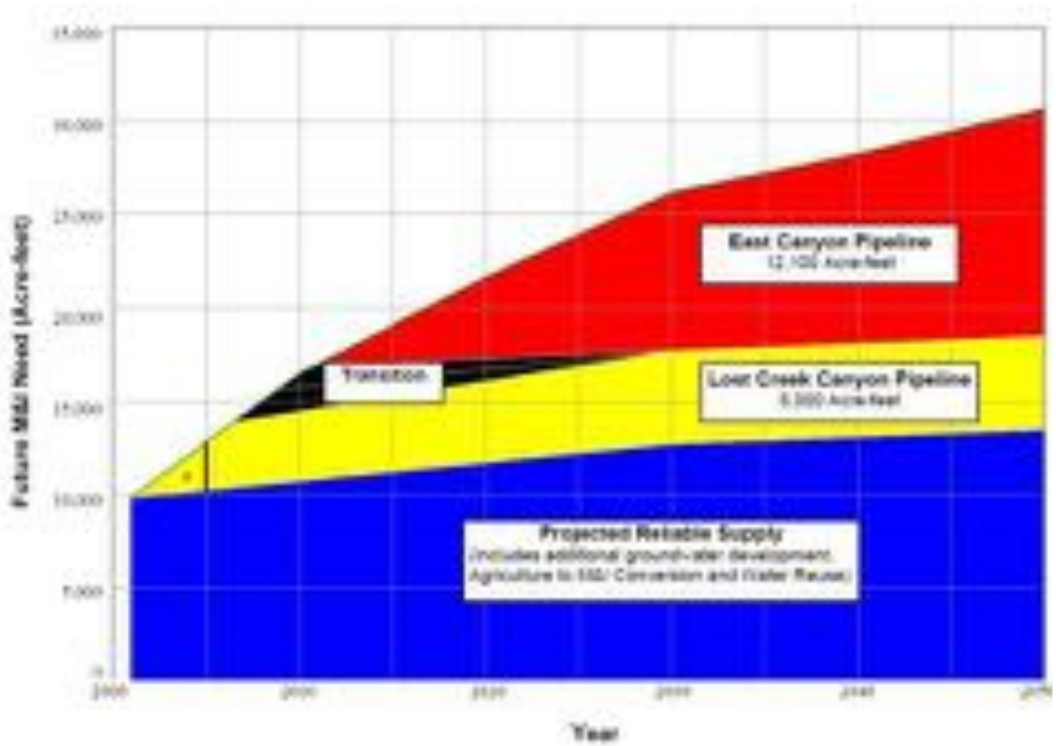
Figure 6. Projected Salt Lake City Production Requirements vs. Supply (Dry Year)

Water managers generally consider surface water sources, wells, and springs on the Wasatch Front to be allocated. State law allows Salt Lake City to sell water considered "surplus" to its current needs to entities located outside of its corporate boundaries. This has allowed areas of Salt Lake County to grow and prosper, and resorts and campgrounds to operate within the Central Wasatch. In 1991, using its authority pursuant to the Utah Constitution and state and federal statutes, Salt Lake City enacted a watershed ordinance, §17.04 (Watershed Areas), establishing watershed regulations and enforcement authority for each of the Wasatch watersheds that provide water for public water supply purposes. A key component of §17.04 is to not allow new uses of water, beyond what existed in 1991 in the Wasatch Front watersheds, and to not expand geographically, or in volume, existing water agreements for the use of "surplus" water. Areas within the Central Wasatch Mountains that benefit from surplus water agreements with Salt Lake City include the Town of Alta, Snowbird, Service Area #3, Solitude, Brighton, and numerous cabin and subdivision developments. Each agreement establishes a volume of water available, and the geographic area in which the water can be used. Pursuant to §17.04, these interruptible agreements cannot be expanded.

"Beginning in 1888, Salt Lake City acquired extensive water rights to Wasatch Canyon stream flows through exchange agreements with irrigation companies and control over the city's watersheds through state and federal legislation. Under state law, the city can only sell its surplus water outside the city's limits. The city has determined that except for snowmaking, fire protection and water from possible canyon springs it does not have surplus water for sale in its watershed canyons. This determination is based upon the following: canyon waters are extremely valuable to the city because they are the city's closest high-quality water supplies; water from canyon streams can be delivered to most city customers by gravity flow without pumping; and water used for snowmaking affords a degree of storage as it is usually the last to melt. Additionally, the city has made major capital expenditures for facilities to treat water coming from the canyons and they operate most economically when they have greater quantities of water to treat. Also, controlling issuance of new permits for water supply in the watershed area hereunder is consistent with the city's 1989 SLC Watershed Ordinance §17.04 4 Watershed Management Plan for the protection of the city's watersheds" (Preamble, §17.04.020, Salt Lake City Code).

Park City Area

Over eight different water suppliers produce water to meet the current municipal and industrial demands within the Park City and Snyderville Basin area. The 2003 long-term reliable water supply is approximately 14,000 acre-feet per year. The 2003 demand was approximately 9,800 acre-feet per year leaving a reserve of about 4,200 acre-feet per year to meet fire suppression and other emergency needs. Of the 14,000 acre-feet, approximately 30% is sourced from springs and 67% from wells. The remaining 3% is from surface sources (U.S. Bureau of Reclamation [USBR], 2006). The supply of water to the Park City area is significantly reliant upon springs and surface water sources emanating from the Central Wasatch Mountains and the groundwater recharge provided by those mountain sources. Figure 7 illustrates the mix of water resources currently used and projected to meet water demand for Park City and Snyderville Basin. Future water supply and demand projections are discussed in the Future Trendlines section of this report.



Source: USBR, 2006, Park City and Snyderville Basin Water Supply Study Special Report

Figure 7. Preferred Plan for Existing and New Supply for the Park City and Snyderville Basin

Water Conservation Efforts

The state of Utah set a goal to reduce water use for municipal and industrial water supplies by 25 percent by the year 2050, using 2000 usage rates as a baseline. To help meet this goal, the Governor's Water Conservation Team (GWCT) was established in 2000 to raise awareness and educate Utahns about water conservation, with the overall objective of changing water use behaviors (www.slowtheflow.org). The MWDSLS has tracked actual conservation achieved across their district since the year 2000 and results indicate that conservation efforts have already resulted in a 25 percent reduction by 2013 (reducing daily usage per capita from 289 to 216 gallons per day, inclusive of worker population).

Surface Water Quantity and Quality

Precipitation and Snowpack

Mean annual precipitation varies widely throughout the project area. Mean annual precipitation is approximately 15.3 inches at Salt Lake City, 21.4 inches at Park City, and 42.4 inches at the high mountain elevation of Brighton.

Snowpack and the amount of water it contains (also called Snow Water Equivalent [SWE]) are important for water supply and watershed ecology. Average annual precipitation increases dramatically with elevation throughout the central Wasatch and is greatest in the high terrain flanking Little Cottonwood Canyon (Figure 8). At comparable elevations, precipitation is generally lower along the Park City ridgeline and the Parleys Canyon area than found in and around Mill Creek, Big Cottonwood, and Little Cottonwood Canyons.

The snowpack acts as the region's largest reservoir, storing winter precipitation and releasing it to stream flow in the spring and summer. Climate change will be a major stressor on snowpack, impacting the spatial extent, duration, quantity, and melt; all of which affect water supply (refer to the Climate Change and Trendlines section of this report).

Surface Water Runoff

The timing, intensity, and volume of surface water runoff are important considerations associated with water supplies, water rights, flood control, and ecosystem health. A healthy ecosystem slows down and filters surface water runoff which both improves water quality and prolongs availability. Periodic flooding, sustained winter flows, and other hydrologic characteristics of natural systems are needed to support the riparian conditions responsible for providing important environmental benefits (e.g., good water quality, sustained flows, groundwater recharge, and aquatic habitat). Average annual flows in the canyon streams are shown in Table 2.

Table 2. Average Annual Flows in the Canyon Streams

Mountain Creek	Flow (acre-feet/year)
Little Cottonwood	51,240
Big Cottonwood	46,190
Mill	10,760
Parleys	18,130

Source: UDWR, 2010

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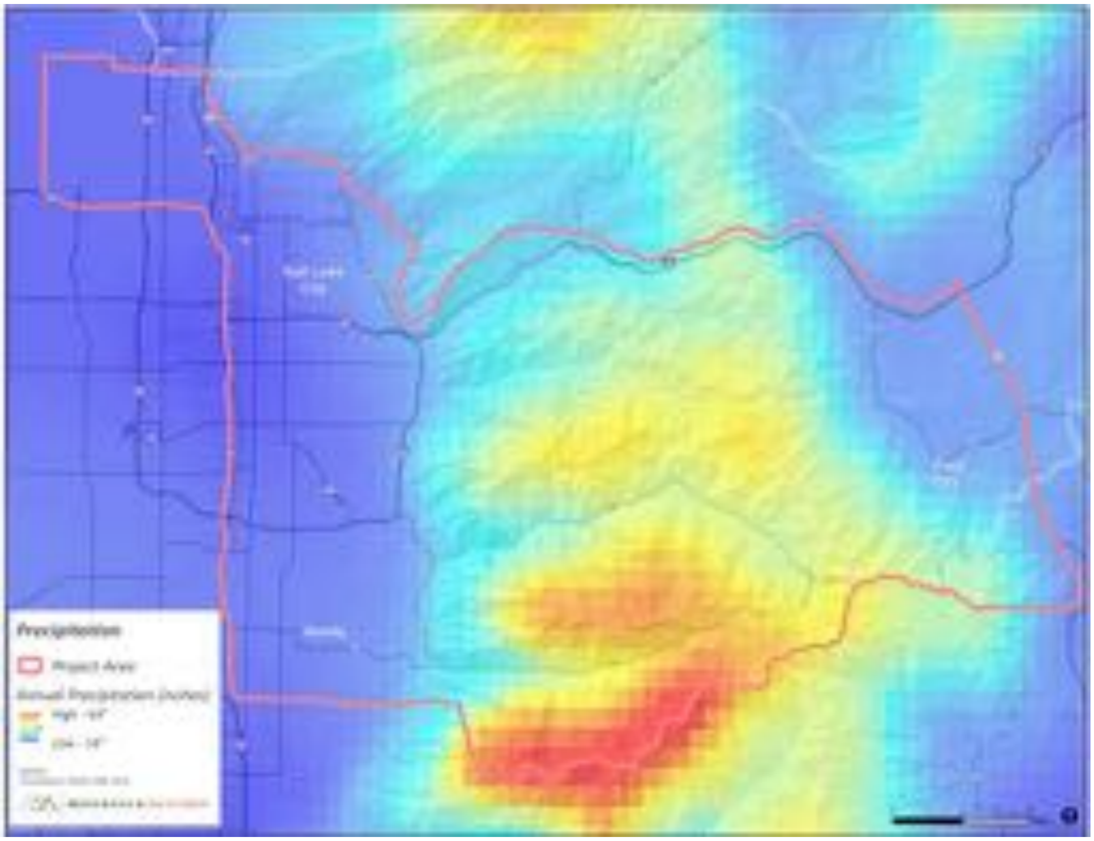
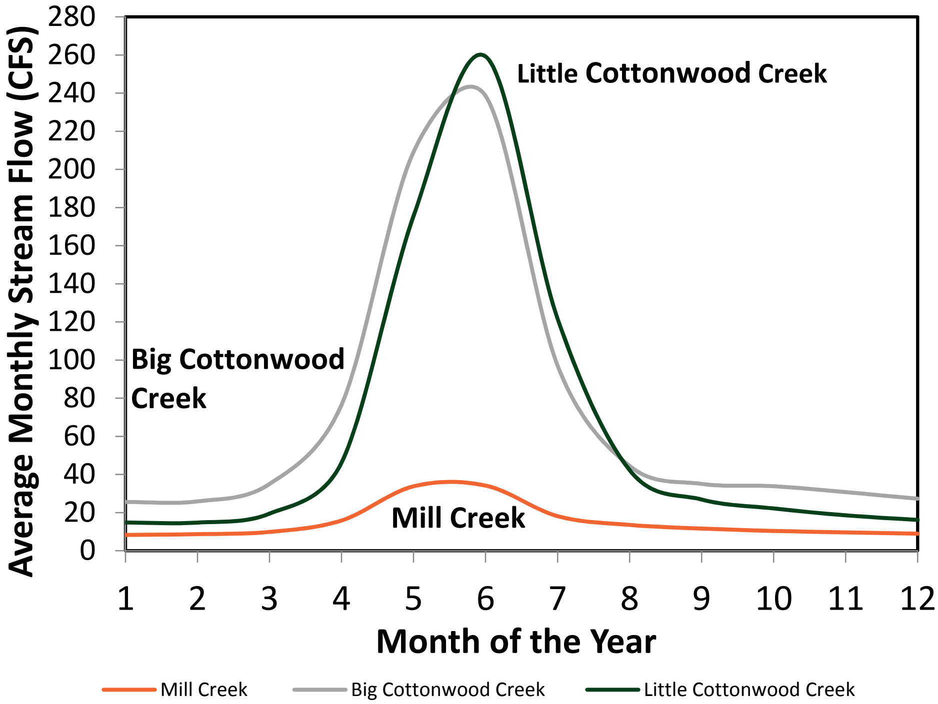


Source: PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu

Figure 8. Average Annual Precipitation (inches, liquid precipitation equivalent) in the Central Wasatch Mountains and Surrounding Region

Stream flows typically peak in late May to early June. For illustration purposes, Figure 9 shows the typical hydrograph of three Wasatch streams. Understanding the hydrograph of a stream is an important concept for water managers in meeting water demand, managing potential flood events, and managing water rights.



Note: Daily or instantaneous peak stream flows are significantly higher.

Source: Salt Lake City Department of Public Utilities

Figure 9. Average Monthly Stream Flows for the Three Wasatch Front Canyon Creeks (1910–2011)

Floodplains

Floodplains encompass the stream channels plus the adjacent lands that are temporarily inundated during a flood event. The Federal Emergency Management Agency (FEMA) has established the 100-year flood as the nominal standard for protecting buildings and most infrastructure, and has prepared floodplain maps for primary flooding sources in the project area based on existing condition 100-year hydrology. Development within the 100-year floodplain must comply with floodplain development standards. Any alteration of the watershed can potentially affect the magnitude of flood flows or the ability of the streams to convey those flows, and thus potentially affects downstream flood levels.

An interactive Mountain Accord water map, including FEMA's100-year floodplains for the project area, is available by clicking on the following link: http://bit.ly/1jDZyjc. 100-year floodplain maps are available for Dry Creek, Little Cottonwood Creek, Big Cottonwood Creek, Mill Creek, Parleys Creek, Silver Creek, East Canyon Creek, and other minor drainages.

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Water Quality (Clean Water Act Impaired Waters)

In the Western United States and in Utah, clean water is a limited and valuable resource. The goals of the Federal Clean Water Act (CWA) and the Utah Administrative Code (UAC) R317 are to protect, preserve, and restore the quality of the Waters of the State for designated beneficial uses by establishment and maintenance of water quality standards. The water quality standards consist of designated uses (drinking water, recreation, and aquatic life), numeric and narrative water quality criteria, and anti-degradation policies and procedures. The intent of the anti-degradation policies and procedures are to protect water quality in waters where the water quality is already higher than established water quality criteria. Utah's anti-degradation policy (UAC R317-2-3) does not prohibit degradation of water quality, unless the water has been previously considered to be of exceptional recreational or ecological significance.

Septic Systems

Inadequate wastewater management can cause significant degradation of surface and/or groundwater. Septic systems are designed to partially treat domestic wastes and then disperse remaining pollutants into the natural environment in quantities that can safely be assimilated. However, when septic tank system densities are too high within a watershed, or when systems are not properly designed or maintained, water quality may be affected.

Both Salt Lake and Summit Counties have ordinances and programs in place to regulate septic systems that comply with state regulations. Though sewer collection systems are used in the Cottonwood canyons and in the Park City and Snyderville Basin, where building sites are far from the main lines, septic systems are also used for areas where it is not practical to tie into the public sewer collection system. However, in watershed areas of Salt Lake County all wastewater from toilets and urinals must be contained in holding tanks, and only domestic wastewater (i.e., wash water) may be discharged into a drainfield and water quality has remained protected. Though Summit County allows drainfields to be used for all domestic wastewater, to address recent septic system issues a new wastewater policy was established in 2013 that includes county health department oversight and adherence to strict septic system design and maintenance requirements.

Surface Water Quality Assessment

If a water body fails to meet the water quality standards, section 303(d) of the CWA requires the water body to be listed as "impaired" and placed on what is referred to as the 303(d) list. At that point the State of Utah will prepare a Total Maximum Daily Load study (TMDL), which includes a plan to restore water quality of the impaired stream, river, or lake. A TMDL establishes the maximum amount of a pollutant allowed in the water body while maintaining all of its designated beneficial uses.

In the project area and the portion of the Provo River watershed adjacent to the project area, 11 water bodies have been designated as impaired and are included on the 2010 Utah 303(d) List of Impaired Waters (see Figure 10 and the interactive Mountain Accord water map at http://bit.ly/1jDZyjc). The beneficial uses for 303(d) listed water bodies include terrestrial habitat, aquatic habitat, domestic and agricultural uses, and recreational use.

The State of Utah has grouped the Waters of the State into classes to protect beneficial uses from controllable pollution (UAC R317-2). Class designation for the primary water bodies in the study area are listed in Table 3.

Table 3. State of Utah Waters Protection Classifications for Study Area Streams

Study Area Stream	Class 1	Study Area Stream	Class 1	Study Area Stream
Parleys Creek (1300 East to Mountain Dell Res)	1C	2B	3A	
Parleys Creek (Mountain Dell Res. to headwaters)	1C	2B	3A	
Mill Creek (I-15 to headwaters)		2B	3A	4
Mill Creek (Jordan River to I-15)		2B	3C	4
Big Cottonwood Creek (WTP to headwaters)	1C	2B	3A	
Big Cottonwood Creek (Jordan River to WTP)		2B	3A	4
Little Cottonwood Creek (WTP to headwaters)	1C	2B	3A	
Little Cottonwood Creek (Jordan River to WTP)		2B	3A	4
Bell Creek (Res to headwaters)	1C	2B	3A	
Silver Creek	1C	2B	3A	
Kimball Creek	1C	2B	3A	
East Canyon Creek	1C	2B	3A	
Provo Deer Creek	1C	2B	3A	
Snake Creek (Wasatch State Park and Confluence with Provo River)	1C	2B	3A	
Provo River (Deer Creek to Jordanelle Reservoir)	1C	2B	3A	

Class 1 -- Protected as a raw water source for domestic water systems. Class 1C -- Domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water.

Class 2 -- Protected for recreational use and aesthetics. Class 2B -- Infrequent primary contact recreation and secondary contact recreation (wading, hunting, fishing).

Class 3: Protected for aquatic wildlife. Class 3A -- Cold water game fish and other aquatic life, including food chain organisms.

Class 3C -- Protected for nongame fish and other aquatic life, including food chain organisms.

Class 4: Protected for agricultural use.

WTP – wastewater treatment plant

Res - reservoir

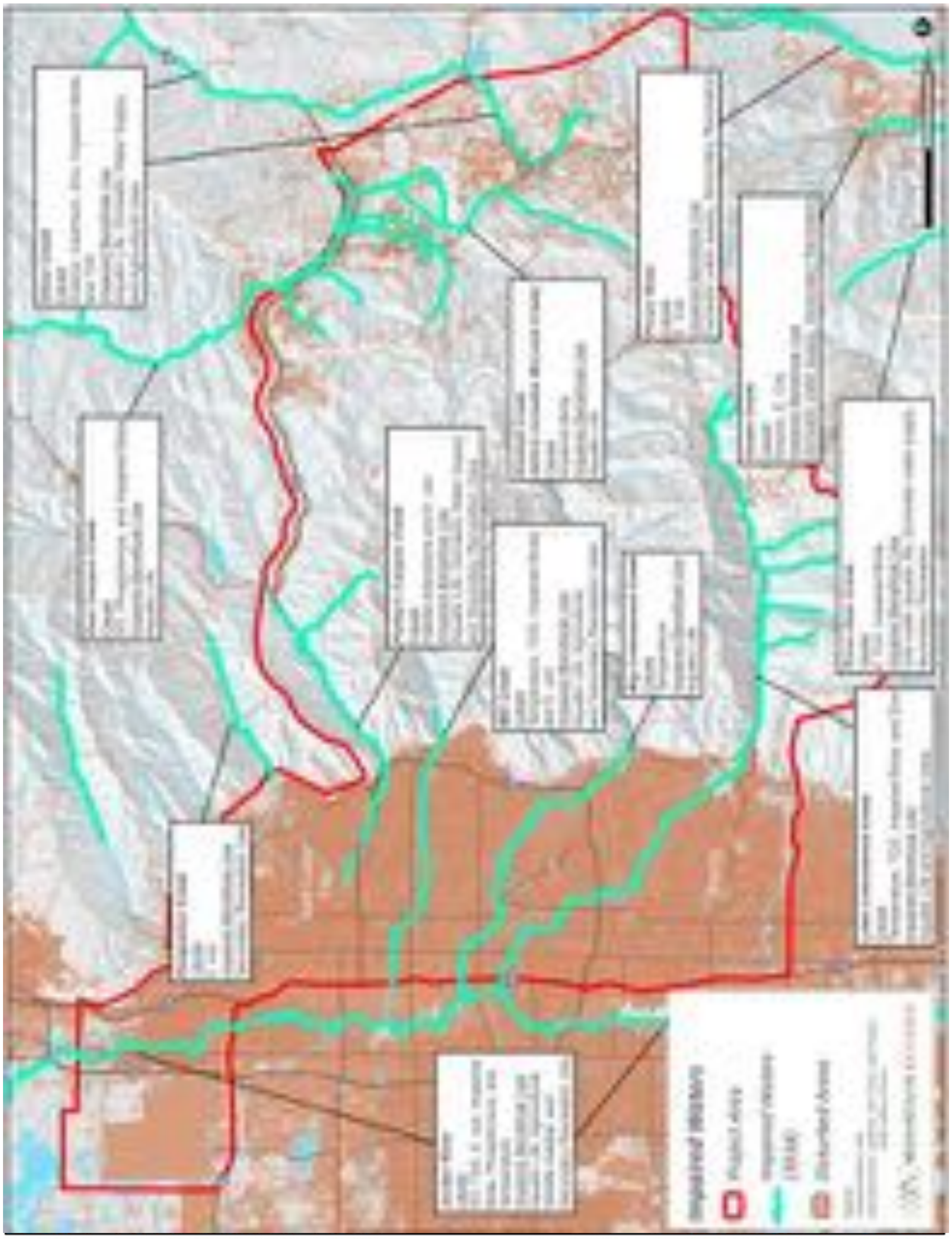

Figure 10. Clean Water Act Impaired Waters

Water Quality (Safe Drinking Water Act)

Along the Wasatch Front and Wasatch Back, we are very fortunate to have a supply of fresh, clean water. However, it is important to be cognizant of sources of the water supply and the quality of the water we receive. The quality of surface waters in the study area is the fundamental basis of the environment system. Surface waters are critical to the health of the watershed and are impacted by all activities that occur within the watershed boundary. In addition, surface water from streams, rivers, and reservoirs and lakes in the study area are a critical component of the drinking water supply for the region. As such, a primary concern and goal for the Mountain Accord process is the preservation of the high-quality source waters and the protection of human and ecological health to users and consumers. **Within the multi-use watershed, prioritization of water quality comes first and multiple use of the watershed is second.** This prioritization is documented in watershed management plans and by the State of Utah beneficial use classification program.

The CWA and State of Utah beneficial use designations described above are meant to protect, preserve, and restore the quality of surface waters for beneficial uses. As the source water provides safe and clean water to greater than a million consumers, the culinary watersheds in the study area are a priority for the Mountain Accord process and the environment system. The Safe Drinking Water Act (SDWA) is relevant to the process as it is the primary federal law that ensures public health is protected through drinking water quality. Under the SDWA, the EPA sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards. The Utah Division of Drinking Water (DDW) is the State of Utah regulatory agency. As previously mentioned under the CWA, the watersheds that are designated as Class 1C are protected for domestic purposes with prior treatment by treatment processes as required by the Utah DDW. In the project area along the Wasatch Front, these Class 1C watersheds are identified in Table 3. For the Wasatch Back, Class 1C watersheds include portions of Kimball Creek and East Canyon Creek as well as Provo Deer Creek and segments of Snake Creek the Provo River.

The SDWA authorizes the EPA to establish national health-based standards for drinking water with the goal to protect consumers against contaminants whether man-made or naturally occurring. There are a number of threats to drinking water and drinking water supplies (e.g., chemical use and disposal, animal and sanitary sewage waste). The EPA and DDW recognize this and as a result have set up multiple barriers/tiers to protect against the threat of pollution to and contamination of drinking water. These tiers include: source water protection, water treatment, distribution system integrity, and public information.

These tiers integrate the natural system and the built infrastructure. It has been previously mentioned that the environment system is a series of interdependencies between the natural and built environments. Nowhere is this interdependency more relevant than in regard to protecting and ensuring high-quality drinking water. Each of the tiers mentioned above is a critical component and failure of any one of these tiers could have catastrophic consequences to public health. Examples include the 2013 chemical contamination of the water supply and distribution system in West Virginia and the 1993 outbreak of Cryptosporidiosis in Milwaukee, Wisconsin. Treatment facilities are not designed to treat every conceivable contaminant, and in both instances unexpected contaminants entered the source water and were conveyed through the treatment facility and on to consumers.

The first barrier to protect the consumers and to ensure high-quality drinking water is source water protection. The beneficial use classification is one of the steps taken toward source water protection. The EPA recognizes source water protection as the first line of defense against water-borne disease. In addition, watershed protection is cost effective and good business practice (Postel et al. 2005). Protection of the watersheds is accomplished through City and County Ordinances, close collaboration with USFS and other agencies, agreements between numerous and varied stakeholders, land protection and purchases, and diligent monitoring of uses and potential impacts in the watersheds.

Water treatment is a second line of defense to address potential contamination sources. Most surface waters used for drinking water in the project area can currently be treated using standard treatment processes, which include flocculation, sedimentation, filtration, and disinfection. Each of these tiers acts as a barrier to protect against the threat of pollution to and contamination of drinking water and when combined effectively treats surface water to high standards. However, all potential contaminants cannot be treated and water treatment facilities are not designed to address all types of treatable contaminants, which makes the quality of source water very critical. For example, average antimony levels were detected above federal and state maximum contaminant levels in water from Park City's Judge Tunnel in 2009. Consequently, the source water has been carefully monitored and actions to meet drinking water standards have been evaluated. System improvements are planned to be implemented in 2014, including treatment plant capacity and process upgrades and source water blending (*Park City Water Quality Update*, November 2012 found at www.parkcity.org).

In summary, the drinking water sources (both surface water and groundwater) that exist within the Mountain Accord project area are critical to the water supply for the region. The high-quality source waters allow for standard water treatment facilities. The source protection is a critical component of the process and is the first line of defense against potential contaminant sources. The water treatment facilities are the second line of defense and are not equipped to handle all potential contaminants.

Groundwater Quantity and Quality

Groundwater is an important source of water supply in the project area, and is used in combination with the surface water supplies described previously. Groundwater also is important in sustaining healthy riparian communities.

Salt Lake Valley Groundwater Use

Groundwater is a key source of water supply and is produced from the deep confined principal aquifer in the Salt Lake Valley. The aquifer is recharged by infiltration of precipitation and surface water from stream channels along the eastern edge of the valley. The total estimated withdrawal of groundwater from wells in the Salt Lake Valley in 2012 was approximately 167,000 acre-feet, which is 41,000 acre-feet more than in 2011 (USGS 2013). This increase in groundwater use is likely attributable to variations in available surface water due to lower-than-average precipitation. Of this increased demand between 2011 and 2012, 76 percent was for public use, with the remainder for industrial use (U.S. Geological Survey [USGS], *Groundwater Conditions in Utah, Spring of 2013*, 2013). A key to meeting future water supply needs may be the conjunctive use of surface water and groundwater. For example, when surface water supplies are available at times when water demand is low, the available surface water may be injected or allowed to seep into the groundwater aquifer. The unused surface water is “stored” underground during wet periods.

Water levels have generally declined since 1987 in wells measured in the Salt Lake Valley. Water levels in two wells completed in the principal production aquifer within the study area, one located in Holladay and one in east Murray, have decreased approximately 22 and 24 feet, respectively, from 1987 to 2013 (USGS 2013).

Maintaining the pristine quality of the watersheds and the mountain streams is necessary to allow for proper management of the quality of groundwater sources. Groundwater in the deeper confined aquifer in the Salt Lake Valley that is used for municipal water supply is generally of high-quality and meets Safe Drinking Water Act criteria. Areas having “Pristine” or “Drinking Water Quality” groundwater cover about 19 percent and 62 percent, respectively, of the Salt Lake Valley basin (Utah Department of Natural Resources [UDNR], *Ground-Water Quality Classification Salt Lake Valley,* 2009). However, legacy groundwater contamination issues associated with the dry cleaning chemical perchloroethylene (PCE) are a problem in some areas of Sandy City and Salt Lake City; as a result, the city has discontinued use at some wells. For example, SLCDPU removed one groundwater well from service after detections of PCE were identified associated with the 700 South 1600 East PCE Plume (currently being addressed by the U.S. EPA and Utah Department of Environmental Quality under the Superfund program). Chloride concentrations have steadily increased in the principal aquifer, most likely from salt used for de-icing roads (Thiros 1995). Other potential groundwater contaminant sources have been compiled for the Salt Lake Valley and can be viewed at:

http://waterquality.utah.gov/GroundWater/Plate_3_SaltLakeValleyPotentialContaminateSources.pdf. Groundwater source protection zones are also located throughout the project area as shown on the interactive map at http://bit.ly/1jDZyjc. Source water protection programs are required by the federal SDWA, as well as the Salt Lake City and County Groundwater Source Protection and Water Source Protection ordinances, respectively. Salt Lake County's groundwater source protection zones are primarily administered by the Salt Lake County Health Department, as well as by specific municipalities in the area, such as Salt Lake City and Sandy City.

Park City Area

The estimated annual groundwater withdrawal for the Park City area in 1999 was 4,800 acre-feet. Despite a steady increase in pumping from 1983 to 1995, groundwater levels in a Park City well indicate no long-term decline. However, according to the Bureau of Reclamation Special Report (USBR 2006), the Snyderville Basin groundwater system is divided into a number of isolated bedrock formation aquifers that are not significantly interconnected, and each has limited storage capacity; therefore, significant future groundwater resource development is not anticipated.

Park City has a drinking water source protection ordinance that protects both surface and groundwater sources. Data pertaining to groundwater quality for the Park City area were not available at the time this report was developed.

Stormwater Quality

Stormwater either flows directly into surface waterways or is channeled into storm sewers, which eventually discharge to surface waters. Stormwater is of concern for two primary reasons: (1) the volume and timing of runoff water can lead to flooding and (2) the potential pollutants the water carries to the surface waters which could affect watershed quality. Stormwater runoff is classified by EPA as a nonpoint source of pollutants to the nation's waterways, and is regulated under the Nationwide Pollutant Discharge Elimination System (NPDES) program. Runoff from urban development, transportation corridors (roadways, maintenance facilities, etc.), agricultural areas, and other disturbed land has pollutant concentrations that routinely exceed natural background levels. Stormwater runoff from these land use types in the project area may contribute to the surface water quality problems described previously.

Municipalities in major urban areas including Salt Lake County must comply with provisions of EPA's municipal separate storm sewer system (MS4) permit program, which requires that best management practices be implemented to reduce stormwater pollution to the maximum extent practicable. The program is administered by the Utah Department of Water Quality. Best management practices must be applied at construction sites, industrial sites, and in areas of new development and significant redevelopment. Smaller communities in the project area like Park City do not have the same requirements for implementing stormwater quality best management practices.

Salt Lake County holds a Utah Pollutant Discharge Elimination System (UPDES) permit to discharge stormwater. This permit requires stormwater quality monitoring to determine any trends in stormwater quality and to assist with the implementation of best management practices. The sampling constituents include total suspended solids, total phosphorous, biological oxygen demand (BOD5), and total metals (copper, lead, and zinc). Upon comparison of event mean concentrations (EMCs) to receiving waters among the years 2000, 2005, and 2008 the following:

- The EMC for the discharges to Big Cottonwood Creek is generally lower compared with the other receiving water bodies within Salt Lake County. This includes all of the parameters, with the exception of metals in 2008. The majority of the land use in this basin is residential.
- The EMC for the discharges to Parleys Creek was higher than the other receiving water bodies for total suspended solids and total lead. The land use in this basin consists of mixed and residential mixed (Stantec 2009).

Stormwater runoff from transportation facilities can contain elevated levels of several pollutants including heavy metals (e.g., copper, lead, zinc, cadmium, chromium), hydrocarbons, and salt and other de-icing chemicals. In addition, road construction and maintenance in forested areas can be responsible for increased watershed erosion and sediment deposition in downstream waterways. Stormwater runoff from transportation facilities is regulated by the Utah Department of Environmental Quality, which issued a Multi-Sector General Permit for a group of industrial facilities that includes transportation facilities. The permit requires implementation of water quality best management practices during construction and long-term operation and maintenance.

3.3 Air

Air quality is a major concern of many Utahns, especially for people living in areas influenced by the Wasatch Front in the greater Salt Lake City metropolitan area. In recent surveys, more than half of Utahns reported being concerned or very concerned with air quality and almost all respondents were willing to act to clean their air.

Pollutants of Concern

The two main air pollutants of concern in the Central Wasatch are ozone and particulate matter. Ozone and most particulate matter are formed in the atmosphere through chemical reactions of precursor pollutants.

Areas that are not in compliance with the EPA's National Ambient Air Quality Standards are referred to as nonattainment areas. A maintenance area is an area

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that was once designated as nonattainment, and which subsequently demonstrated to the EPA statistically that it will attain and maintain a particular standard for a period of 10 years.

Ozone: Ozone is the main component in smog and is most problematic during days with high temperatures and high solar radiation, usually in the summer. Ozone and ozone-precursors (volatile organic compounds and oxides of nitrogen) can be carried hundreds of miles from their original sources. Survey monitoring of the Wasatch Back have reported high levels of ozone that can be greater than the Wasatch Front for the same period of time; ozone levels in the Central Wasatch canyons are a combination of transported ozone formed in the Salt Lake City area and ozone formed at higher altitudes from transported precursors.

Particulate Matter: Particulate matter is composed of solid and semi-solid particles and tiny liquid droplets. Particulate matter can be emitted directly from sources or it can be formed chemically from precursor gases. During the winter, under inversion conditions particulate matter comes from the following sources: approximately 57 percent from mobile sources (vehicles), 11 percent from point sources (industrial), and 32 percent from area sources (e.g., residences, small businesses, consumer goods).

Much of the Wasatch Front experiences high levels of particulate matter during winter inversion periods. A winter inversion occurs when warm air at higher altitudes traps cooler air in valleys. During inversions, the cooler air remains stagnant and particulate matter is trapped near the surface and concentrations gradually build up. High concentrations of particulate matter can also be found during other times of the year when dust storms or fire smoke can impact the Wasatch Front.

Due to various reasons—including improvements made to automobile fuel economy and fuels, strengthened emission standards, periodically restricting open burning of solid fuels, and industrial air pollution controls—“criteria” pollutant levels have decreased substantially in Utah since monitoring began in the 1970s. EPA’s criteria air pollutants include; PM_{10} (particulate matter smaller than 10 microns), $PM_{2.5}$ (particulate matter smaller than 2.5 microns), sulfur dioxide, carbon monoxide, ozone, lead, and nitrogen dioxide. However, in recent years levels of ozone and particulate matter have leveled out and, as EPA has revised the National Ambient Air Quality Standards (NAAQS) downward, these two pollutants remain problematic.

Standards for ozone and particulate matter are shown in Figures 11 and 12, respectively. Davis and Salt Lake counties are just below the NAAQS for ozone and are considered air quality maintenance areas for ozone. Salt Lake and Utah counties are nonattainment areas for PM_{10}; Cache County, Box Elder County, portions of Weber, Cache, and Box Elder and Utah counties, and all of Davis and Salt Lake counties are nonattainment areas for $PM_{2.5}$. EPA has announced that it is planning to again lower the ozone NAAQS in the near future.

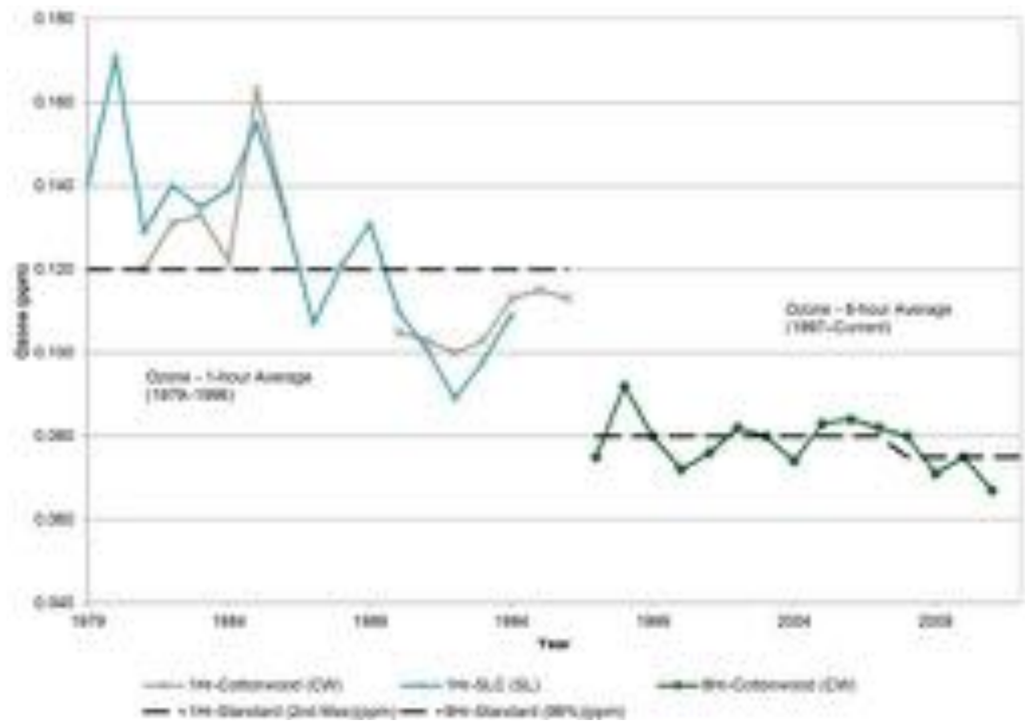


Figure 11. Ozone (O_3) Standards

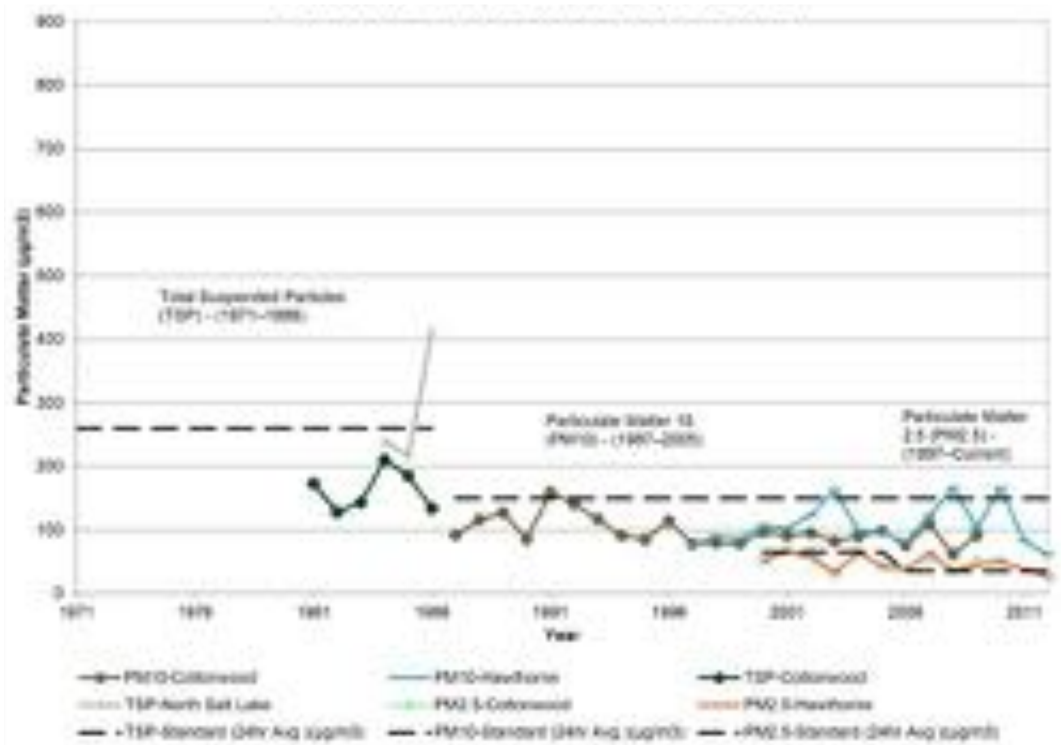


Figure 12. Particulate Matter (PM) Standards (24-Hour)

The Wasatch Front and Back also experience haze—composed of natural particles such as airborne salt and water vapor that are not necessarily health concerns—and particulate pollution, which can be harmful. Haze also affects enjoyment of the viewshed of the Wasatch Front and Back areas. The EPA issued the Regional Haze Rule in 1999, which calls for the improvement of visibility in 156 national parks and wilderness areas across the U.S.

3.4 Ecosystems

Ecological resources, including plants and wildlife and the conditions that support them, are an important component of the environment system in the project area. Ecological resources can be described by their distribution, quantity, and health, which contribute to their ability to adapt to changes, recover from random or severe events, and continue to provide important values and services.

Terrestrial and Aquatic Ecosystems

Credit: worldofstock.com/slides/NAL1950.jpg

Habitats within the project area can be classified as aquatic (water-based) and terrestrial (land-based) ecosystems. These ecosystems and the plants and wildlife that depend on them are distributed throughout the Wasatch Mountains and do not follow jurisdictional or land ownership boundaries. Furthermore, unlike water resources which are heavily regulated under the Clean Water Act and Safe Drinking Water Act, these ecological resources are managed by multiple agencies and landowners and do not have strict legal monitoring requirements. Therefore, the current status and long-term trends are not always well understood and are not routinely or systematically monitored throughout the Central Wasatch. An interactive Mountain Accord ecosystem map can be accessed at: http://bit.ly/1jDZq36.

The biotic (plants and wildlife) and abiotic (soil, water, air) components of ecosystems all play an important and interdependent role in the overall function of the ecosystem. Due to the complexity of the relationships between each component it is often difficult to predict an ecosystem's response to specific stimuli. However, there is broad agreement and understanding of how many significant human actions affect these systems.

Changes in land cover are a significant factor that affects the health of both terrestrial and aquatic systems. Large-scale changes such as urban development and catastrophic fire or relatively local changes such as mine sites can cause long-lasting and significant changes to aquatic and terrestrial systems. Historic and current environmental protections put in place to protect aquatic and terrestrial ecosystems have been successful at remediating some historic impacts and have generally prevented rapid declines in ecosystem health in the mountain areas. Actions to restore degraded sites have also locally improved the condition of ecosystems in the Wasatch Mountains. Avoidance of further impacts, active management to minimize the effects of past and ongoing human actions, and restoration to desired conditions where ecosystem health is poor are strategies that in combination will maintain and improve the existing condition of terrestrial and aquatic ecosystems.

Aquatic Ecosystems

Aquatic ecosystems are extremely limited in Utah but provide a disproportionately high value to both wildlife and humans. These ecosystems are typically limited in distribution to valleys and canyon bottoms and areas along streams or other perennial water sources. Wetlands cover approximately 0.2 percent of Utah, with the majority surrounding the Great Salt Lake. Similarly, wet meadows cover approximately 0.1 percent of the Utah and montane riparian areas approximately 0.2 percent (Utah Division of Wildlife Resources 2005). Healthy aquatic systems provide important services such as groundwater discharge and recharge, flood control, erosion control, sediment and pollutant trapping/filtering, food chain support, fishery and wildlife habitat, and recreation value (Jensen 1993). The health of aquatic systems is directly tied to the surrounding terrestrial systems.

Comprehensive wetland and riparian inventories have not been conducted for the project area and therefore it is difficult to accurately estimate their abundance or distribution in the project area. These ecosystems are most common in areas adjacent to surface water. Therefore, the potential distribution of wetland and riparian areas in the Wasatch Mountains can be estimated by placing a buffer around know surface water features (Figure 13). Note that for illustrative purposes, a 200-meter buffer was added to streams on Figure 13, and buffers do not reflect the relative size of each stream. Extra caution should be exercised when evaluating development activities in these areas. Efforts are needed to identify and classify priority wetlands in the project area and to develop funding programs for protection, conservation and acquisition of these areas (Salt Lake County 2009, Chapter 3).

Wetlands are known to be limited in extent in portions of the project area where they have been inventoried (e.g., Albion Basin), The limited distribution of wetlands in the mountainous portions of the study area, as well as the rugged topography and existing distribution of environmental resources, can make it challenging or impossible to restore or mitigate impacts to existing wetlands (Jensen 1993). Mitigation for impacts to wetland areas is a legal requirement of the Clean Water Act and critical for maintaining water quality in the streams and rivers. Therefore, the distribution of wetlands and other aquatic ecosystems (though not comprehensively understood) can limit development potential in the mountainous areas of the project area.

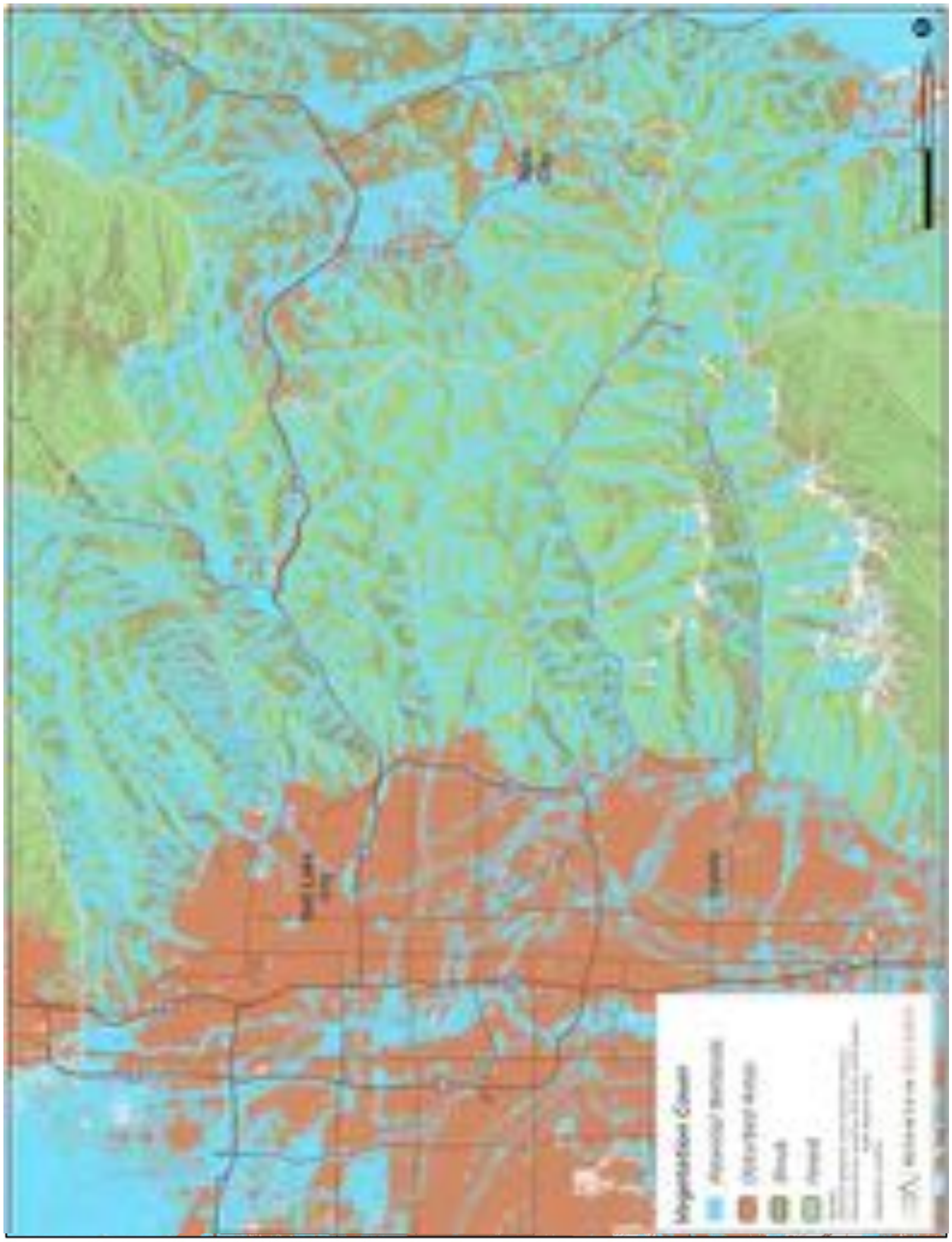


Figure 13**. Vegetation Cover**

Aquatic ecosystems in the Wasatch Mountains within Salt Lake County have been managed protectively and have low levels of physical modification relative to in the highly disturbed Salt Lake Valley (Salt Lake County 2009). As evidence to this proactive management impacts such as historical mining are being remediated in some areas and sewer systems have been mandated in areas supplying culinary water to improve in-stream water quality (e.g., Big and Little Cottonwood Canyons). However, these aquatic systems do not exist in a pristine state. Aquatic system function is generally reduced near development along riparian stream channels, wetland areas, and other areas where stream environments have been physically modified (e.g., where streams have been channelized to accommodate transportation corridors). Other existing impacts include withdrawal or diversion of water, sediment from unpaved roads, ski area and residential expansion, campground use, potential over-fishing, and stocking of fish species not historically present (Schwager and Cowley 2000).

The condition of aquatic systems decreases considerably for all Wasatch Front streams once the streams reach high-density development in the Salt Lake City metropolitan area (Salt Lake County 2009). In general, urbanization has altered the natural function of valley streams as they flow west toward the Jordan River. Loss of function includes reduced flood buffering capacity, fisheries degradation, and natural filtration and capture of sediment and pollutants. Impacts to stream function frequently arise from flood control (i.e., channelization and bank modification), replacement of natural riparian vegetation with invasive species and domestic landscapes, and physical barriers such as dams, culverts, or other manmade structures. Man-made structures also limit the movement of aquatic species and diminish the natural regional connectivity of the mountain streams.

An evaluation of the physical, chemical, and biological function of the waterways in Salt Lake County found that mountain stream segments in the project area scored higher than valley streams, with the exception of Little Cottonwood. Little Cottonwood Creek was found to be similar in function to some valley stream segments that have experienced extensive modification (e.g., Jordan River). This degraded condition can be largely attributed to impacts of historic mining. However, Big Cottonwood Creek maintains an overall healthy ecosystem and productive riparian communities despite existing stressors (Schwager and Cowley 2000). While the mountain watersheds draining to the Wasatch Front generally support relatively high levels of stream, wetland, and riparian system health and function (Salt Lake County 2009, Addendum Stream Function Index Main Report), there are cases in which montane riparian ecosystems have been severely altered. For example, diversion of in-stream flows in Little Cottonwood Canyon has resulted in complete loss of aquatic habitats, loss and modification of riparian habitats, desiccation of vegetation, and increased risk of fire in the surrounding terrestrial system.

Stream, wetland, and riparian systems on the Wasatch Back are less well studied, but have experienced degradation due to development, agriculture, historic mining, and runoff from mineral-rich soils (Utah Department of Environmental Quality Division of Water Quality 2000).

Historical mining has exposed minerals that decrease water quality in some streams on both the Wasatch Front (e.g., Little Cottonwood Creek) and Back, which has resulted in the extirpation (local extinction) of some native and desirable fish (e.g., Bonneville cutthroat trout). Recent management of aquatic species in mountain streams is beginning to take the existing condition and fragmentation of these aquatic environments into consideration. For example, USFS is initiating a reintroduction of Bonneville cutthroat trout into Mill Creek Canyon. This reintroduction includes removing structures that limit fish migration, replacing current fish stock with native stock, and establishing native riparian vegetation.

Terrestrial Ecosystems

The diverse topography and elevations in the project area support a variety of terrestrial ecosystems, including coniferous and deciduous montane woodlands, shrubland-dominated vegetation in the Snyderville Basin, and valuable habitats such as alpine meadows and tall forb (i.e., wildflowers and other herbaceous plants) communities. Human induced changes on the landscape have altered the quantity and distribution of terrestrial ecosystems in the project area, even in areas that currently appear healthy and intact to casual visitors. For example, meadows and tall forb communities are thought to have lost approximately half of their historical extent due to past excessive livestock grazing and soil loss (USFS 2003). These degraded sites are difficult or impossible to restore and are vulnerable to invasion by non-native plants.

Data from the Landscape Fire and Resource Management Planning Tools Project (LANDFIRE) suggest that, with the exception of small areas primarily in the Lone Peak Wilderness, much of the vegetation in the project area has experienced a moderate to high level of departure from historical reference conditions. Lower elevation areas generally have experienced a greater degree of departure compared to higher elevations (see Figure 14). In some areas, important shrubland ecosystems are being converted to grasslands due to the combined effects of invasive species encroachment and associated changes in fire regimes as well as drought induced shrub mortality. Contributing factors to vegetation change in shrublands include grazing, drought, and invasive plants. In woodlands, fire suppression has resulted in high fuel loads and conifer encroachment in aspen stands. Aspen stands provide wildlife habitat, biological diversity, water retention, and aesthetic values and populations are declining state wide (Utah Division of Wildlife Resources 2005). Aspen are adapted to relatively frequent fires and other disturbance (e.g., avalanches). In the absence of disturbances, coniferous species become established and eventually shade out aspen. Coniferous forests are also experiencing increased fuel loads that can result in catastrophic wildfires. Drought and infestations of disease and insects such as pine beetles are a major contributing factor to increased fuel loading.

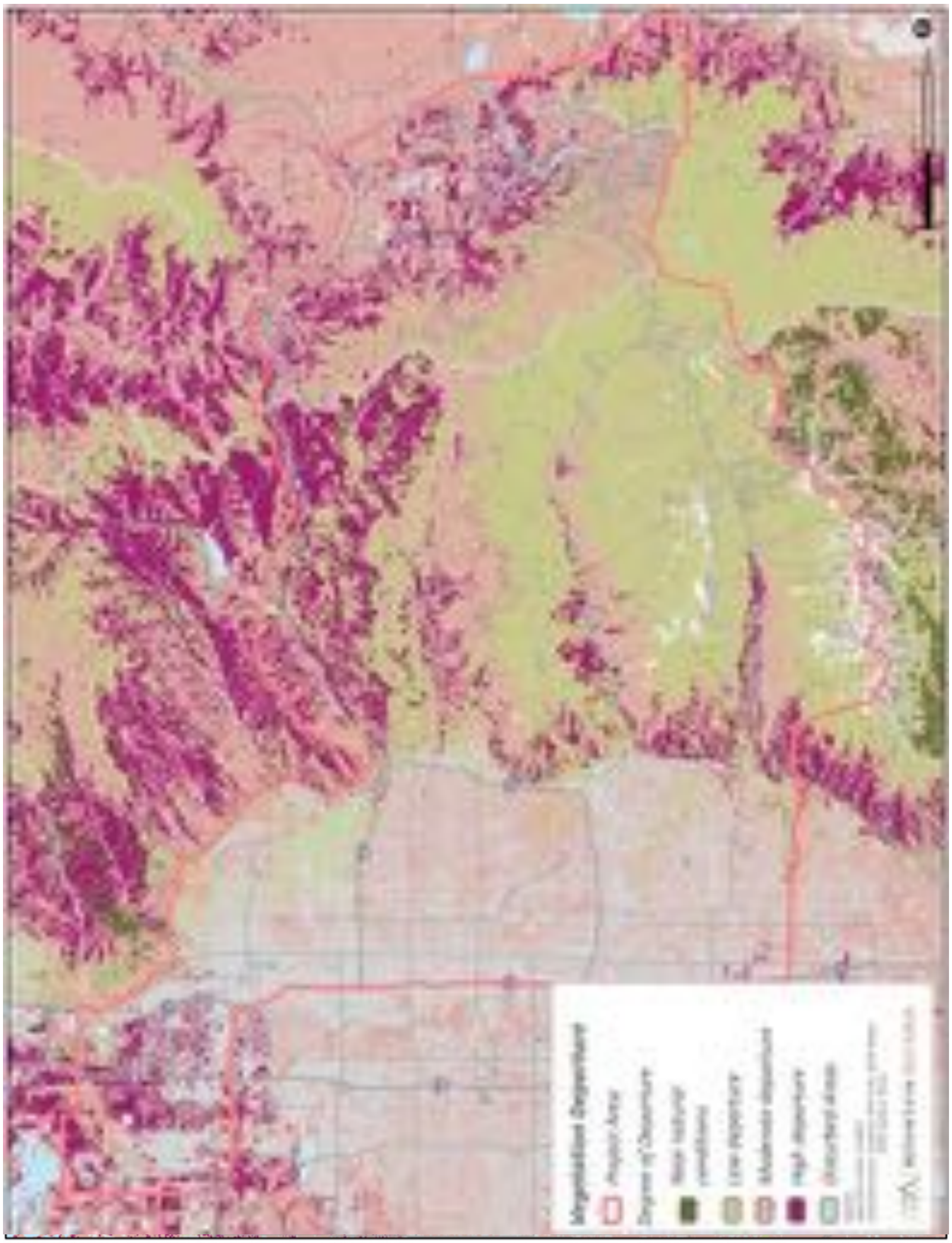


Figure 14. Vegetation Departure

What is "departure"?

- *Changes in ecosystem function, species composition, structural stage, and canopy closure from reference (potential natural vegetation in a healthy system) conditions.*
- *Changes can result from wildfire and fire suppression, invasive species, insect infestations and disease, climate change, drought, and large-scale landscape management (e.g., clear-cutting, stream diversion).*
- *Identifies areas not functioning in their natural range of variation (i.e., unhealthy areas).*

Why is departure important?

- *Areas with high departure may be more prone to catastrophic events (e.g., wildfire, flooding) that endanger human life, property and water quantity and quality.*
- *Areas with high departure provide reduced ecological services (e.g., reduce wildlife habitat quality, stream buffering capacity).*
- *Departure affects forest water/carbon balance (i.e., how much carbon the forest can store, and how much water is absorbed by the forest).*

Plants and Wildlife

The current status and distribution of plant and wildlife species in the Central Wasatch today reflects historical changes to the ecosystems upon which they depend. Many native plant and wildlife populations in the project area have declined where ecosystem health is poor or declining. Additionally, many non-native plant and wildlife species have been introduced and become established in the project area. Some species are rare or declining due to the fragmentation and degradation of the terrestrial and aquatic ecosystems that provide their habitat.

Many species of mammals, birds, amphibians, and invertebrates that were historically present in the project area are now absent as a result of hunting, disease, habitat loss, and fragmentation. Species believed to be extirpated include gray wolves, wolverines, Canada lynx, Rocky Mountain bighorn sheep, Columbia spotted frog, least chub, and boreal toad as well as numerous migratory birds and aquatic invertebrates. Other species whose populations are believed to have declined from historic levels in the Wasatch Mountains include black bear, bobcats, river otter, and beaver. Many of these species (e.g., beaver) provide important services that are important for the natural function of the ecosystem. Their decline and extirpation is an indicator of the substantial environmental modification that has occurred compared to pre-settlement conditions.

Some species are used by land managers to indicate the overall health of ecosystems. Management approaches that improve the habitats of these species are likely to have benefits for a variety of other plant and wildlife species as well

(Graham et al. 1999). Many of these species are known or believed to be in decline in the project area. Some native fish are absent from the project area (e.g., least chub), and others such as Bonneville cutthroat trout have declined substantially from historic levels or have been extirpated from streams (e.g., Little Cottonwood Creek, Mill Creek). Amphibians and aquatic invertebrates are other commonly used indicators of riparian and aquatic health, and declines or extirpations have been observed in some species in the Central Wasatch.

Northern goshawks are indicator species for overall forest health. While no detailed studies have been conducted in the Central Wasatch, populations are believed to be in decline. This decline may be indicative of declining forest health. At a statewide level, threats to goshawk habitat are primarily related to fire-suppression, timber harvest, and urbanization of forests. Similarly, greater sage-grouse are present in the Snyderville Basin and can indicate health of sagebrush ecosystems. Suitable sage-grouse habitat is increasingly fragmented by development, fire suppression, over-grazing, and invasive plants (Crawford et al. 2004).

Other wildlife in the project area includes big-game species that migrate seasonally from high-elevation summer ranges to low-elevation winter ranges. Human and agricultural development in lower-elevation winter range (i.e., Salt Lake Valley and Snyderville Basin) has resulted in substantial loss of winter forage, and availability of winter range is a limiting factor for most big-game species in the project area. Natural predators of big game including mountain lions and coyotes occur in the Wasatch, but populations are believed to be substantially reduced from historic levels. Reduced natural predation and loss of winter range can result in populations of big game species exceeding the carrying capacity of available habitats. Active management of herds though regulated hunting is used to maintain herd sizes within the capacity of available habitats, avoid severe habitat degradation from overuse, and maintain herd health of big game animals.

Seasonal migrations place wildlife at risk of fragmentation when barriers limit access to important habitats, and can create a hazard to wildlife and public safety where migration routes cross transportation corridors such as I-80 and U.S. 40. Installation of fences and wildlife underpasses on these highways has reduced, but not eliminated, hazards to both wildlife and humans. Recognizing and promoting the connections between mountain and valley habitats as well as existing patches of suitable habitats is critical to maintaining and improving wildlife populations.

At present, mule deer are widespread in the project area both in high elevation montane habitats in the summer and low elevation habitats in the winter. Elk are present in low elevation areas in the winter. Elk populations are regionally at or above management objectives, although summer population centers are located outside of the project area. Moose are present in the project area, but populations may be declining for unknown reasons. Across the project area, mule deer populations are generally below management objectives. The current status of all of these species may be a result of competition among large herbivores for limited forage, along with the effects of decreased populations of large natural predators that may have limited elk populations in the past.

Populations of rare and endemic plants are present in the project area and have been identified as at-risk due to habitat loss and recreational collection. Rare plant populations are particularly vulnerable to habitat loss and modification because they often rely on unique localized habitats that are difficult to restore or replicate. Additionally, invasive and noxious weeds are increasing in extent, especially surrounding developments, roads, and trails, and they represent a substantial threat to both plant and animal habitats.

Some non-native plant and wildlife species were introduced deliberately, as potential livestock forage (plants) or for sport hunting and fishing (wildlife). Others have been brought in accidentally, including most noxious weeds and aquatic pests. Species that have been introduced include mountain goat, California quail, American bullfrog, snapping turtles, house mice, New Zealand mudsnail, a variety of fish, noxious weeds, and invasive plant species, and numerous bird species that are tolerant to human development. Where present in native habitats, these species compete with and displace native and desirable species, further exacerbating the effects of habitat loss and fragmentation.

Insects and disease are considerable threats to the health of terrestrial ecosystems in the project area. Monitoring has identified localized outbreaks and conditions are expected to decline with long-term drought conditions and climate change. For example, at lower elevations in Millcreek Canyon, subalpine fir, Douglas fir, and white pine mortality can be observed. While these outbreaks are not as extensive as in other areas of Utah (e.g., the Uinta Mountains), recent droughts have compounded the impact that beetles have on tree survival. Gypsy moths are another pest species that can devastate foliage of many tree species. Outbreaks have been detected in the project area but have been successfully managed by implementing early detection and eradication programs (Western Forest Health and Invasive Species Committee 2007). Similar approaches are likely needed to control other pests, insects and invasive plants before outbreaks become unmanageable.

Noxious weeds and other invasive plants are affecting both terrestrial and aquatic ecosystem health by outcompeting native plants, altering vegetation structure and fire regimes, and decreasing forage quality for wildlife. On both the Wasatch Front and Back, reports of weeds in residential and commercial areas have increased recently. Infestations are nearly always associated with human activity such as construction, roads, and trails (Figure 15). Efforts are underway to contain and control existing infestations, but the continued spread remains a serious concern.

Figure 15. Areas with Known Noxious Weeds

Changes to terrestrial vegetation communities, including changes in species composition, fuel loads, and fire cycles, are complicated by an increasing level of human development. Human populations and natural systems meet at the wildland-urban interface (any location where extensive natural vegetation is adjacent to human development) where land managers face the challenge of simultaneously protecting the lives and property of residents while also protecting the ecosystem itself. A statewide wildlife risk assessment conducted by the Utah Division of Forestry, Fire and State Lands identified the forested areas in the Central Wasatch Mountains as having a moderate to high risk of wildfire. The same assessment identified risk of wildfire as high in areas immediately adjacent to the study area to the northeast and south (Utah Division of Forestry, Fire & State Lands 2014). Reducing fuel loads often requires artificially simulating historic conditions (e.g. manually removing accumulated fuels to simulate fire). These efforts can be costly and cannot completely replicate the full effects of natural ecological processes; however, they are critical to the protection of both humans and the ecosystems they enjoy.

Restoration and improved management and protection of the ecosystems in the Wasatch Mountains could help stabilize and improve declining wildlife populations and provide opportunities to restore extirpated populations. The success of past and ongoing restoration efforts in the Wasatch demonstrates high potential for future restoration efforts.

3.5 Land

For the purposes of this document, the land discussion focuses on four key topics identified by the public, stakeholders, and project team as areas of concern: land protection and management, viewsheds, cultural resources, and soils. Although limited funding for land protection exists, it is a continual challenge to keep pace with the threat of development. Incredible viewsheds draw people to the mountains; however, development continues to result in impacts, and views are compromised on days with poor air quality. Soil contamination from historic mining is a concern in some areas, especially on the Wasatch Back.

Land Protection and Management

There are lands within the project area that are set aside or managed to conserve and protect natural and cultural values. Levels of protection vary from statutory to regulatory and administrative. Ownership includes federal, state, and local governments, non-profit land trusts, and private landowners. Various types of land in the project area are summarized in Table 4. Different mechanisms are used to protect open space. They range from fee simple purchase to conservation easements or purchase of development rights; these mechanisms are used either separately or in combination with each other in the project area.

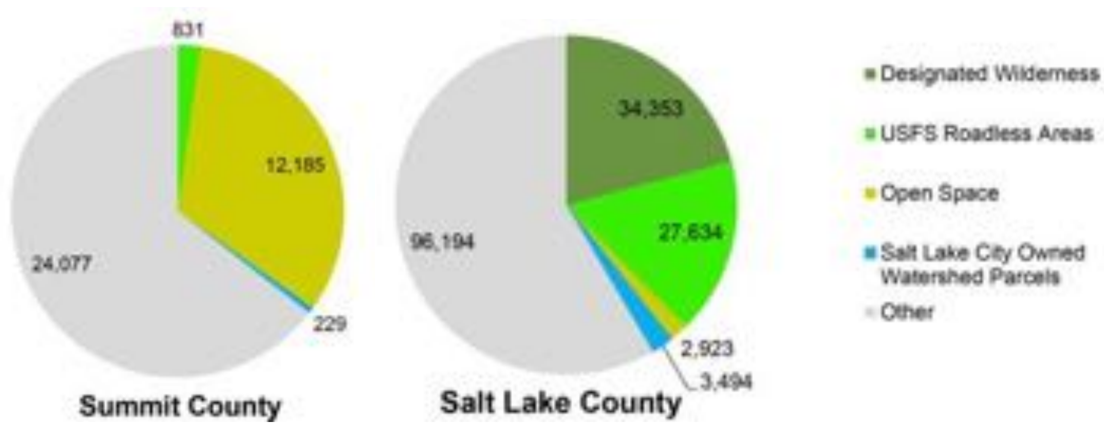
Table 4. Land Types

Land Protection Type	Description
Federally Designated Wilderness	Designated by Congress; no roads, vehicles, or permanent structures allowed
USFS Roadless Areas	Areas without roads that are substantially natural; limited improvements and past activities allowed
Salt Lake City Owned Watershed	Parcels managed for watershed protection
Open Space	Managed to protect values such as recreation, aesthetics, ecological health, community character, or quality of life. Includes: state/city/county/ non-profit/privately owned land with restrictions on use or development
Other	Remaining acreage in the project area not afforded formal protection. Includes: urban space, city/county parks, lands with/without zoning restrictions, and lands managed as open space, but with no formal restriction or easements.

The National Forest Management Act (NFMA) requires the development of a management direction for each National Forest. Various standards and guidelines apply to management areas across the entirety of the lands managed by USFS. These management areas are open to greater or lesser levels of development or activity than others. The Revised Wasatch-Cache National Forest Management Plan guides the management activities for the forest within the project area, specifically those sections that apply to the Central Wasatch Management Area (USDA 2003) and defines the goals, objectives, standards, guidelines, management prescriptions, desired future conditions, and monitoring and evaluation requirements for the forest. The focus of the Forest Plan for the Central Wasatch Management Area revolves around “the need to provide long-term, high-quality culinary water to the large urban population of the Salt Lake Valley” (USDA 2003). The need to balance the congressional direction of protecting the watershed and designated wilderness while continuing to provide high-quality recreational opportunities will require ongoing management efforts.

Open space in this document is defined as city, county, non-profit, or privately owned land encumbered by a conservation easement or a deed restriction. It is recognized that the level and term of protection and the manner in which condemnation occur are different for a conservation easement and deed restriction but for the purpose of this document these two types of land protection categories are combined. Lands which may have zoning or development restrictions in sensitive areas (i.e. riparian habitat, steep slopes, and ridgelines) as well as city/county parks are not included as part of open space.

Figure 16 shows the approximate distribution of different types of lands in the project area.



Note: Data shown in acres; Wasatch County includes 150 acres of open space.

Figure 16. Approximate Distribution of Land Types within Project Area

MOUNTAIN ACCORD

Figure 17 shows an overview of these lands. There are a total of 164,598 acres in the project area in Salt Lake County of which 68,608 acres are afforded some level of protection/management (approximately 42 percent). Summit County has just over 37, 000 acres in the project area with 13,245 acres protected (approximately 36 percent). The predominant type of protection in Salt Lake County is on federal land (designated as wilderness or roadless areas, approximately 21 and 17 percent, respectively); the predominant type of protected land in Summit County (approximately 33 percent) is open space as defined above. Approximately 42 percent of lands in Salt Lake County within the project area are afforded some level of protection whereas in Summit County only 35 percent of lands are protected. Only 3 percent of lands in the project area in Wasatch County are protected open space.

Protected land serves many functions such as safeguarding ecosystem health and water quality, preserving views, and providing solitude and passive recreation opportunities. Protected areas in developments improve public health and safety by protecting hazard areas such as steep slopes.

In 2006, Salt Lake County voters approved a $48 million bond to purchase future parks and open space; these funds were expended by 2010. In 2003, Salt Lake City voters approved a $5.4 million bond for open space. A surcharge on Salt Lake City water bills provides roughly $1.5 million in funding per year for watershed protection. Park City and Summit County are increasing protected area acreage through purchases and conservation easements. Since 1998, nearly $59 million has been approved by Summit County residents for open space bonds. Park City residents have approved an additional $22 million for open space. The LeRay McAllister Critical Land Conservation Fund has been a key funding component for conserving open space in the project area in the past; however, the Legislature has not funded any monies to the LeRay McAllister Fund for the past three years.

Both Salt Lake City and Park City have ordinances in place to protect sensitive lands within their jurisdiction. The general purpose of the Salt Lake County Foothills and Canyons Overlay Zone (FCOZ) is to “promote the health, safety, and public welfare of the residents of the county, and while being cognizant of private property rights, to preserve the natural character of the foothills and canyons by establishing standards for foothill and canyon development proposed in in the unincorporated areas of the county” (Salt Lake City, no date). Similarly, Park City has a Sensitive Areas Overlay Zone (SOD) whose “purpose is to require dedicated open space in aesthetically and environmentally sensitive areas; encourage preservation of large expanses of open space and wildlife habitat; cluster development while allowing a reasonable use of property; prohibit development on ridgeline areas, steep slopes, and wetlands; and protect and preserve environmentally sensitive land” (Park City, no date). Salt Lake City requires protection associated with development in the city’s watersheds to protect its water supply under Chapter 17.04 of its municipal code. The Salt Lake County Health Department has regulations concerning development and sanitary conditions under its Regulation #14 and others.

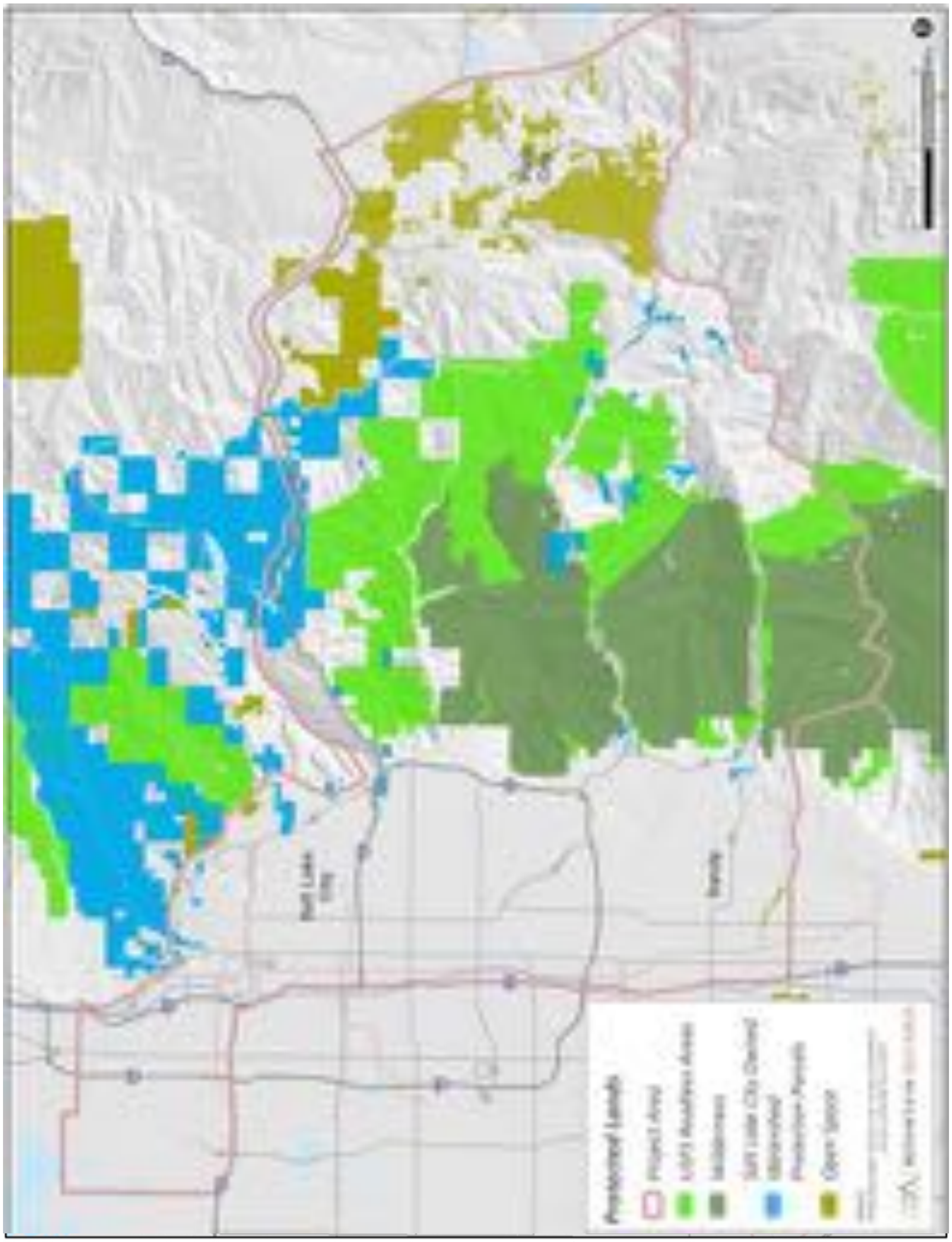


Figure 17. Land Classification

While no new federal wilderness areas have been designated in the project area since 1984, Representative Jim Matheson re-introduced the Wasatch Wilderness and Watershed Protection Act (HR 2808) to the U.S. House of Representatives in 2013.

Viewsheds

Viewsheds are areas of high natural visual quality. In the project area, much of the focus is on ridgeline protection, with some focus on maintaining vegetation for visual buffering of development.

To date, few jurisdictions have mapped viewsheds and ridgelines for protection. Salt Lake County's FCOZ and Park City's SOL protect ridgelines, in some cases completely prohibiting ridgeline development.

According to the recommendations of the Blue Ribbon Commission on Salt Lake County's FCOZ, the development of human-made structures should be harmonious with the landscape's natural settings, retain the natural topographic features, fit the natural slope of the land, and make the best use of the natural terrain. It recommended the preservation of environmentally sensitive areas and open space through the use of design techniques such as clustering so as to preserve the natural terrain, and minimize disturbance to existing trees and vegetation. Development of night-time lighting ordinances that recognize and allow night-time recreation at mountain resorts was also recommended (Blue Ribbon Commission 2013).

USFS applies a Scenery Management System to manage scenic views on national forest land by management zone. Mitigation is often required to protect elements such as ridgelines and other scenic elements.

Cultural Resources

The Mountain Accord Study encompasses an area with a long and significant history. During the prehistoric period, the area was occupied by various groups beginning as early as 10,000 years ago. These groups left behind a great body of material culture as evidence of their occupation, including stone artifacts, ceramics, and rock art. The documented history of the region began with the arrival of the first European American trappers and explorers during the early part of the 19th Century. At that time the Salt Lake Valley was occupied by mobile Shoshone groups subsisting on edible plants, hunting, and fishing. The Wasatch Range, the rivers of the Salt Lake Valley, and the shores of the Great Salt Lake remain significant places of traditional use for these native peoples. The first permanent European-American settlers were a result of the westward movement of Mormon pioneers to the Utah Territory in 1847. With the arrival of these settlers the native inhabitants of the region were marginalized and ultimately displaced.

Though the area was occupied by prehistoric peoples dating back thousands of years, it is primarily known for its significance in the early economic development of Utah associated with the mining and railroading industries. The Cottonwood Canyons and Park City Mining Districts produced millions of dollars of precious metals during their heyday. Many historic structures and archaeological features remain as a legacy to the historic mining and railroading period in the region.

There are two National Register Districts in Park City: the Main Street Historic District and the Mining Boom Era Residences Thematic District. In addition, six Historic Zoning Districts have been designated in the city and there are multiple standing landmarks and historic properties associated with the mining and settlement era. Preserving and maintaining the historic character of these districts is one of the core values in the Park City General Plan. In addition to precious metals, large blocks of quartz monzonite were hand quarried at the Temple Quarry Site (42SL109) in Little Cottonwood Canyon and transported by teams of oxen to Salt Lake City for the construction of the Salt Lake City Temple of the Church of Jesus Christ of Latter-day Saints (Mormons). This site has been determined eligible to the National Register of Historic Places and the Wasatch National Forest has established the Temple Quarry Trail, with signs describing the cultural and natural features of the quarry, to provide an easily accessible opportunity for public interpretation of this significant historic site. Today, the Cottonwood Canyons and Park City area are the focus of a multi-faceted recreational industry.

Soils

Soils are interrelated to water, air, and ecosystems. Erodible soils are a concern for water and air quality and play an important role in ecosystems. Soil characteristics including permeability and runoff potential are important considerations for watershed protection.

The soils in the project area are directly related to the surficial geology. The Wasatch Front falls within the Basin and Range Physiographic Province, whereas the Wasatch Back is in the Rocky Mountain Physiographic Province. Soils in the mountains of the Wasatch Front are susceptible to soil erosion which is controlled by factors such as poor land management practices, overgrazing, and agriculture and construction activities (Salt Lake County 2009). Soil erosion rates are controlled by precipitation intensity, soil texture and erodibility, land slope, land cover, and land management practices. Soils in the Salt Lake County have been characterized as having a “slight” erosion potential in the valley as defined by the Nation Resource Conservation Service (NRCS)(Salt Lake County 2009). Big and Little Cottonwood Canyons have a “severe” potential at lower elevations and “moderate” potential at the highest (and rockiest) elevations. Soil erosion potential in Parleys Canyon and surrounding area ranges from “moderate” to “severe”, with the majority of the area being classified as “severe.” A map of the erosion potential for Salt Lake County is shown in Figure 18.

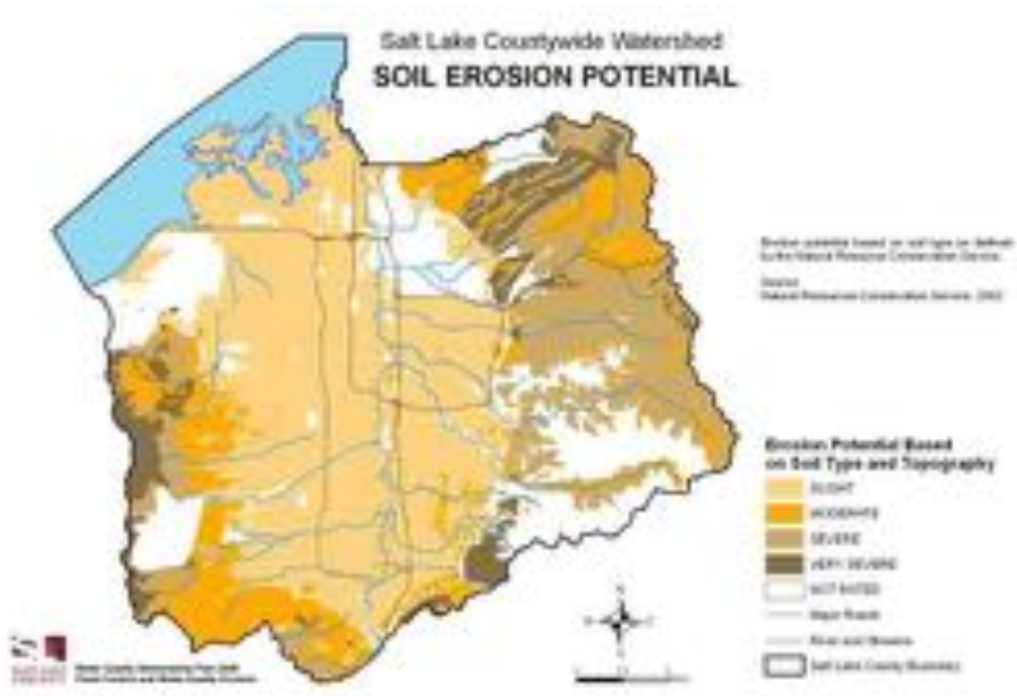


Figure 18. Salt Lake Countywide Watershed Soil Erosion Potential

Soil contamination is a concern in the project area and occurs largely as a result of historic mining activities, although other more recent waste generators have also resulted in contamination. Figure 19 illustrates areas of contamination in the project area. There are four Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (a.k.a. "Superfund") sites in Salt Lake County, with, notably, the Davenport and Flagstaff Smelters located at the mouth of Little Cottonwood Canyon. A number of other sites are identified on the EPA's Compensation and Liability Information System (CERCLIS) database throughout the valley.

Many areas in Park City have been affected by historic mine-related waste. Some contaminated soils in the city have been mapped and are addressed in the Park City Soil Ordinance; the extent of which is illustrated on Figure 19.

Within Park City area, there are currently six CERCLIS sites, one Utah Voluntary Cleanup site, and an Institutional Control administered by Park City. Two sites, the Silver Creek Tailings Site and the Richardson Flats Tailings Site lie just outside the project area boundary. In addition, other sites within Summit County and the Park City municipal boundaries have not yet been assessed or may warrant additional assessment.

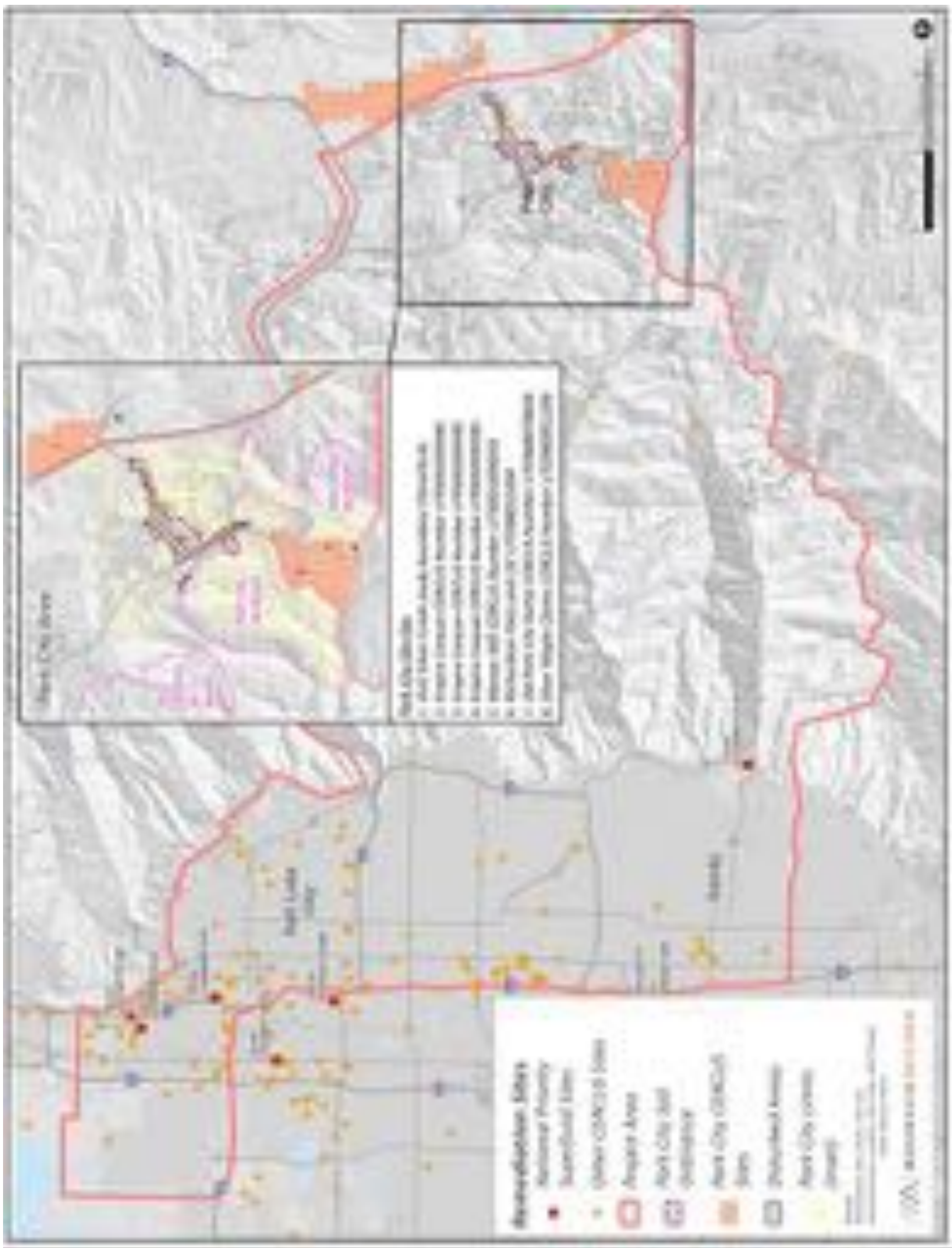


Figure 19. Remediation Sites

3.6 Comments & Poll Results on Existing Conditions

Comments Received at First Group Meeting

What is the biggest environmental issue facing the Wasatch (in the natural and human/built environment)? Issues identified were:

- Lack an inventory of flora and fauna and their relationship to the Wasatch and its vitality
- Population growth and its impact (increased demand and use)
- Climate change (uncertainties, impacts to resources)
- Water quality and quantity
- Air quality
- Management by multiple overlapping political jurisdictions
- Recreation impacts to environment (as a function of increasing population, changing demographics, ski expansion, mountain biking)
- Vegetation management
- Funding for preservation of open space and agriculture
- Guarding against land swaps/long-term [land] preservation. There is an inability to preserve lands because there is neither money available nor priority to do so. Land is getting developed via trading or land swap.
- Piecemeal decisions without management ability to manage population growth

“Physical land use” and land ownership (public versus private) needs to be considered when looking at performance metrics and other aspects. Roughly 20% of the canyons in the Wasatch Front portion of the study area are privately owned. Future development or re-development of the privately owned lands holds the potential to impact the environment and other systems.

Note: The Executive Board has agreed that climate change is occurring; however, there is not agreement on what is causing it.

What should be the [environment] group’s highest focus?

- Climate change
- Population
- Land preservation
- Data (or lack thereof)

What types and sources of data should be used in establishing the existing conditions?

Data Types:

- Stream/riparian function and condition
- Water quantity: in-stream flow and uses
- Land use: agriculture, open space, etc.
- Fragmentation (e.g., utility corridors, roads)
- Soils: contamination
- Ecosystems/biodiversity
- Invasive/noxious weeds
- Stream health
- Wildlife health
- Impermeable surfaces/development
- Historic plant/animal species
- Population (current, growth)
- Water: groundwater (levels, quality, surface water interaction), runoff, source water protection zones, geothermal wells, wastewater, and stormwater
- Air: visual standards/viewshed, National Parks Service haze standards, inversion (relation to canyons), greenhouse gas emissions, air quality studies (Big and Little Cottonwood canyons)

Data Sources:

- Salt Lake Countywide Water Quality Stewardship Plan (2009): rapid water assessment
- EPA Emap
- USFS: Watershed Condition Framework (http://www.fs.fed.us/publications/watershed/)
- Noxious/invasive weeds: EDD Maps, Salt Lake County, Summit County
- Utah Department of Air Quality: air quality data
- EPA: carbon monoxide and carbon dioxide data
- NEON: National Science Foundation study (migration of particulate matter up Red Butte Canyon)
- Seth Arens (Utah Department of Environmental Quality): Study of ozone at higher elevations
- University of Utah: Migration/altitude study (elevation of pollutants)

Data Requests that could not be Filled

Most of the requests for additional data or information from the first Environment System Group meeting are addressed in this document. Mountain Accord is focused on integrating existing data and information, not collecting new data. Where data was considered relevant to the project goals, and was either provided by system group members or readily attainable form other sources, it has been incorporated. However, not all of the requests could be filled within these parameters.

For example, a request was made to manipulate existing GIS data to create a dataset showing potential wetlands and riparian areas by buffering streams (with variable width based on order) and including hydric soils and data from the National Wetlands Inventory. Additionally, requests were made to collect species occurrence data, collect information on historic vegetation and wildlife species that occupied the project area, and conduct a detailed analysis of habitat fragmentation based on manipulation of existing data regarding the locations of wildlife habitats and human disturbances. The consultant team reviewed available information related to these requests and incorporated observations from this information into the existing conditions report. However, time did not allow for a detailed quantitative GIS analysis of potential wetlands and existing habitat fragmentation.

Summary of System Group Poll Results on Existing Conditions Information

Poll is yet to be completed; after poll is complete the poll results will be summarized below.

The members of the Environment System Group were polled on their level of concurrence with the draft existing conditions report plus changes recommended by the group…

4. DRAFT FUTURE TRENDLINES

4.1 Introduction

The following is a first draft summary of future trendlines information that could be relevant to Mountain Accord. The intent of this draft is to solicit input from the public and the Environment System Group before the report is updated and finalized. The future trendlines discussion is organized in three sections. Section 4.2 includes baseline projections and forecasts that affect all four system groups (environment, transportation, recreation, and economy). All four groups are using the same projections and forecasts for population growth, land use, transportation, and climate change. Section 4.3 includes discussion on how population growth, land use, transportation and climate change projections affect the four major sub-groups of the environment system (water, air, ecosystems, and land). Section 4.3 will include a summary of comments and poll results after review of this draft (it is currently just a placeholder).

4.2 Baseline Projections and Forecasts

Population Growth

Utah's population has experienced consistently high growth, which has outpaced national growth rates continuously for several decades. According to the U.S. Census and Utah Governor's Office of Planning and Budget, between now and 2040, population is anticipated to grow about 58 percent statewide, from approximately 2.90 million to 4.57 million. In Salt Lake County, the anticipated growth will be slightly slower because developable land is scarcer. Summit and Wasatch counties, on the other hand, are anticipated to have steeper population growth rates than Utah as a whole:

- Salt Lake County: 1.08 million to 1.51 million (an increase of 42 percent)
- Summit County: 38,000 to 71,000 (an increase of 86 percent)
- Wasatch County 26,000 to 59,000 (an increase of 123 percent)

With so many new residents interacting project area, significant shifts in patterns of living, working, commuting, transacting business, and recreating will occur. These shifts will lead to increased challenges and opportunities, and will require thoughtful planning and investment in transportation and infrastructure projects, developed and undeveloped recreation accommodations, and environmental resource protection. Along with population growth, sustained growth in tax revenue will occur and will provide significant resources for the investments that are needed.

Land Use

The significant population bump in Salt Lake, Summit, and Wasatch counties between now and 2040 will increase the need for land development, driving construction of housing, retail, and commercial structures for nearly 500,000 new residents. This would result in an approximate 43 percent increase in the built environment in these three counties. Along with this population increase, important shifts in household size will occur. In each county, more units will be required per capita compared with current conditions:

- Salt Lake County: Average household size will **decrease** from 3.01 to 2.62. To accommodate the future population in the county, land development to support 231K new housing units, along with appropriate, retail, commercial, and office space is anticipated.
- Summit County: Average household size will **decrease slightly** from 2.80 to 2.74. Land development to support 13K new housing units, along with appropriate, retail, commercial, and office space is anticipated.
- Wasatch County: Average household size will **decrease** from 3.23 to 2.95. Land development to support 12.7K new housing units, along with appropriate, retail, commercial, and office space is anticipated.

Currently, the average residential acreage developed per person is: SLCO- 0.13; Summit-1.87; Wasatch-1.19 acres/person.

All three counties have undertaken planning in the most recent decade to shift land use and development patterns toward more dense, integrated, and sustainable patterns. Generally speaking, the average land consumed per capita in Salt Lake County would remain stable because it is already low. In Wasatch and Summit counties, significant reductions in land consumption per capita are likely, as more dense, clustered developments with preserved open spaces will be a common and standard development pattern.

Transportation Performance

Average daily traffic volumes have remained relatively constant on most corridors for the last decade, and generally the primary roadways accessing the Wasatch Front and the Wasatch Back function well under typical conditions. Unlike most urban-type roads that have the highest traffic loads during commute times, corridors in the study area frequently experience congestion during weekends and evenings from travel associated with recreation, tourism, and special events. Inclement weather, incidents, special events, and road closures also significantly impact mobility.

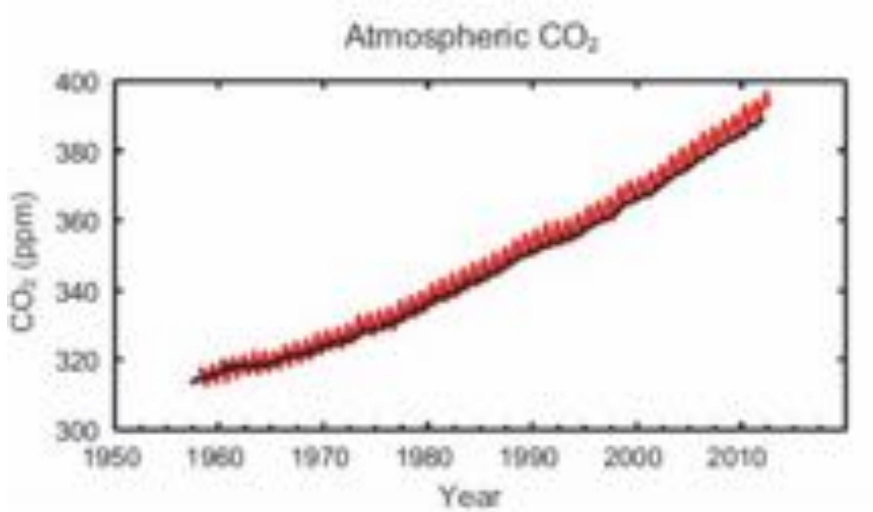
There is an extensive network of bus and rail throughout the Wasatch Front, and Park City Transit operates a free year-round bus service throughout Snyderville Basin and Park City with service to mountain resorts. Additionally, there is an express bus service to Park City and seasonal (winter) bus routes serving the Cottonwood Canyons.

Although transit service is available, travel by private automobile is by far the dominant travel mode, as evidenced by parking congestion. In the Cottonwood Canyons, trailhead parking is at or near capacity on weekends, and ski areas struggle to accommodate visitor demand on holiday weekends. Transit park-and-ride lots are well utilized during the winter. Parking is frequently at capacity at recreation access points in the Wasatch Back during peak summer periods, and parking is usually scarce in Park City during the ski season.

Climate

Existing Conditions

Atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years (IPCC 2013). In addition, the mean rates of increase in atmospheric concentration of greenhouse gases over the past century are unprecedented in the last 22,000 years (IPCC 2013). Carbon dioxide (CO_2) concentrations have increased by 40 percent since pre-industrial times, primarily from fossil fuel emissions, contributing to a global warming trend. Figure 20 shows the increase in atmospheric concentrations of carbon dioxide since 1958 from Mauna Loa, Hawaii (red) and the South Pole (black).

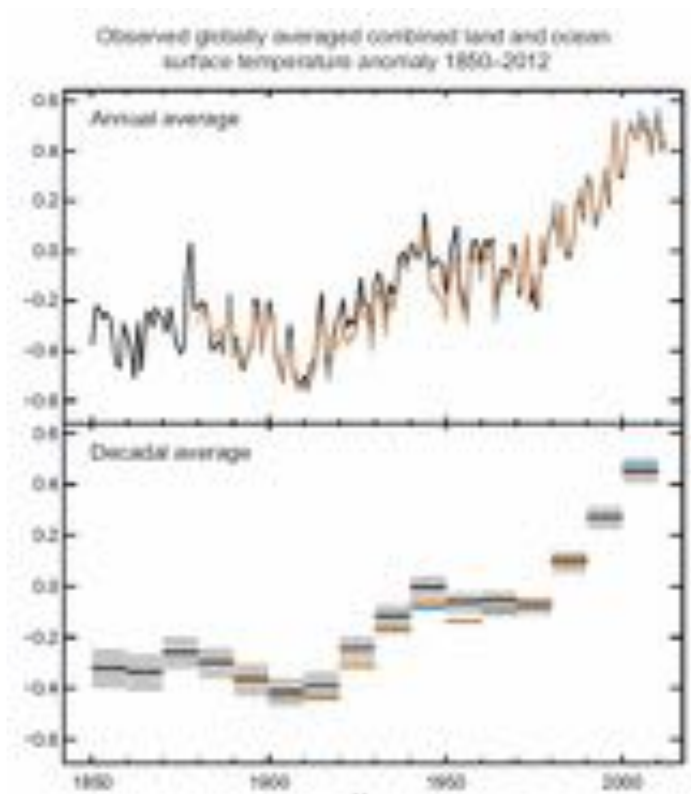


Source: IPCC, 2013 Summary for Policy Makers

Figure 20. Increase in Atmospheric CO_2 Levels

MOUNTAIN ACCORD

Warming of the climate system is unequivocal. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. In the Northern Hemisphere, 1983 to 2012 was likely the warmest 30-year period of the last 1400 years (IPCC 2013). The globally averaged combined land and ocean surface temperature data as calculated by a linear trend, show a warming of 0.85°C (1.53°F) over the period 1880 to 2012, when multiple independently produced datasets exist (see Figure 21). The increase in temperature has reduced the frequency of low temperatures and frost while heat waves have become more common.



Source: IPCC, 2013 Summary for Policy Makers

Figure 21. Average Global Temperature, 1850 – 2012

Utah

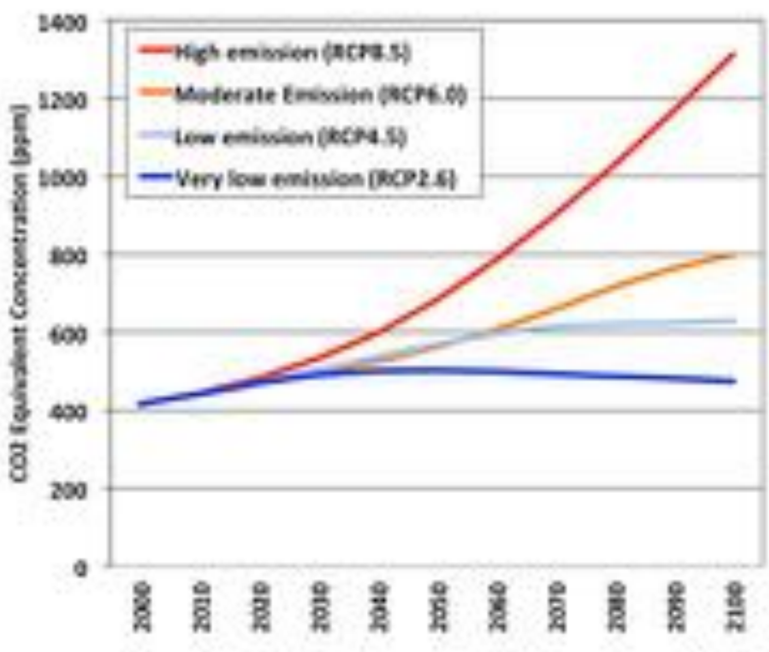
Historic long-term trends in stream flows and mountain snowpack remain uncertain. Annual precipitation amounts vary dramatically in Utah from year to year, making it difficult to identify precipitation trends. Geologic records and tree-ring data in the Colorado River Basin, reveal periods of very long droughts (*Climate Change and Utah: The Scientific Consensus: Report to Governor Jon Huntsman's Blue Ribbon Advisory Council on Climate Change*, 2007). Reconstructions in the Intermountain West suggest that droughts in previous centuries have often exceeded those of the past 100 years of observed record in both duration and magnitude (Bekker et al. 2014).

On a statewide basis during winter (January to March) the fraction of wintertime precipitation that falls as snow, snow depth, and snow cover have exhibited long-term declines during the past few decades (Gilles et al. 2012). These trends are likely dominated by declines at low elevations, with little or no trend at upper elevations.

Future Trendlines

Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gases (IPCC 2013). Figure 22 below shows a range of greenhouse gas concentration (mainly CO_2) trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC) for its 2013 assessment report.

Representative Concentration Pathways or RCP is the current generation of climate change scenarios adopted by the IPCC. RCP emission scenarios allow for a range of modeling scenarios (very low, low, moderate and high emissions).



Source: RCP Database version 2.0.5, http://tntcat.iiasa.ac.at:8787/RcpDb/dsd?Action=htmlpage&page=compare.

Figure 22. Greenhouse Gas (Mainly CO_2) Concentration Trajectories

The global mean surface temperature increase for the period 2016 to 2035 relative to 1986 to 2005 will likely be in the range of 0.3°C to 0.7°C (0.5°F to 1.3°F). This assessment is based on multiple lines of evidence and assumes there will be no major volcanic eruptions or secular changes in total solar irradiance (IPCC 2013).

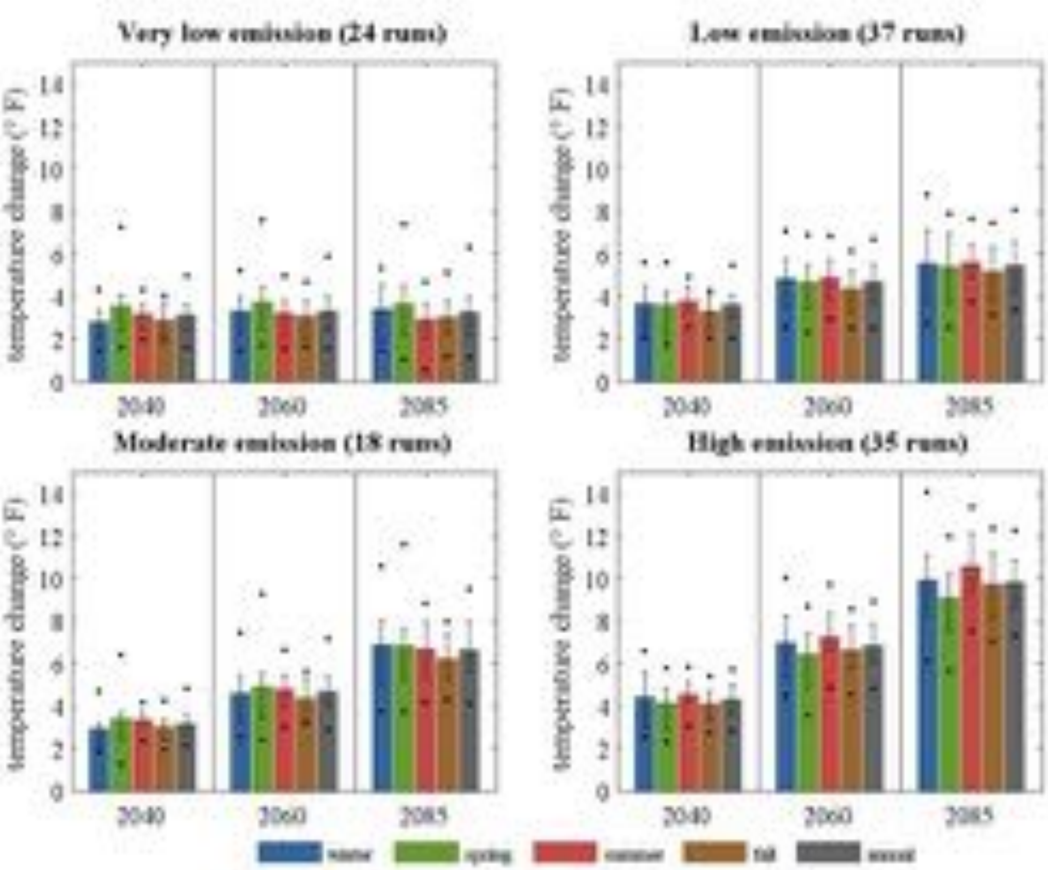
Increase of global mean surface temperatures for 2081 to 2100 relative to 1986 to 2005 is projected to likely be in the ranges of 0.3°C (0.5°F) to 1.7°C (3.1°F) based on RCP 2.6 simulations up to 2.6°C (4.7°F) to 4.8°C (8.6°F) based on RCP 8.5 simulations (IPCC 2013). There is a very high confidence that the Arctic region will warm more rapidly than the global mean, and mean warming over land will be larger than over the ocean (IPCC 2013).

It is virtually certain that there will be more frequent hot and fewer cold temperature extremes over most land areas on daily and seasonal timescales as global mean temperatures increase. It is very likely that heat waves will occur with a higher frequency and duration. Occasional cold winter extremes will continue to occur (IPCC 2013).

Looking forward, Utah is expected to warm more than the global average increasing the likelihood of the following trends continuing to emerge and strengthen in the 21st century:

- Increased temperatures, longer growing season, more heat waves
- Reduction in natural snowpack and snowfall in the early and late winter, particularly in lower-to-mid elevation mountain areas (trends in high elevation areas are unclear)
- Earlier and less intense snowmelt-driven spring runoff
- Increased demand for agricultural and residential irrigation due to more rapid drying of soils
- Warming of lakes and rivers with associated changes in aquatic life including increased algal abundance and upstream shifts of fish habitat

Utilizing the RCP scenarios, Figure 23 below shows projected seasonal and annual near-surface air temperature change over the central Wasatch and surrounding region for the 30-year periods centered on 2040 (2026 to 2055), 2060 (2046 to 2075), and 2085 (2070 to 2099) relative to 1976-2005. Winter is December through February, spring is March through May, summer is June through August, and fall is September through November. Bars show the average change across the model runs, whiskers show the range between the 25th and 75th percentile of the model runs, and filled circles show the range between the 10th and 90th percentile of the model runs. All scenarios show a 2.5°F to 4.5°F temperature increase by 2040 with considerable variability between climate models and emission scenarios.



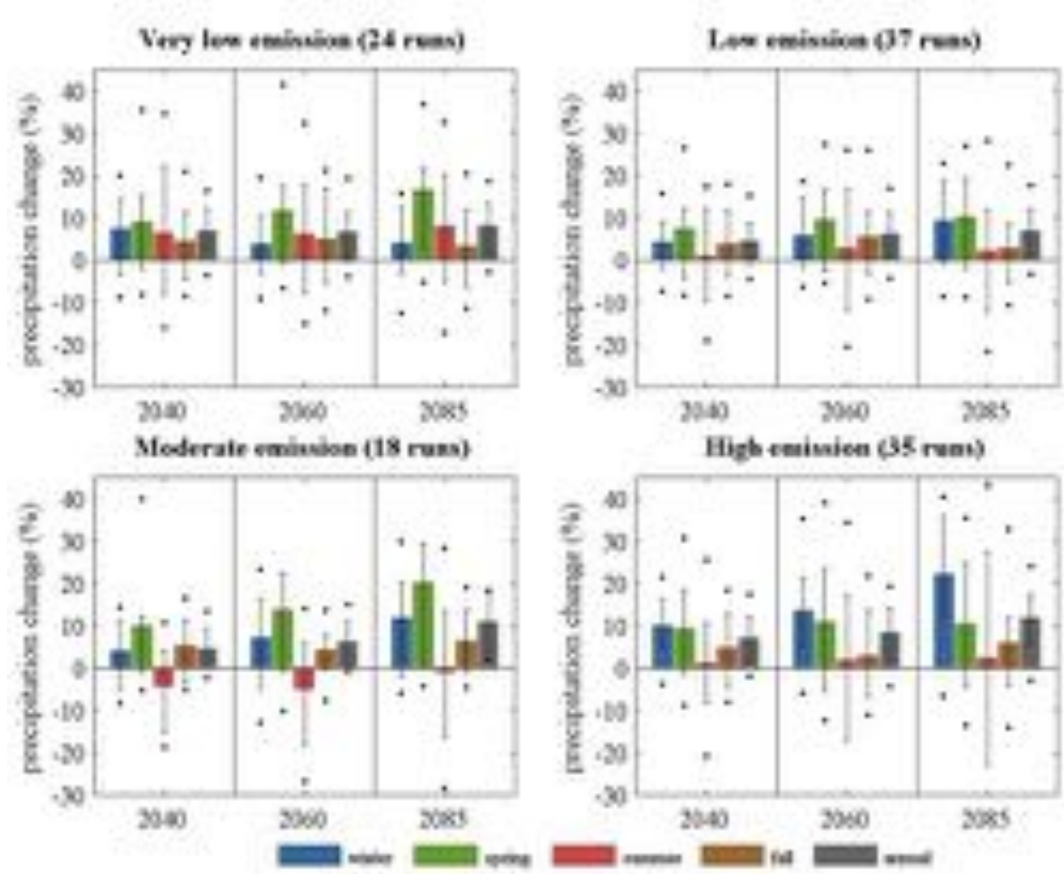
Source: http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html

Figure 23. Projected Seasonal and Annual Near-Surface Temperature Change

There is greater uncertainty in precipitation projections for northern Utah than temperature. While projections on average indicate wetter conditions on average, Utah is located in an uncertain transition zone. The models produce a broad range of overall precipitation trends (from as much as 30 percent drier to 40 percent wetter for the middle 80 percent of projections depending on season and the emission scenario).

Figure 24 below shows seasonal and annual precipitation change over the central Wasatch and surrounding region utilizing the RCP scenarios and the same 30 year periods highlighted in Figure 23 above. While bars show an average increase in precipitation across model runs, one should note the range of uncertainty represented in each scenario.

Climate model projections, combined with knowledge of past climate variations from tree-ring reconstructions, suggest the potential for larger year-to-year and decade-to-decade fluctuations in precipitation and stream flow during the 21st century than observed during the 20th century.

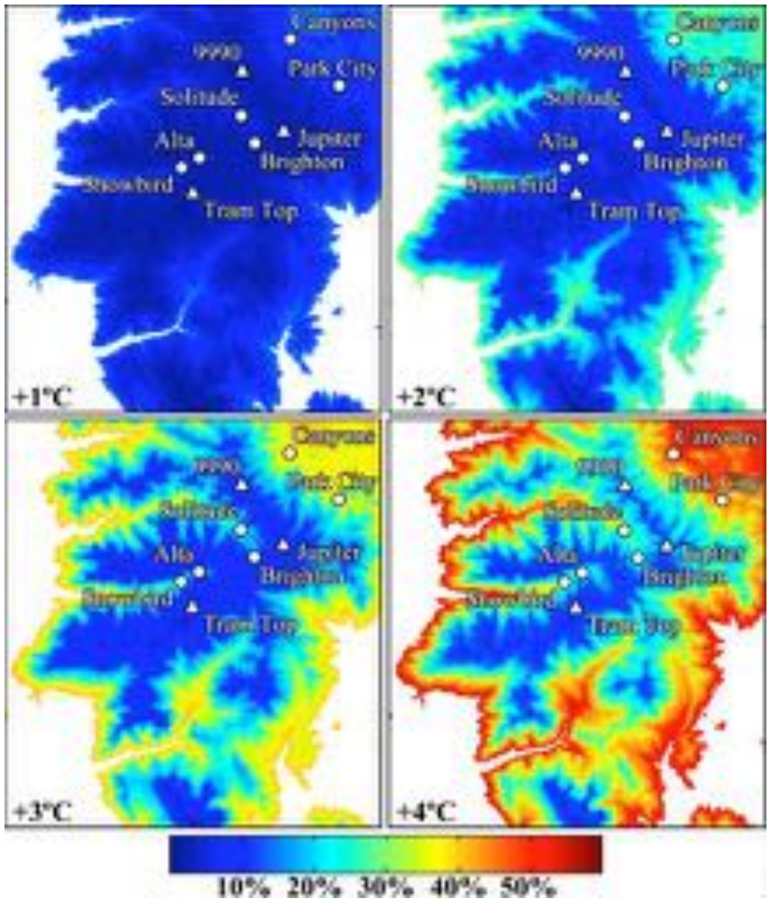


Source: http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html

Figure 24. Projected Annual and Seasonal Precipitation Change

Recent research shows that the influence of climate change on snow varies depending on the measure. Temperature and the fraction of winter precipitation that falls as snow exhibit measurable trends first, followed by the fraction of winter precipitation retained in the spring snowpack, and then the water content of the spring snowpack (Pierce et al. 2013).

While changes in total cool season snowfall are the hardest to detect, it is believed that year-to-year variations in snowfall will continue to dominate mountain snowpack during the next couple of decades. As temperature increases through the century, the fraction of precipitation that falls as snow will decrease it and the length of the snow accumulation season will decrease. Figure 25 below shows the percentage of precipitation (liquid equivalent) that currently falls as snow that would instead fall as rain per °C of warming.

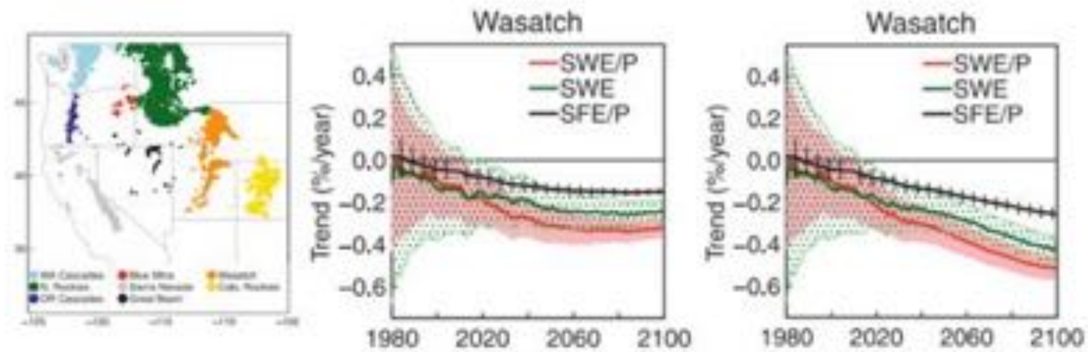


Source: Steenburgh, J., 2014: Secrets of the Greatest Snow on Earth. Utah State University Press. In press.

Figure 25. Percent Increase from Snow to Rain per °C Increase

Figure 26 below shows the mean trends (%/year) in snow-related variables in the "Wasatch Mountain Region" (orange in left figure) derived using downscaled climate models for the RCP4.5 (center) and the RCP8.5 (right) climate scenarios. Model results bulleted below indicate a downward trend in snow levels and increasingly earlier spring runoffs.

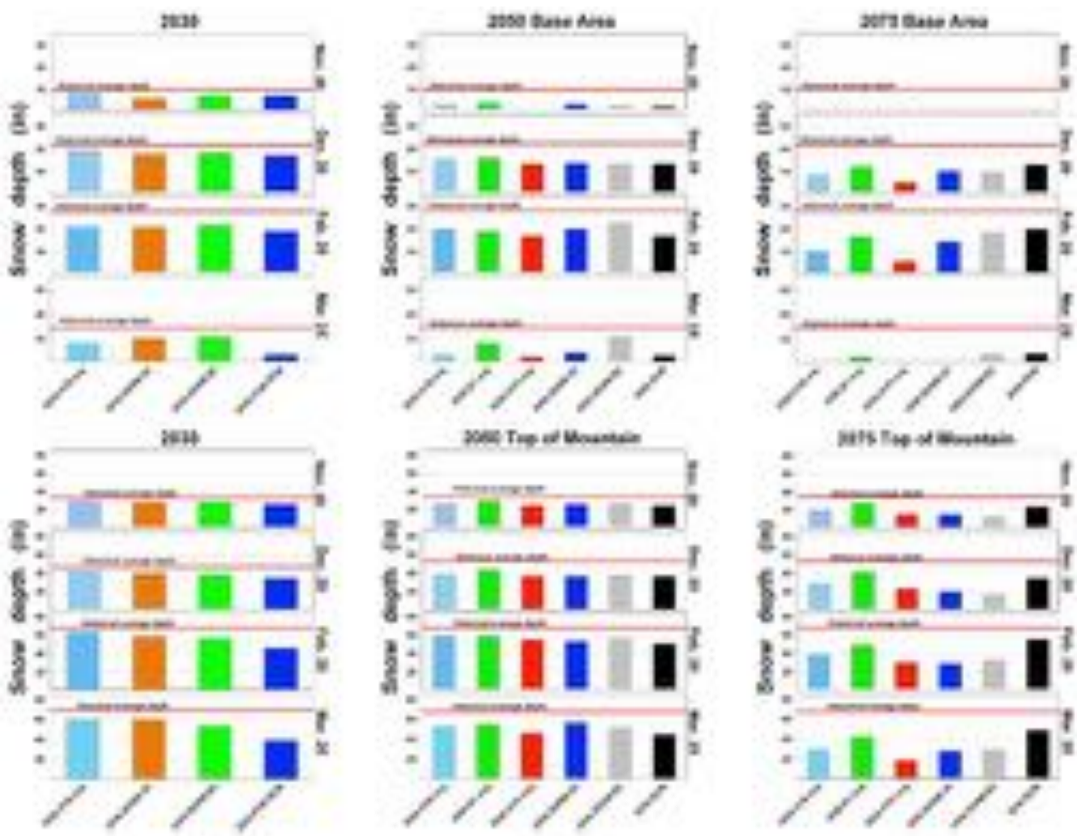
- SWE/P (snow water equivalent/fraction of precipitation) = Fraction of precipitation from October 1 through March 31 that remains in the snowpack on April 1 (orange curve with 95 percent confidence limits indicated by orange shading)
- SWE (snow water equivalent) = Amount of water contained in the snowpack on April 1 (green curve with 95 percent confidence limits indicated by green stippling)
- SFE/P (snow fall equivalent/fraction of precipitation) = Fraction of total water in the precipitation from October 1 through March 31 that has fallen as snow (black curve with 95 percent confidence limits indicated by vertical black bars)



Source: D. W., and D. R. Cayan, 2013: The Uneven response of different snow measures to human-induced climate warming.

Figure 26. Wasatch Mountain Snow-Related Variables

Figure 27 below shows projected snow depths at the base and top of Park City Mountain in 2030, 2050, and 2075 for several climate model scenarios generated in 2009. Note that the figure is based on previous-generation climate change models projections.



Source: Stratus Consulting, Inc., 2009: Climate change in Park City: An assessment of climate, snowpack, and economic impacts. Not peer reviewed.

Figure 27. Projected Park City Snow Depths

4.3 Trendline Effects to the Environment System

Water

Population Growth

As populations along the Wasatch Front and Wasatch Back continue to grow, additional water sources will need to be developed to meet projected demands. Water supply graphs shown previously in Figures 5 and 6 for the Wasatch Front, and in Figure 7 for the Wasatch Back, project annual water needs into the future and identify additional water sources as demands increase with time. (Note that climate change impacts, which are likely to alter both demand and supply as discussed in the Water and Climate Change section below, are not reflected in these figures.)

Current and future water sources for the Wasatch Front from 2000 to 2100, shown by the "Projected Production Requirement – With Conservation" line in Figure 5, barely meet water demand during a typical dry year, assuming the conservation goal to reduce the 2000 per capita water demand by 25 percent continues to be met and that necessary additional water resources are developed. Figures 5 and 6 reflect water supplies available in a typical dry year, which is used for planning by urban water providers in the project area.

Future water needs for the Wasatch Back, which include the rapidly growing Park City and Snyderville Basin areas, are projected through the year 2050 in Figure 7. The population increase assumed (approximately 24,000 to 86,000 from 2001 to 2050) does not account for the anticipated 3.1 million annual visitors to the area. The forecast shows that projected reliable water sources will not meet future demands even with additional groundwater development; therefore, future pipeline development projects have been identified to meet the projected demand.

Land Use/ Development

Future land development could adversely affect water resources in the project area. Water quality could be adversely impacted by increased recreational use in the Wasatch Mountains as a result of waste disposal, sewage, roadways, and other factors. Increased development, particularly in the higher elevations and foothills, may also degrade water quality in streams as runoff from more impervious surfaces will affect stormwater quality. Wildfire is a significant threat to water quality, and the wildfire risk is increasing due to climate change, degrading forest health, water diversions, and in some cases forest management practices.

Relative water quality improvements are also expected to occur, including cleanup of historical abandoned mines, tighter water quality regulations (e.g., on wastewater effluent and stormwater management programs particularly for the Wasatch Back).

Development and enforcement of waste load allocations associated with TMDLs for 303(d) listed impaired streams by the State of Utah are also expected to address water quality issues and ideally result in overall water quality improvements.

Transportation

Expansion of transportation systems to meet the needs of future populations, and/or increased traffic on existing transportation systems, could adversely affect water quality in project area watersheds. Roadway runoff typically contains relatively high concentrations of heavy metals, hydrocarbons, and salt or de-icing chemicals. Roadways with higher traffic volumes produce more of these pollutants. Transportation corridors in natural areas can produce increased loads of sediment relative to undisturbed areas due to land grading and road maintenance. Constructing new or widened roadways in sensitive watershed areas could degrade water quality in receiving waters, even with application of water quality best management practices typically applied to transportation projects.

Overall Watershed Health

The previously discussed future trends in water demands, water quality, and climate change all could have an adverse effect on watershed health. The stressors of additional water development, water quality degradation, and a drier climate could lead to future conditions in which the project area watersheds would not be able to provide the ecological and social benefits they have in the past. This could affect the ability of the watersheds to produce water supplies in quantities needed to meet future demands and with a quality that can be treated to drinking water standards with conventional treatment processes. The effectiveness of current watershed protection efforts could be tested as these stressors become more acute, and new more stringent efforts could be needed to preserve current water quality and quantity conditions.

Water and Climate Change

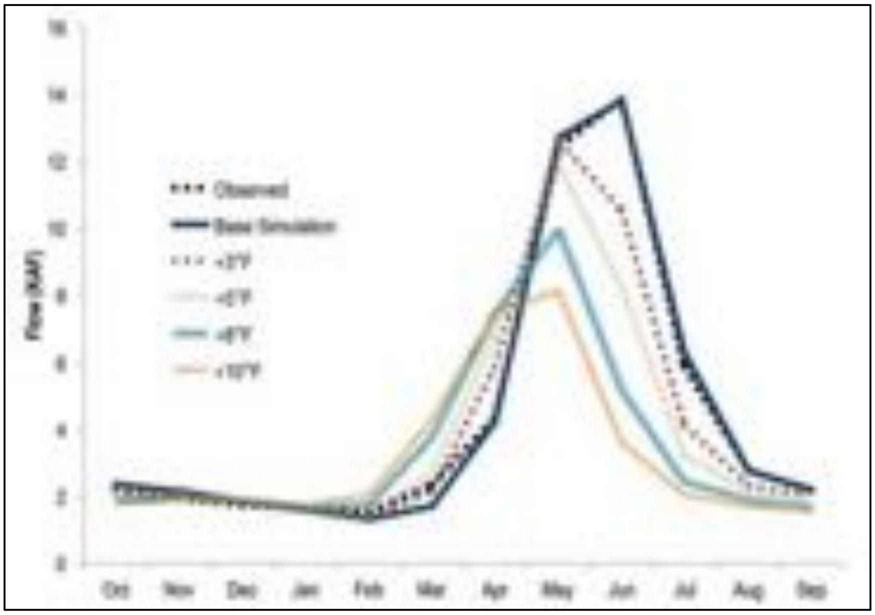
The potential drivers and impacts of future climate change were discussed in Section 3.2.5. Current forecasts and assessments of climate change for the State of Utah indicate that it could have significant impacts on water resources in the project area. The key findings of previous climate change assessments as they relate to water, as compiled in Climate Change and Utah: The Scientific Consensus (2007), are as follows:

- Short-term projections
  - Year-to-year variations in snowfall will continue to dominate mountain snowpack, stream flow, and water supply during the next couple of decades.

  - As temperature increases through the century, it is likely that a greater fraction of precipitation will fall as rain instead of snow, and the length of the snow accumulation season will decrease.

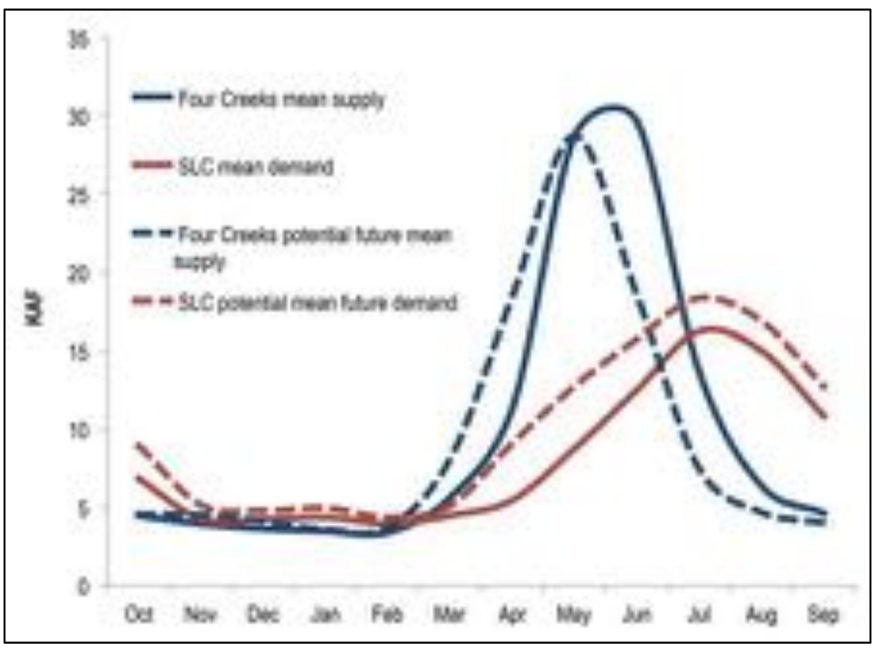
- Long-term projections for the second half of the 21st century:
  - Climate models project an increase in global mean temperature of 3°F to 7°F, with greater warming for larger increases in greenhouse gas concentrations.
  - Utah is expected to warm more than the global average.
  - Reduction in snowpack and snowfall in the early and late winter, particularly in lower-to-mid elevation mountain areas (trends in high elevation areas are unclear).
  - Earlier and less intense snowmelt-driven spring runoff.
  - Increased demand for agricultural and residential irrigation due to more evapotranspiration and rapid drying of soils.
  - More frequent and severe flooding from extreme storm events.

Figure 28 shows the simulated impact of potential temperature increases on the average annual flow hydrograph for Big Cottonwood Creek. Higher temperatures are expected to result in less annual runoff and a shift to earlier peak snowmelt runoff compared to average conditions from a base historical period of 1981 to 2010. Figure 29 is additional demonstration of the anticipated effect of climate change in shifting peak snowmelt earlier in the runoff season. It is an illustration of the likely impact of climate change (+5°F) on runoff timing for the Four Creeks Region (City, Parleys, Big Cottonwood, and Little Cottonwood creeks), which results in consequences in meeting Salt Lake City's potential future water demand, managing potential flood events, and managing water rights.



Source: Bardsley et al, 2013

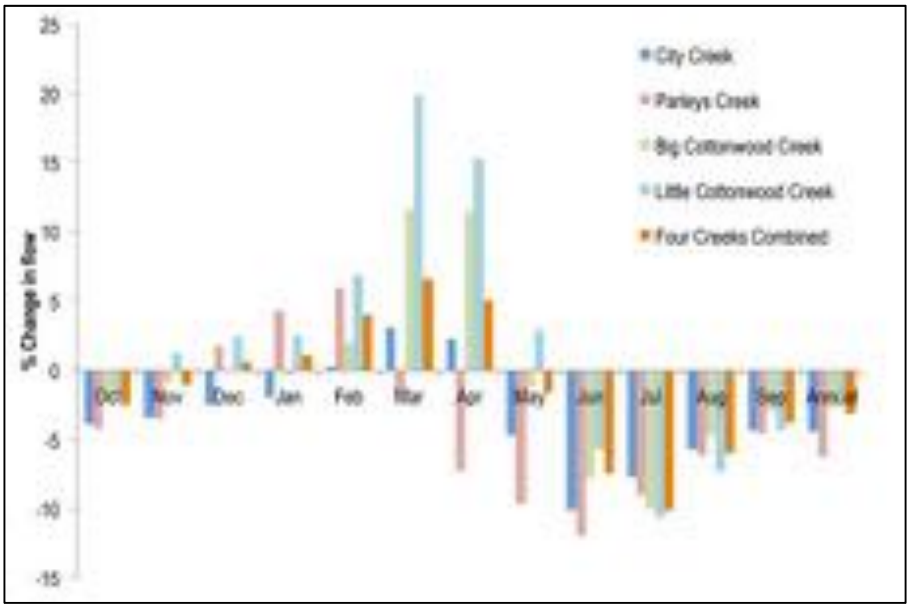
Figure 28. Big Cottonwood Creek 30-Year Average Monthly Runoff Sensitivity to Temperature Change



Source: Bardsley et al, 2013

Figure 29. Potential Climate Change Impact on Runoff Timing, Water Supply, and Water Demand

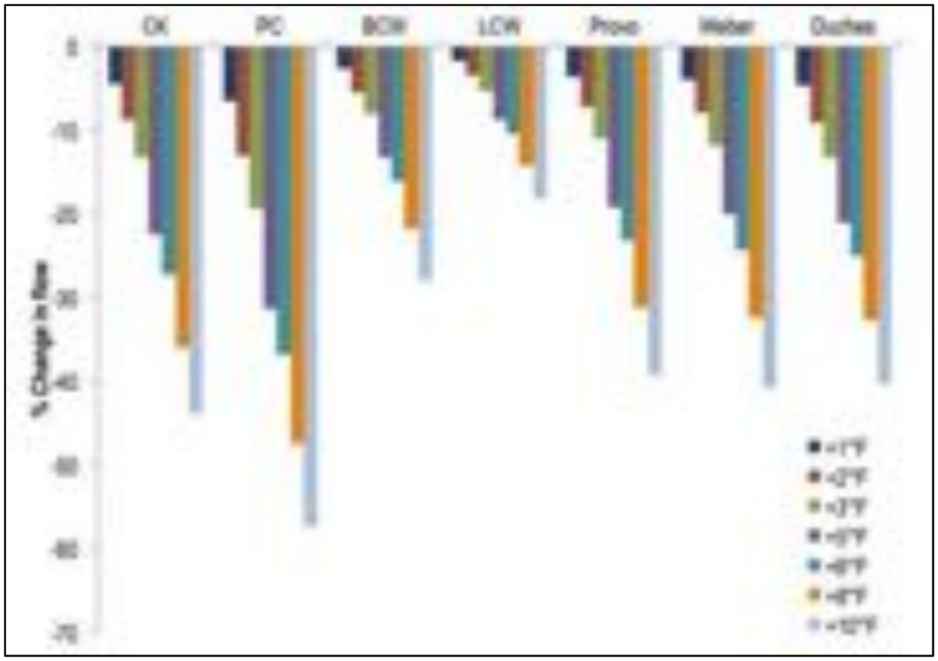
Figure 30 presents possible future changes to monthly stream flow for streams in the project area due to regional temperature changes. The plot shows the estimated percentage change in average monthly stream flow that would occur from a 1°F temperature increase. Flows in winter and early spring would increase due to more precipitation falling as rain rather than snow. Flows in late spring, summer and fall would decrease as a result of overall higher temperatures.



Source: Bardsley et al, 2013

Figure 30. Average Monthly Flow Responses to 1°F Increase for City Creek, Parleys Creek, Big Cottonwood Creek, and the Four Creeks Combined

Figure 31 shows the projected reduction in average annual runoff for streams in and near the project area that could be associated with a range of possible future average temperature reductions. A 1°F temperature increase in regional climate could reduce average annual runoff by 2 to 6 percent compared to recent historical conditions (1981 to 2010). A 5°F temperature increase, which is within the range of many of the global climate model forecasts for Utah, could reduce average annual runoff in project area streams by 9 to 32 percent compared to recent historical conditions.



Source: Bardsley et al, 2013

Figure 31. Average Annual Runoff Volume Decrease Under Various Assumed Temperature Changes for City Creek (CK), Parleys Creek (PC), Big Cottonwood Creek (BCW), Little Cottonwood Creek (LCW), Provo River (Provo), Weber River (Weber) and Duchesne River (Duches)

Any reduction in average annual runoff would impact the ability of water providers who rely on supplies from the project area watersheds to meet their demands. Temperature increases in the 3°F to 7°F range, as have been forecasted for Utah in the second half of the 21st century, could present a serious threat to water supply sustainability. At the same time, warmer temperatures would increase water requirements for outdoor landscape watering and other types of demands.

More rain and less snow, combined with earlier snowmelt runoff and more flood events, would require changes in how water supply diversions and storage reservoirs are designed and operated. Diversions may have to be re-designed to divert higher peak flows, and reservoirs may have to be operated to fill earlier and spread deliveries over a longer period of the year. All of these adaptations present challenges to water providers in assuring a sustainable supply for future customers.

Lower stream flows would compromise water quality in streams and lakes, especially for temperature. Lower stream flows would make it more difficult for wastewater treatment plant operators to meet their effluent discharge limits that are based on the flow in the receiving water that is available for mixing.

More frequent and extreme flooding due to climate change could expand floodplains, increasing the risk to property currently in the floodplain and putting additional properties at risk of flooding.

Climate change models predict future climates with higher temperature, and in many cases lower precipitation, which would adversely affect forest and watershed health. Stressed forests are more susceptible to invasive species, insect infestations, and severe wildfires. Greater frequency and extent of wildfire in the project area watersheds would affect water quantity and quality, and cause significant impacts to water providers and ecosystems. Runoff from burned areas contains pollutants that are difficult to treat in standard water treatment plants. Increased sediment production from burned areas would compromise downstream diversion structures, reservoirs and other water infrastructure.

Air

Population Growth

Population growth will likely result in an increase in emissions from area sources such as home heating, agricultural activity, construction, residential and commercial energy generation, open burning and emissions from biogenics (vegetation and landscaping). Many other types of activities also produce pollutants, such as dry cleaners, gas stations, and while the emission from each source can be relatively small, collectively their emissions can be a cause for concern. Emissions from area and biogenic sources can be expected to increase at the same rate as the population.

Some point sources, such as power plants, can also be expected to increase activity in response to the higher demands brought about by population growth, but the use of control technologies is expected to limit emissions from these types of sources at or below current emission rates.

Land Use/Development

Changes in air quality due to land use and development are more closely tied to the associated changes in transportation and population growth. While along the Wasatch Front the tendency will likely be towards in-fill and an increase in density compared to a tendency towards expansion in the Wasatch Back, the localized changes to land use will likely have little direct effect on regional air quality.

A negative effect of increased density is the unavoidable necessity of siting sensitive land uses, such as residences, parks and playgrounds, undesirably close to air pollution sources such as heavily traveled roadways, dry cleaners and gas stations. The effects of those sources are typically localized to nearby properties, but as density increases the number of such properties will gradually increase.

Land use development that includes mass transit would have a positive effect on air quality by fostering and encouraging travel by way of modes that typically emit fewer pollutants per passenger-mile than cars and light trucks. Land use that accommodates and encourages pedestrian and bicycle travel would have an even greater positive impact on air quality.

In-fill in an urbanized area may result in trip origins, such as residences, being located closer to destinations, such as workplaces, shopping areas and schools, thereby reducing the lengths of trips, reducing fuel consumption and reducing emissions. Conversely, land use development which is more spread out may encourage driving further distances to attractions and an increase in fuel consumption and emissions.

Transportation

Increases in transportation growth and vehicle miles traveled will not necessarily translate into increases in emissions. Improvements in vehicle mileage, fuel mixtures and emissions controls are expected to result in lower emissions even if travel demand increases.

Modal shifts from passenger cars and light trucks to mass transit, bicycles and walking would result in positive effects to both local and regional air quality through a reduction in fuel consumption and emissions. Fewer vehicles would also have the indirect effect of reducing congestion which would also result in fewer emissions from mobile sources.

Climate

While the exact impacts on area climate are unknown, the effects of climate change on air quality are also unknown. Cooler temperatures during winter months and higher temperatures in summer months may lead to increased energy consumption for heating and air conditioning which may indirectly lead to an increase in emissions. Climate change may also increase or decrease the effect of thermal inversions which have a direct effect of trapping pollutants in the Wasatch Front and in area canyons. An increase in the length of the growing season may also result in an increase in naturally occurring volatile organic compounds.

Ecosystems

Population growth, changes in land use and development, climate change, and changes in transportation performance will affect aquatic and terrestrial ecosystems in the Central Wasatch and the ability of these ecosystems to provide the services utilized by plant, wildlife, and human populations. In addition to predicted trends related to these four stressors, plants, wildlife, and ecosystems in the project area will be affected by many other factors. Potential effects of and interactions between the major stressors and additional factors are uncertain, due in part to the complexity and interdependence of the components of the ecosystems in the Central Wasatch. Although previous studies suggest probable trends, detailed predictions can rarely be made. However, there is broad consensus about the ways in which some of the most important trends will stress the system.

Aquatic Ecosystems

Population growth and changes in land use and development are anticipated to further stress and degrade the aquatic ecosystems in the Central Wasatch. Aquatic ecosystems are a highly regulated resource under the Clean Water Act, Safe Drinking Water Act, and many other authorities. However, modification of aquatic ecosystems and adjacent terrestrial ecosystems is not explicitly prohibited, and many small projects have been developed in the project area. These projects have collectively resulted in the loss, modification, and reduction in quality of aquatic ecosystems. Given the existing development pressure, the number of entitled but unconstructed units in the project area, and the uncertainty regarding the location, quality, and quantity of aquatic ecosystems in the Wasatch Mountains, this trend is anticipated to continue and result in additional loss, modification, and degradation of aquatic ecosystems. Completion of existing entitled developments in the Wasatch Front canyons will also likely result in increased or full utilization of water allocated to canyon landowners through agreements with municipal water suppliers. Much of the water used within the canyons is withdrawn in the upper watersheds, and increased usage could therefore reduce in-stream flows in the lower canyon areas.

Population growth is also anticipated to increase the number of people visiting the Central Wasatch for recreational purposes. Aquatic ecosystems (e.g., lakes, waterfalls, streams) and adjacent terrestrial ecosystems are popular recreational destinations for hikers and other visitors to the mountains. High levels of use, especially when not appropriately managed, can damage and reduce the functionality of aquatic ecosystems (Palaniappan et al. 2010). Increased visitation will strain the limited existing staff, budget, and other agency resources for law enforcement and visitor management. If visitation exceeds the ability of agencies to manage recreational users of aquatic ecosystems, further declines in function of these ecosystems could occur.

Systems to manage recreational use in consideration of ecosystem function exist, but are not designed to accommodate substantially higher levels of use. Increased recreational use is therefore anticipated to cause additional stress to aquatic ecosystems as the population increases. In addition to the impacts caused by use of aquatic ecosystems, increased recreational and resident populations would result in an increase in traffic. Impermeable road surfaces act as an important vector of nutrients and other foreign materials to aquatic ecosystems by breaking up the buffering role originally played by riparian vegetation. Organic and inorganic materials such as hydrocarbons are often found to accumulate in aquatic ecosystems near roads (Trombulak, Frissell 2000).

Climate change has the potential to alter and stress the aquatic ecosystems located in the study area. Climate model projections combined with knowledge of past climate variations suggest the potential for larger year-to-year and decade-to-decade fluctuations in precipitation and stream flow during the 21st century than observed during the 20th century. At a regional scale, climate change is also anticipated to increase the temperatures of streams, lakes, and rivers. Water temperature is a key regulator of aquatic ecosystems and increase in temperature has the potential to result in upstream shifts in the distribution of temperature-sensitive species, as well as increasing algal abundance. However, water in many of the high-gradient mountain streams in the Wasatch has a relatively short transit time, and therefore relatively low exposure to temperature increase, between sources in headwater areas (e.g., snowpack melt, springs) and valley locations. For this reason, these mountain streams may be less susceptible to increases in temperature compared to valley streams or standing bodies of water such as lakes. As the effects of climate change affect aquatic ecosystems on a regional scale, the cold-water aquatic ecosystems in the Wasatch Mountains may become increasingly important refugia for organisms that depend on them.

Terrestrial Ecosystems

Changes in land use patterns are predictably important factors in changes to terrestrial ecosystems (Reyers and O'Farrell 2009). Population growth and accompanying land use changes will have clear, direct effects on the terrestrial ecosystem of the Central Wasatch, similar to the way that increased water use and recreation are expected to reduce the amount and function of aquatic ecosystems. Although the majority of streams and lakes will be affected by increased population and land use, effects of those stressors on terrestrial ecosystems tend to be concentrated in certain areas. Development and agriculture are concentrated in valley bottoms. Increased population may replace some agricultural lands with residential developments, or may cause development in undisturbed areas, contributing further to fragmentation and reduced potential for wildlife movement. Although many wildlife species can be tolerant of low-density residential developments designed to allow movement, plans for the area predict increased density of future developments.

Noxious and invasive weeds have the ability to reduce biodiversity, alter soil characteristics, alter fire intensity and frequency, and can reduce the complexity of vegetation communities. Noxious and invasive weeds have various traits that make them more competitive than native species in the area such as fast, deep growing root systems and the ability to produce thousands of seeds each year (BLM 2013). As invasive plants are currently concentrated near agriculture and other developed areas, an increase in development is anticipated to facilitate further spread of those plants.

Climate change is predicted to modify the current terrestrial ecosystems of the complex Wasatch ecosystems. The ecological and geographic complexity of these ecosystems is high, and it is difficult to predict exactly which changes will occur and how dramatically. Vegetation communities can have complex responses to climate change driven by the response of individual species, and do not respond with a simple, community-wide change in elevation. However, as in most cases treeline is determined by the effects of temperature on seedling establishment and growth rates of trees, the increasing regional temperatures predicted by climate change models will allow the treeline to shift towards higher altitudes (Walther and others 2003), potentially replacing or reducing the extent of alpine habitat. However, this shift may be slower than temperature changes would predict in some areas, due to the low growth rates of high-elevation trees and existing lack of soil development. Climate change may also increase temperatures at any elevation faster than some plant or wildlife species are able to disperse or adapt. Although forests and other terrestrial ecosystems in the study area have been somewhat resilient so far to stressors, factors associated with climate change such as bark beetles, noxious weeds, fire, and invasive plants are predicted to cause widespread changes in vegetation cover.

Within forested areas of terrestrial ecosystems, fire suppression is expected to continue to increase fuel loads. Increased fuel loads typically lead to an increase in size, intensity, and frequency of future fires, although forest thinning projects and other treatments may take place to reduce these risks. Fire suppression also supports conifer encroachment into aspen stands (Wall et al. 2001), resulting in a declines of plant and wildlife species associated with aspen communities, and lowered ecosystem resilience to disturbances such as fire.

Plants and Wildlife

Plants and wildlife in the study area are dependent on the health and extent of aquatic and terrestrial ecosystems, and will thus be affected by the four major stressors of those ecosystems, as well as additional factors that may affect individual species or entire communities. Population growth will increase the amount of people residing and recreating in the area, which will increase wildlife-human interactions. Increased development, as well as increased population density, will further fragment existing wildlife corridors and blocks of habitat. Lowered dispersal of wildlife, seeds, and plant pollinators is expected to contribute to further local extinctions of sensitive species, even when wildlife corridors are incorporated into development planning (Harrison and Bruna 1999). Although the effects of transportation planning can be slightly different than changes in land use for some species, increased traffic will still generally contribute further to habitat fragmentation.

Climate change can cause several potential responses in plant and wildlife species: some may adapt to changing temperatures without a change in geographic range, others may shift their distribution to follow temperatures, and those unable to adapt or disperse are predicted to decline. Each species may respond differently, as the response may be driven by different components of climate change such as changes in precipitation amount and patterns, summer temperatures, and minimum or average winter temperatures (Crimmins et al. 2010). Shifts in the distribution of individual species can alter community structure and function as a whole.

Increasing water temperatures will likely occur as a direct result of climate change, but may also occur through a loss of riparian vegetation that would have provided shade. Increased water use and decreased stream flow will also increase the variability in stream temperatures by reducing the buffer effect of high volumes of water. Warmer bodies of water will support an altered community of aquatic species, although as discussed previously the high-gradient montane streams in the study area may be somewhat resilient to temperature change. However, increased water temperatures may reduce the ability of cold-water fish to migrate through low-elevation streams, and may reduce connectivity of the system as a whole.

Land

As presented in Section 4.2, the rate of land use and development will continue or increase in the future as a function of geographic area. Salt Lake County will likely experience redevelopment and in-filling in the project area, whereas, growth in Summit County will occur as redevelopment and expansion into natural areas as population increases. This development will result in increased pressure on those lands not currently afforded protection as open space and will be particularly evident in Summit County.

In addition, as the amount of land available for acquisition as open space decreases it is likely that the cost per acre will increase. New and ongoing funding will be required for the acquisition of land for watershed, recreation, and other open space purposes. Past expenditures in the form of government obligation bonds, budget allocations, grants, fees, and private fundraising contributions will need to stay at or above current levels in order maintain the rate of acquisition. Funding will also be needed to cover operation and maintenance of current and future protected lands.

Development suitability, particularly in the canyons, further complicates the subject of land protection and management. Not all unprotected lands in the project area are considered suitable for development. Factors which could influence development suitability from the environment perspective include: wildlife habitat and fragmentation, proximity to streams and wetlands, availability of water, slope steepness (geology) and soil erosion potential, and forest health (Salt Lake County 2010).

The viewshed within the Cache-Wasatch National Forest will be managed to sustain the scenic resources (USDA 2003). USFS will work to maintain and/or acquire additional public access in the National Forest as well as acquire additional properties for watershed protection.

Additional sites will become eligible for National Register of Historic Places listing as they pass the 50-year threshold and enter into consideration for historic properties status. A significant number of cultural resource sites would be subject to adverse effects due to increased future development. Greater risk of vandalism to historic properties would result from increased accessibility and visibility of sites in development areas leading to accelerated deterioration of historic structures.

4.4 Comments & Poll Results on Future Trendlines

Comments from System Group on Draft Future Trendlines Information

Following the Environment System Group Meeting #3, comments regarding future trendlines will be summarized here in the final report.

System Group Poll Results on Future Trendlines Information

The System Groups have not yet been polled on their level of concurrence with the Future Trendlines information. They will be polled on an updated version at their meetings on April 29 and 30. The results will be summarized in the final report.

5. CONCLUSION

5.1 Summary of Comments on Existing Conditions & Future Trendlines

Summary of Public Comments

Following public review of this draft report, public comments will be summarized in the final report.

Summary of Comments from Stakeholder Meeting

Following the stakeholder meeting on this draft report, comments from stakeholders will be summarized in the final report.

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Note: This report reflects the input of the Environment System Group, which is an advisory body to Mountain Accord. As such, this report may not necessarily reflect the opinions of the Mountain Accord Executive Board organizations. The intent of this report is to lead to the development of a recommendation from the Environment System Group to the Executive Board for their consideration.