
WASATCH FRONT REGIONAL COUNCIL

*- February 2012 -*

## Acknowledgements


**Funding Partners**

The George S. and Dolores Dore Eccles Foundation
Paula M. Swaner, PhD
U.S. Forest Service
Utah Division of Forestry, Fire & State Lands
Utah Quality Growth Commission


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# 1. PREFACE

In May of 2008, Wasatch Front Regional Council (WFRC) staff hosted a green infrastructure workshop facilitated by The Conservation Fund, a national non-profit conservation organization. Workshop participants included planners, engineers, resource managers, and others from the intermountain west. Participants learned the basics of a green infrastructure planning approach and the need for communities to consider these principles when planning their future. As a result, the Wasatch Front Regional Council was asked to initiate a green infrastructure plan for the Wasatch Front Region. The WFRC is an association of 60 cities and five counties organized in 1969 for the purpose of pursuing goals of common interest. The area of service comprises Davis, Weber, Morgan, Salt Lake, and Tooele Counties and the cities contained therein.

In a two-year collaborative effort between communities, counties, and state and federal agencies, the Wasatch Front Regional Council partnered with the Center for Green Infrastructure Design in September of 2009 to develop a coordinated regional green infrastructure planning document, known as *(Re)Connect: The Wasatch Front Green Infrastructure Plan*.

*(Re)Connect* represents the beginning of the Wasatch Front's exploration of a green infrastructure approach to regional and local land use patterns. The Plan promotes an integrated approach to conservation, transportation, and land use planning within the overarching context of the Wasatch Front Regional Council's *Wasatch Choice for 2040*. To maintain Utah's great quality of life as we grow, elected officials in Weber, Davis, Salt Lake and Utah Counties have adopted the *Wasatch Choice for 2040*, a vision for how we will develop our communities and transportation system. By implementing the *Wasatch Choice for 2040*, we can provide the region's residents with more choices for safe and affordable housing, have healthier and more vibrant communities, save billions in tax dollars, conserve beautiful natural areas, and make travel more convenient.

*(Re)Connect* is the product of a collaborative effort between the Wasatch Front Regional Council, the Center for Green Infrastructure Design, the U.S. Forest Service, the Utah Division of Forestry, Fire and State Lands, and the Governor's Office of Planning and Budget. These agencies and organizations came together in support of this project because they saw a need to identify, protect, and/or preserve the region's most valued, functional landscapes.

***(Re)Connect acknowledges the relationships of land use, transportation, green infrastructure, economic development, and community livability.***

**Graphic 1 Liberty Park, Salt Lake City, Utah**

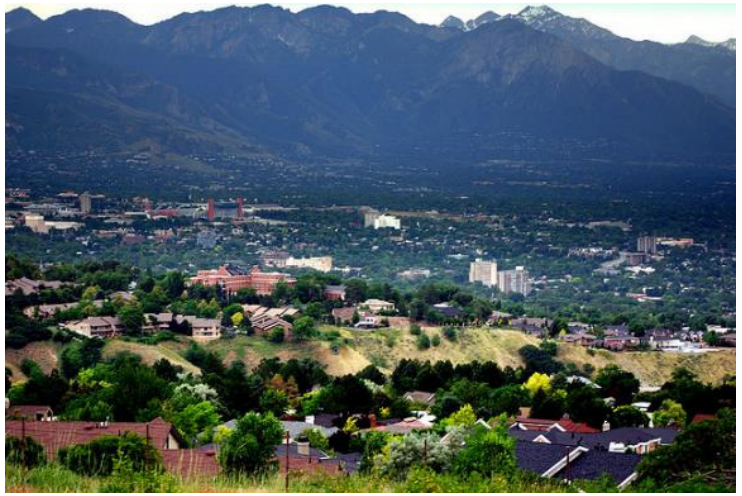
## 2. INTRODUCTION TO GREEN INFRASTRUCTURE

Green infrastructure is an interconnected network of natural systems that provides a diverse range of environmental, social, recreational, psychological, public health, and economic benefits. Green infrastructure features include greenways, wetlands, parks, forests, farms and ranches, fertile soils, creeks and streams, mountains, foothills, shorelines, trails, watersheds, open space, and recreational areas.

Green infrastructure is most effectively viewed as a *system* with each part relying on and affecting a larger network. Mark A. Benedict and Edward T. McMahon (2002) of The Conservation Fund write, "Green infrastructure differs from conventional approaches to open space planning because it looks at conservation values and actions in concert with land development, growth management and built infrastructure planning." To do this, green infrastructure planning must examine the social assets of a place in addition to the natural resources and attempt to understand the relationships between them.[1]

Beyond aesthetic value and social well-being, green infrastructure provides valuable *services* that clean the air, protect and filter water, support biodiversity, maintain agricultural productivity, and conserve energy. Natural systems provide multiple goods and services, just as grey infrastructure, but often at a considerably reduced cost. Green infrastructure can be viewed in the same way as grey infrastructure. It is the support network for the natural systems that keep our communities functioning, just as grey infrastructure provides the roads, sewers, utilities, and other built systems upon which our communities rely.

For example, if a storm-water pipe is not connected to the main line that conveys the water, it is just an isolated pipe with limited capacity. A water line that is not linked to your house is not providing you with the water you need. An electrical power line that is not connected to the grid serving a community of homes will not provide power where it is needed. Green infrastructure connectivity may be less obvious, though no less important, when it comes to the functionality of natural systems. Achieving optimum connectivity requires green infrastructure to coordinate with grey infrastructure, such as roads, transit, utilities, city parks, trails, and other public facilities.



**Graphic 2 View of the Salt Lake Valley**

[1] Berik, G., & Gaddis, E. (2011). *The Utah genuine progress indicator (gpi), 1990 to 2007: A report to the people of Utah*. Retrieved from Günseli Berik and Erica Gaddis website: www.utahpop.org/gpi.html

## DESIGNING A GREEN INFRASTRUCTURE NETWORK

The Wasatch Front Region is a dense matrix of human and natural landscapes. Since the first pioneers arrived in the Salt Lake Valley, humans have prospered from the relationship founded with the environment. The Wasatch Front is now at an important juncture in planning for future growth and resource management.

Green infrastructure planning can be utilized to help initiate and reconnect the Wasatch Front communities to their natural landscape and to ensure the welfare of existing natural and social green infrastructure systems. A comprehensive green infrastructure approach seeks to raise the quality of life for present and future generations while simultaneously enhancing the social and cultural benefits, environmental functionality, and economic vitality of our communities.

Green infrastructure planning provides an advantageous method for identifying social and natural assets, viewing them as a series of interconnected systems, and assessing potential future locations for connectivity and enhancement. Green infrastructure planning is not an entirely new concept. The principles that form its foundation have arisen from multiple disciplines. The term originated in the strategic conservation planning field led by The Conservation Fund and the U.S. Forest Service. These agencies felt that natural systems should be identified as infrastructure because they support essential ecosystem functions. Their primary emphasis was forests, wetlands, and large natural areas as these areas are the foundation for a green infrastructure network. However, in urban environments, large connected green infrastructure areas are uncommon due to development patterns that have led to fragmentation of these areas.

***Green infrastructure not only describes physical attributes of the landscape, it also describes a planning process that promotes strategic land conservation while encouraging land use practices that are good for nature and people.[2]***


**Graphic 3 Historic Site**

[2] Sanker, L. (2008, January). *Integrating trails and open space into parks and recreation plans*. Presentation delivered at Regional trails and greenways summit.

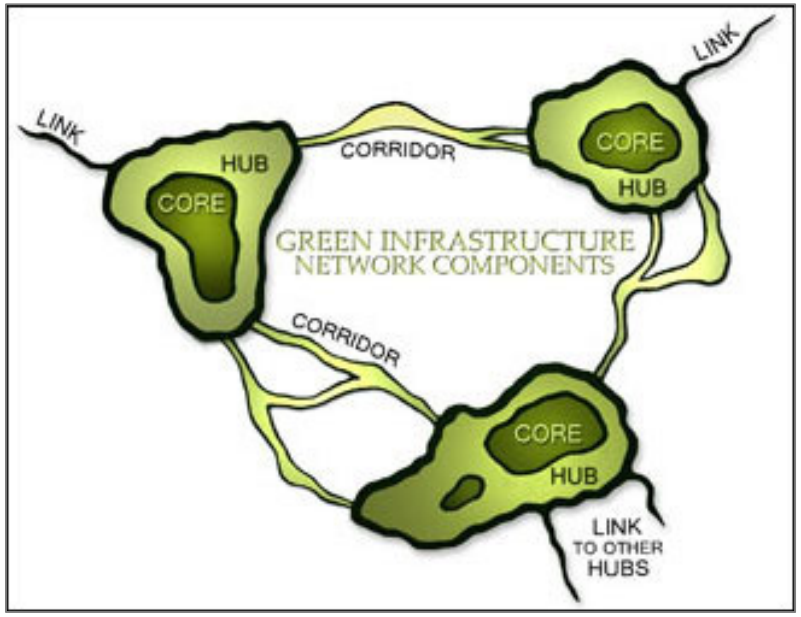
## COMPONENTS OF A GREEN INFRASTRUCTURE NETWORK

Individual green infrastructure components are referred to as green infrastructure assets. When combined, they make up a system of cores, hubs, and corridors that form the green infrastructure network (refer to Graphic 4). When this network is appropriately planned, designed, and managed, it has the potential to deliver a wide range of environmental, social, and economic benefits.

***CORES*** are highly functional lands that provide multiple benefits.

***HUBS*** are lands that support core functionality.

***CORRIDORS*** facilitate movement, link core and hub areas together, and enable network functionality through connectivity.




**Graphic 4 The Conservation Fund's Core, Hub, and Corridor Components**

## SCALE

Green infrastructure exists at multiple scales, from specific sites to large landscapes between rural and urban areas. A useful approach to defining green infrastructure is to classify it according to the spatial scale it is typically found. Improvements made at any scale contribute to the value of the system; it is the connection between the scales and individual resources that enables green infrastructure to function as a complete system.

***SITE SCALE*** site specific projects such as water wise gardens, permeable pavement, tree-lined streets, community gardens, green roofs.

***COMMUNITY SCALE*** city or countywide projects such as parks or open space that preserve habitat and ecosystem functionality.

***REGIONAL SCALE*** large natural areas such as designated wilderness, forest preserves, or wildlife management areas.

***When designed and preserved, green infrastructure systems can provide the essential functions that are normally provided through more expensive man-made or grey infrastructure. When implemented, green infrastructure offers tangible, financial value.***

## BENEFITS OF GREEN INFRASTRUCTURE

Green infrastructure system connectivity allows for greater vitality, value, and function of the green infrastructure network, which in turn increases the benefits provided to humans and communities. These benefits have often been described as *ecosystem services*, the broadest definition of which can encompass all of the services and benefits, both direct and indirect, provided by a green infrastructure network. They include cleaning the air, cooling and filtering water, storing and cycling nutrients, conserving and generating soil, the pollination of crops and other plants, climate regulation, carbon sequestration, storm and flood damage protection, and maintenance of aquifers, streams, and rivers.

Green infrastructure lands offer natural benefits that affect our health and our economy.[3] The clean water you drink is naturally purified by the roots and layers of soil in a forest. The trees in your front yard trap dust and harmful gases from the air you breathe. Certain medicines come from unique plants and flowers. For example, Yarrow is used to treat ear, tooth, and headaches and can be used as a tonic or stimulant. Sage is used to calm an upset stomach. Elm Bark is used as an antiseptic and a poultice for ulcers.

### HEALTH BENEFITS

- Absorption of air pollution[4]
- Water filtration and cleansing[5]
- Provides for fresh, local food from local markets and gardens[6]
- Increases in physical activity[7]
- Decreases the number of doctor visits[8]
- Reduces obesity and the effects of depression[9]
- Provides for medicines (some new)[10]
- Provides opportunities for a variety of recreational activities

***Nature plays a critical role in ensuring health. Of the top 150 prescription drugs used in the U.S., 118 come from natural sources. Nine of the top ten drugs originate from natural plants. Conserving nature protects the natural laboratory that provides medicines we rely on today and may come to need in the future.[11]***

[3] The Nature Conservancy. (2011). *The natural capital project*. Retrieved fromhttp://www.nature.org/ourinitiatives/urgentissues/peopleandconservation/natural-capital.xml

[4] Environmental Protection Agency. (2011, January 04). *Green infrastructure: Managing wet weather with green infrastructure: How does green infrastructure benefit the environment?* Retrieved from http://cfpub.epa.gov/npdes/home.cfm?program_id=298

[5] Environmental Protection Agency

[6] American Planning Association. (2010, December 15). *New food system principles emphasize health benefits*. Retrieved from http://www.planning.org/newsreleases/2010/dec15.htm

[7] President's Council for Physical Fitness, Sports, and Nutrition. Research Digest, President's Council for Physical Fitness, Sports, and Nutrition. (2008). (Series 9, No. 1). Retrieved from website: http://www.presidentschallenge.org/informed/digest/docs/march2008digest.pdf

[8] President's Council for Physical Fitness, Sports, and Nutrition

[9] President's Council for Physical Fitness, Sports, and Nutrition

[10] The Nature Conservancy. (2011)

[11] Metz, D., & Weigel, L. (2010). Key findings from recent national opinion research on "ecosystem services". *Public Opinion Strategies*

## SOCIAL BENEFITS

- Reduces stress
- Increases quality of life and family enjoyment[12]
- Preserves viewsheds[13]
- Increases interaction within a community[14]
- Enhances a community's character[15]
- Creates safer public spaces as a result of increased activity[16]
- Provides opportunities for children to experience nature[17]

## ENVIRONMENTAL BENEFITS

- Provides plant & animal habitat which maintains biodiversity[18]
- Facilitates carbon storage[19]
- Cleans water and facilitates aquifer recharge[20]
- Protects communities from catastrophic flooding[21]
- Increases resilience to climate change and other disturbances[22]
- Improves air quality, reduces the urban heat island effect, and minimizes inversion[23]
- Complies with federal laws requiring improvements for stormwater discharge[24]

***American cities spend billions of dollars every year to clean up our water. But it is much cheaper and easier to prevent water pollution naturally, by protecting and restoring wetlands and rivers, than it is to treat water after it has been contaminated. For example, when faced with critical water quality problems in New York City, the state restored rivers and lands surrounding the City's water supply, at one-eighth the cost of a new water treatment plant.[25]***

[12] Environmental Protection Agency

[13] Lilieholm, R.J. & Fausold, C.J. (1999). The economic benefits of open space in Utah. *Utah recreation and tourism matters: Institute for outdoor recreation and tourism.* Logan, UT: Utah State University Extension

[14] Environmental Protection Agency

[15] Lilieholm, R.J. & Fausold, C.J. (1999)

[16] Sherer, P. M. (2003). *Benefits of parks: Why America needs more city parks and open space*. Trust for Public Land. Retrieved from http://www.tpl.org/publications/books-reports/park-benefits/benefits-of-parks-white-paper.html

[17] Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder.* Chapel Hill, NC: Algonquin Books

[18] Environmental Protection Agency

[19] Environmental Protection Agency

[20] Environmental Protection Agency

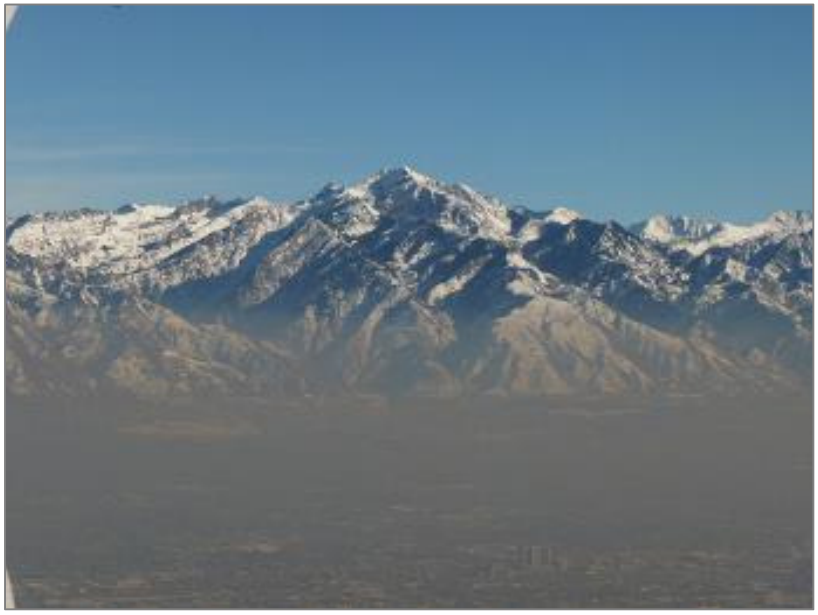
[21] Environmental Protection Agency

[22] Gill, S.E., Handley, J.F., Ennos, A.R., & Pauleit, S. (2007). Adapting cities for climate change: The role of the green infrastructure. *Built Environment, 33*, 1, 115-133

[23] Environmental Protection Agency

[24] Environmental Protection Agency. (2011, January 20). *National enforcement initiatives for fiscal years 2011 - 2013*. Retrieved from http://www.epa.gov/compliance/data/planning/initiatives/initiatives.html

[25] The Nature Conservancy. (2011). *The nature conservancy: Homepage*. Retrieved from http://www.nature.org



Graphic 5 Poor Air Quality in the Wasatch Front

## ECONOMIC BENEFITS

- Increases property values when homes are adjacent to parks, homes worth 22% more than homes located 2,600 feet away[26]
- Raises home values 15-20% when near park and recreation areas[27]
- Raises property values 19-35% when near permanently protected forests[28]
- Increases opportunity to sale homes and attract businesses and residents[29]
- Raises commercial property values[30]
- Increases tourism
- Attracts employment with relatively higher wages[31]
- Enhances the leisure, recreational, and hospitality sectors[32]
- Provides environmental services that reduce municipal grey infrastructure costs
- Reduces public expenses for stormwater management, flood control, water treatment, and other built infrastructure[33]
- Reduces urban core temperatures resulting in lower cooling costs[34]

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[26] Donjek Inc. (2009, September 23). [Web log message]. Retrieved from http://donjek.com/blog/category/open-space/page/2

[27] Donjek Inc. (2009, September 23)

[28] Donjek Inc. (2009, September 23)

[29] Peper, P. J. U.S. Forest Service, Rocky Mountain Chapter, American Public Works Association. (2007). C*onsidering the green infrastructure: Benefits & costs*. Ecologist center for urban forest research, U.S. Forest Service. Retrieved from website: http://www.fs.fed.us/psw/programs/uesd/uep/products/powerpoint/psw_cufr714_Grn_Infrastr_WY.pdf

[30] RNA. (n.d.). *Homepage*. Retrieved from http://www.rnacorporate.com/pages/inthenews.aspx

[31] Ecotec & Amion (n.d.). *Economic value of green infrastructure*. Northwest Regional Development Agency, Natural England. Retrieved from http://www.nwda.co.uk/PDF/EconomicValueofGreenInfrastructure.pdf

[32] Ecotec & Amion (n.d.)

[33] Green Infrastructure Center. (2008). *About gic*. Retrieved from http://www.gicinc.org/about.htm

[34] Environmental Protection Agency

*"With our economy in a recession, we cannot afford to ignore the vast economic benefits that the Wasatch Front's natural areas provide us. Thousands of jobs and millions of dollars are in the farming, ranching, tourism and recreation industries – numbers that would shrink if more of our natural resources were lost." – Sumner Swaner, Center for Green Infrastructure Design*

## AGENCY AND ADMINISTRATIVE BENEFITS

- Provides a regional perspective that enables agencies and municipalities to assess their priorities and implement green infrastructure strategies
- Seeks to integrate natural resource conservation with the needs associated with increasing human populations
- Provides communities the tools and information necessary to allow for green infrastructure planning within their own specific framework and initiatives
- Provides a framework that can be presented to conservation organizations and other agencies for potential sources of funding and assistance

*Large scale green infrastructure activities facilitates wildlife movement and connects wildlife populations between habitats. Green infrastructure in smaller scale environments such as city parks, community gardens, or green roofs, provide habitats for birds, mammals, amphibians, reptiles, and insects.*[35]

## STATEWIDE BENEFITS

Green infrastructure lands provide marketable goods and services like agricultural products, vital habitat for fish and wildlife, and minerals such as salt, brine, and potash. These lands also promote recreation and tourism industries that provide billions of dollars to our region's annual economy.

## TOURISM AND RECREATION BENEFITS

- In 2008, 20 million visitors brought $7 billion dollars and created an estimated 113,030 jobs in Utah[36]
- Utah's tourism industry provides for 9% of Utah's total non-agricultural jobs [37]

**Graphic 7 Recreational Areas**

## HUNTING AND FISHING BENEFITS

- These activities bring more money to Utah's economy than the skiing and biking tourism industry[38]

[35] Environmental Protection Agency

[36] Utah governor's office of economic development, Office of Tourism. (2008). *2008 Utah tourism at a glance*. Retrieved from website: http://travel.utah.gov/research_and_planning/documents/TourismataGlance2008.pdf

[37] Utah governor's office of economic development, Office of Tourism. (2008)

[38] Utah governor's office of economic development, Office of Tourism. (2008)

## GOODS AND SERVICE BENEFITS

- Agricultural activities account for $15 billion (nearly 14%) of Utah's total economic output and employ 66,500 people[39]
- Wood products from publicly and privately owned forests in Utah generate $243 million in annual sales[40]
- Forest ecosystems provided $12 billion worth of goods and services
- In 2007, Utah's ecosystems provided $25 billion in goods and services[41]
- Wetland services were calculated at $9 billion
- Desert grasslands and scrubland services were calculated at $5 billion

**Graphic 8 Lake Shorelands**

[39] Ward, R.A., Jakus, P.M., & Feuz, D. (2010). The economic impact of agriculture on the State of Utah. Utah State University Economic Research Institute Report #2010-02, January 25, 2010

[40] Lilieholm, R. J., & Fausold, C. J. (1999). *The economic benefits of open space in Utah*. Institute for outdoor recreation, Utah State University, Logan, Utah. Available from Utah State University Extensions. (NR/RF/003) Retrieved from http://extension.usu.edu/files/publications/publication/NR_RF_003.pdf

[41] Berik, G., & Gaddis, E. (2011). *The Utah genuine progress indicator (gpi), 1990 to 2007: A report to the people of Utah*. Retrieved from Günseli Berik and Erica Gaddis website: www.utahpop.org/gpi.html

# 3. (RE)CONNECT

Green infrastructure planning provides a method for identifying the region's social and natural assets, viewing them as a series of interconnected systems, and assessing their potential for connectivity and enhancement. *(Re)Connect: The Wasatch Front Green Infrastructure Plan* views the region's landscape without regard to jurisdictional boundaries in order to provide city, county, and regional planners with a strategic framework to identify which lands are the best to protect, preserve, conserve, or connect. In addition, many studies have examined only one particular feature, such as water quality or wildlife habitat. While these approaches have immense value, they often do not account for the more holistic context of green infrastructure system functionality.

*(Re)Connect* follows a comprehensive approach that assigns value to the lands within the green infrastructure network. It identifies the network systems, allowing land use managers and others the ability to protect, preserve, or conserve them before development or degradation begins. This approach also seeks to restore network connections. Green infrastructure planning identifies the most appropriate places for development while also considering what areas should be conserved or preserved. It seeks to do this via a comprehensive framework, known as a "network design" that provides an illustration of how natural and social systems contribute to the region's economic vitality, livability, and sustainability. The Plan seeks to address challenges and present solutions that can be undertaken by the Wasatch Front Regional Council, transportation entities, government agencies, municipalities, and others to incorporate green infrastructure planning into longer range initiatives.

***"We want to keep this an attractive place to live and work. Preserving these amenities provides many economic and social advantages." - John Bennett, Utah Quality Growth Commission***

## MISSION STATEMENT

*(Re)Connect: The Wasatch Front Green Infrastructure Plan* is a collaborative effort that identifies the highest quality green infrastructure resources in the Wasatch Front and clarifies the structure, function, and value of the region's interconnected green infrastructure network. The Plan determines which lands can best accommodate growth and which lands are better suited for protection, preservation, conservation, restoration or enhancement while also considering the region's ecosystems, habitat, economy, health, and resident quality of life.

## PLANNING GOALS

To plan, design, and manage an interconnected network of regionally significant landscape features that retain ecological function, maintain or improve water quality and habitat, provide recreational opportunities, preserve working land productivity, and sustain the high quality of life and enjoyment of the Wasatch Front for present and future generations.

### GOAL #1

Increase public support and awareness regarding the benefits of a green infrastructure approach and an interconnected green infrastructure network.

### GOAL #2

Collaboratively map an interconnected network by identifying and prioritizing the region's existing green infrastructure assets and resources.

### GOAL #3

Identify existing green infrastructure lands and propose objectives and strategies to plan, design, and manage the region's green infrastructure network.

### GOAL #4

Bring together local and regional stakeholders that play a part in planning, engineering, studying, managing, and maintaining green infrastructure.

### GOAL #5

Support an interconnected green infrastructure network in order to provide environmental, social, recreational, psychological, public health, and economic benefits.

### GOAL #6

Encourage the incorporation of green infrastructure planning and implementation strategies into existing plans and studies.

## PROJECT AREA

*(Re)Connect* encompasses the Wasatch Front region which includes Salt Lake, Weber, Davis, Tooele, and Morgan Counties and the 54 cities therein, It has nearly 10,000 square miles and home to nearly 1.7 million residents. Most of the region's residents are found along Interstate 15, in the 'urban corridor' between the Wasatch and Oquirh Mountains and the Great Salt Lake. It is through this urban corridor that residents and visitors are able to reach and enjoy the many landscapes throughout the Wasatch Front. The population is estimated to increase by 34,000 people every year, with over two-thirds of that growth from natural increase. As the region prepares for this growth, the benefits provided by green infrastructure resources will be indispensable.

Three major interstates bisect the region. Salt Lake City, the capitol city, is ranked number three in the nation for metropolitan transit areas. The Wasatch Front is also home to an international airport, the Kennecott Copper Mine, and Hill Air Force Base along with a world-class array of outdoor recreation opportunities. Thousands of acres of agricultural and pasture lands lend a rural feel to portions of the region, while other areas are intensely urbanized.

***"What is unique about this project is that it takes a regional perspective. We are looking at the area comprehensively from a green infrastructure standpoint. We are building off of current plans and resources, which typically only look at one particular asset, say wildlife or water quality, and combining them into an overall analysis, plan, and strategy." - Rick LeBrasseur, Executive Director, Center for Green Infrastructure Design***

Graphic 9 The Wasatch Front Region's Urban Corridor

## HOW TO USE THIS PLAN

*(Re)Connect* can be utilized by many different agencies and organizations to promote cooperation towards attaining mutually beneficial goals. It views the Wasatch Front from an asset-based perspective. This approach, inherent in the green infrastructure methodology, identifies the valuable or service-providing natural systems in the region and then identifies ways of strengthening them through stewardship actions, planning recommendations, and land use strategies. The Plan presents information to better educate land managers which will allow for more educated decisions when reviewing development applications, allocating funding, updating municipal general plans, and making land acquisition decisions.

### THE PLAN CAN BE USED TO

- Increase inter-agency cooperation and coordination
- Formulate strategies when updating policies and plans
- Engage stakeholders in green infrastructure related activities
- Promote a unified green infrastructure perspective
- Analyze the consequences of a particular action or policy
- Facilitate the implementation of long-range initiatives
- Identify organizations and other land managers for implementation efforts
- Enhance sustainability impact assessments
- Guide conservation priorities and land acquisition decisions
- Identify potential partnerships and funding opportunities

*(Re)Connect* is an interactive process designed to be updated over time, as needed. The Plan's data and methodology is available to all stakeholders and decision-makers. The Wasatch Front Regional Council is hosting all information and data gathered as part of this project, and will share the materials with any interested organization upon request. Information, including a copy of this report and interactive online maps, can be accessed by visiting, www.wfrc.org.

***"We do not want to supersede any local efforts or re-create the wheel. Our goal is to work together and build on existing planning efforts." - LaNiece Davenport, Regional Planner, Wasatch Front Regional Council***

## STAKEHOLDERS

The Plan is the product of a collaborative effort between Wasatch Front Regional Council (WFRC), Center for Green Infrastructure Design (CGID), U.S. Forest Service (FS), Utah Division of Forestry, Fire, and State Lands (FFSL), and the Governor's Office of Planning and Budget (GOPB). To ensure an accurate and comprehensive approach, four committees were formed to guide the planning process, see Appendix A for the full list of members.

### EXECUTIVE COMMITTEE

An executive committee monitored the Plan's development. This committee is comprised of the project's funders, the organizations ultimately responsible for the success of the project (Table 1).

**Table 1 Executive Committee**

| Agency | Name | Title |
|---|---|---|
| Center for Green Infrastructure Design | Sumner Swaner | Land Architect |
| | Rick LeBrasseur | Project Manager |
| | Sarah Nelson | Planner |
| | Kelsey Pudlock | Planner |
| Wasatch Front Regional Council | LaNiece Davenport | Project Manager |
| | Doug Hattery | Deputy Director |
| | Val John Halford | Long Range Planner |
| U.S. Forest Service | Margie Ewing | Urban Community Forestry Coordinator |
| Utah Division of Forestry, Fire, and State Lands | Meridith Perkins | Urban Community Forestry Coordinator |
| | Geoff McNaughton | Forestry Programs Supervisor |
| Governor's Office of Planning and Budget | John Bennett | Project Manager - Planning and Budget |

### TECHNICAL COMMITTEE

The technical committee consists of individuals who are experts in their fields. These individuals were invited to provide knowledgeable feedback and technical assistance throughout the planning process.

### STEERING COMMITTEE

The steering committee consists of a wide range of decision-makers within the Wasatch Front. These members were invited to review the Plan's mission statement, project goals, and evaluate the Plan's development to ensure alignment with their organization's directives and missions.

### STAKEHOLDER COMMITTEE

The stakeholder committee is made up of a broad group of representatives from private organizations to business owners, to land managers. This committee was invited to review all project materials and offer feedback. Specific members identified by the executive committee met to discuss the project development in depth.

### FUTURE STAKEHOLDERS

Coordinated green infrastructure planning efforts require public and private stakeholders, multi-organizational involvement, and inter-agency cooperation. *(Re)Connect* helps identify the connections between Wasatch Front residents and the surrounding natural environment, effectively engaging new stakeholders.

The lands throughout the Wasatch Front region are owned by a variety of agencies, organizations, and individuals. These landowners benefit significantly from the region's green infrastructure resources. Private landowners in the Wasatch Front have the capacity to protect and improve green infrastructure resources. Site specific actions can contribute significantly to the vitality of the larger network, especially when developers incorporate green infrastructure concerns into their designs and neighbors come together to promote green infrastructure improvement projects.

In order to identify the Wasatch Front stakeholders most likely to implement green infrastructure planning strategies, those responsible for land use planning and management were identified as well as those that permit public access. In addition, other public lands with specific relation to green infrastructure were identified, including public parks and easements. These stakeholders are identified by "*" after each name. The following stakeholders were identified via land ownership and refined through GIS data.

## LAND OWNERS IN THE WASATCH FRONT

- United States Forest Service (USFS)*
- Bureau of Land Management Utah (BLM)*
- Utah Department of Natural Resources (DNR)*
- State and Institutional Trust Lands Administration (SITLA)*
- United States Fish and Wildlife Service (USFWS)*
- Utah Department of Transportation (UDOT)*
- Department of Defense (DOD)
- Federal Trust Lands (Tribal Lands)
- Public Parks (municipally owned)*
- Private Landowners (companies, universities, individuals, etc.)

**Graphic 10 Open House at the Salt Lake City Library**

# 4. PLANNING PROCESS

*(Re)Connect: The Wasatch Front Green Infrastructure Plan* views the region's landscape without regard to jurisdictional boundaries in order to provide city, county, and regional planners with a strategic framework to identify which lands are the best to develop, protect, preserve, conserve, or connect. *Re(Connect)* took a four-step planning approach.

*Step 1: Identify Vision and Gather Data*

- Establish a project mission and planning goal
- Form the Executive/Technical/Stakeholder Committees
- Establish the project boundary
- Review existing reports and studies
- Gather Geographic Information Systems (GIS) data
- Generate maps

*Step 2: Project Outreach*

- Inform public and others of the mission and planning goals
- Conduct information sharing through workshops and open houses
- Conduct an online survey
- Refine GIS data based on input
- Refine mission and planning goals based on input

*Step 3: Develop the Plan*

- Identify high qualify green infrastructure
- Develop specific criteria for each green infrastructure asset
- Identify regional cores, hubs, and corridors
- Finalize GIS mapping in order to develop network maps
- Finalize priorities, recommendations, and implementation strategies
- Ensure information sharing

*Step 4: Create Implementation Plan*

- Create an implementation plan for communities and others to implement the techniques and strategies.

## DATA COLLECTION

Data collection has been a major and continuous endeavor throughout the Plan's development. A wide selection of data types and information were sought to ensure a defensible and technically sound plan. Significant data source types are listed below.

### STUDIES AND REPORTS

Studies, reports, plans, and other resources developed by local and regional agencies were reviewed to determine commonly held goals and objectives (see Appendix B). This comprehensive overview of priorities, developed by the many public agencies and organizations involved in planning, land use, and conservation enabled the development of the Plan's mission statement and goals.

### EXISTING GREEN INFRASTRUCTURE PROJECTS AND CASE STUDIES

Completed green infrastructure projects and case studies were reviewed by *Center for Green Infrastructure Design* staff to provide insight into proven methodologies, final output maps and reports, as well as applications of green infrastructure maps as tools for planners and land use managers (see Appendix B).

## GIS DATA

Geographic Information Systems (GIS) data were obtained from multiple sources, and used to create the maps. Data collection will be an ongoing process; as GIS data, specific to the Plan and the indicators outlined in this report, become updated and available, it will be important that these data are integrated into the ongoing monitoring phase, as well as the GIS database created for this project (see Appendix C).

## OUTREACH EFFORTS

A wide variety of input was instrumental to the Plan's development and facilitated consensus that allowed the Plan to move forward. Input from the following entities kept the project on track, and ensured the continuing adherence to the project mission statement. For a complete list of entities, as well as public input functions held through *(Re)Connect* (see Appendix A).

## COUNCILS OF GOVERNMENTS

Councils of Governments (COGs) are made up of local mayors and county officials in each of the Wasatch Front's five counties. They are regional bodies that address issues of common concern such as regional and municipal planning, water use, public services, safety and transportation planning, economic and community development, hazard mitigation, and emergency planning. Each of the five county Councils of Governments in the region was included in the planning process. Presentations were given to educate the local elected officials about the Plan and the planning process, as well as to seek feedback and participation.

## COMMITTEES

The WFRCs Regional Growth Committee Technical Advisory Committees of Salt Lake and Ogden-Layton area were involved in the planning process. These entities examine long-range transportation planning and other related land use and growth issues pertinent to each area. These committees are made up of city and county engineers, planners, and economic and community development directors. They are responsible for furthering the Regional Transportation Plan, and developing regional growth planning strategies in cooperation with local governments, the Utah Department of Transportation (UDOT), the Utah Transit Authority (UTA), and other organizations and stakeholders.

## PUBLIC OUTREACH

Public input was critical to *(Re)Connect's* planning process. Citizens are often able to provide important feedback for improving the planning process. Public open houses, questionnaires, and an online survey provided the project team with useful information regarding land use, conservation, and inter-connected networks (Appendix A). These values were synthesized into the mapping efforts and implementation strategies.

## CHALLENGES

*(Re)Connect* identifies a set of planning challenges faced by land managers, planners, and other stakeholders. These challenges were identified by reviewing existing planning studies and reports. For example, land use planning that does not consider green infrastructure can lead to economic burdens such as the costs associated with air pollution, water quality, natural habitat and the loss of biodiversity, flood control, and resource depletion. Also, many planning documents include guidelines that address 'smart-growth' or natural resource protection, but too often this language is un-enforced and easily misinterpreted.

### RAPID POPULATION GROWTH

Continuing rapid population growth leads to development in rural agricultural areas, under-utilized lands, floodplains, and hillsides that may threaten the quality of important social and natural resources. Increased population growth and development will place an added strain on the water quality and air quality within the Wasatch Front. Future development will lead to an increase in impervious surface coverage. These surfaces have negative impacts on soils, aquifer systems, watersheds, streams, wetlands, and other water resources. A heat-island effect is also created from standard roof and asphalt surfaces. Rising development pressures place green infrastructure lands under threat of fragmentation, loss of connectivity and accessibility, as well as a decreased quality.

### THE NEED FOR A REGIONAL PLANNING FRAMEWORK

Existing land planning practices do not generally examine resources across agency or jurisdictional boundaries. This results in inadequately managed or lost green infrastructure lands. Some of the deficiencies and challenges that regional planners and land managers face include:

- Geographic, political, and ecological boundaries
- Different terminology and incompatible data across agencies
- Lack of communication among stakeholders
- Political pressures (e.g. district priorities)
- Lack of trust among agencies
- Liability concerns and risk aversion
- General policy language and lack of regulation
- General lack of interest or understanding
- Priorities are not shared
- Short-term, project-based funding

***The recent shift in finding more creative solutions to regional environmental concerns has created a growing job market for engineers, designers, and planners. Green infrastructure projects tend to be more people-intensive rather than traditional, equipment-based projects. For one planning company, Stormwater Maintenance LLC based in MD, even through the recession, employees are up 417%, revenue is up 540%, and profits have increased nearly 400%.***[42]

[42] ASLA Dirt. (2011, October 26). [Web log message]. Retrieved from http://dirt.asla.org/2011/10/26/green-infrastructure-means-jobs/

## REFRAMING THE REGIONAL PLANNING APPROACH

Regional planning practices must be reframed to lay the groundwork for cooperation and innovation, which will not only conserve the green infrastructure network, but also expand, restore and reclaim network benefits and services. *(Re)Connect* can facilitate effective decision-making, efficient administration, and increase potential funding opportunities. This regional approach, to date, has been endorsed by:

- U.S. Forest Service
- U.S. Fish and Wildlife Service
- UT Division of Forestry, Fire and State Lands
- UT Governor's Office of Planning and Budget
- Wasatch Front Regional Council

***Green infrastructure functions on a variety of scales, however, regional efforts in green infrastructure planning are particularly influential.***

## REGIONAL PLANNING FRAMEWORK SUMMARY

*(Re)Connect* provides an open ended framework; the strategies and implementation actions identified in the Plan establish a structure for making effective decisions to support the goals of the many agencies and stakeholders in the Wasatch Front. As the regional green infrastructure networks evolve, stakeholder visions, goals and desires for the future of the Wasatch Front may change. *(Re)Connect* should be periodically reviewed, reassessed and revised as the Wasatch Front grows and matures.

*(Re)Connect* unites diverse planning goals for the Wasatch Front into a single overarching green infrastructure framework. It is essential that the education and outreach component of *(Re)Connect* continues to promote natural and social network enhancement. The green infrastructure methodology is a progressive and forward thinking approach and will ultimately achieve ecological and human health for the Wasatch Front.

Meeting the Regional Planning Objectives will provide not only increase green infrastructure services, it will also make substantial contributions to safer and improved grey infrastructure; improved watershed and regional health; increased connectivity and conservation of high quality resources; strengthened networks which provide benefits and services to the communities along the Wasatch Front; and efficient project development and increased transparency.

A coordinated planning approach is most beneficial when the resources are valued by multiple entities. The relationships created during the planning process show that inter-agency or local collaboration is possible. The ideas presented during the planning meetings and discussions give green infrastructure planning activities an opportunity to flourish in the Wasatch Front region.

***Priorities must be balanced to accommodate often competing demands for economic growth and development with those of environmental protection and management within the Wasatch Front.***

# 5. ASSET NETWORK MAPS FOR THE WASATCH FRONT

Early on in the development process, the Executive Committee agreed that the plan must view the Wasatch Front from an asset-based perspective. The objective of the asset network mapping process was to identify and illustrate existing high-quality green infrastructure lands. The asset network mapping process identified similar lands and categorized them into five maps, known as "asset network maps". Each of the five asset network maps has its own set of criteria. The criteria are based on more than forty datasets and used to establish core, hub, and corridor criteria that supported the region's goals.

To ensure the highest level of accuracy, the five asset network maps were presented to national and local experts in pertinent disciplines, as well as members of the Executive and Technical Committees for feedback. These individuals may have contacted other experts to provide additional input on the accuracy of the data and the asset maps. Revisions were made until Committee members were satisfied with each asset map and mapping criteria. For more information, refer to Appendix C.

Each asset network map is a valuable green infrastructure study in itself. Future land planning and management activities will affect the integrity of the asset networks and the entire green infrastructure system. The maps are not scientific implementation tools but generalized, regional asset identification and connectivity instruments. See below for ways the maps can be used.

*How the Asset Network maps Can Be Used*

- As a resource when making land use, planning, and management decisions regarding restoration, acquisition, development, and conservation initiatives.
- As a tool to view and understand how a project fits into the "bigger picture" in order to more fully understand the project's effect on other assets and activities.
- Individual asset network maps can help entities strengthen cores, hubs, and corridors through conservation, restoration, acquisition, enhancement, and other strategies. For instance, the Hydrological Asset Network Map may be particularly useful to the Department of Environmental Quality and the Utah Division of Water Resources.

## MAPPING SCALE

*(Re)Connect* defines the 'urban corridor' as Davis, Weber, and Salt Lake Counties. This area is 1,343,650 acres, has 45 municipalities, and is occupied by over 1.7 million residents. Ninety-five percent of the Wasatch Front's population resides in the urban corridor, while the urban corridor represents only 21% of the project area. The Wasatch Front's populations receive most of their ecosystem services from the surrounding rural areas. It is expected that population growth and development in the Wasatch Front will continue to be focused along the urban corridor. By the year 2040, Weber, Davis, and Salt Lake Counties are expected to grow by 814,000 new residents, a 50% increase from 2010.

## MAPPING COMPONENTS

The majority of green infrastructure projects completed to date have focused primarily on natural systems. These projects often include a cursory assessment of social landscape uses, but rarely do they explore the interconnectivity of natural and social systems in urban areas. *(Re)Connect* used a comprehensive approach specific to the Wasatch Front region to include social system networks (such as recreational lands, working lands, community, and cultural assets) with natural systems such as ecological, wildlife, and hydrological areas. This approach is based on The Conservation Fund's core, hub, and corridor strategy.

The Wasatch Front region's green infrastructure network of cores, hubs, and corridors will change over time due to the influences these diverse systems have upon one another. For instance, stream diversions harness water for human use and consumption, resulting in significantly altered hydrologic systems.

### CORES

Cores are highly functional, high-quality lands. Cores are geographically large, un-fragmented lands that are either connected or close to one another. These lands provide the most effective ecosystem services and sustained functionality.

Example: Forests have the capacity to provide habitat for plants and animals and because they are large and intact and can sustain ecosystem services they are considered a core.

### HUBS

Hubs are lands that support cores, though they are not always connected to cores. The hubs have been identified through qualitative assessments rather than spatially defined locations that surround cores.

Example: If a designated hunting area has been identified as a recreational core then the hub is the habitat where the game species is found.

### CORRIDORS

Corridors are linear landscapes that physically link assets together; they facilitate mobility between cores and hubs. Corridors support and enhance green infrastructure network resiliency.

Example: A river or stream that connects two cores or hubs would be considered a corridor. Corridors allow for both biodiversity and individual species populations to be protected over large areas.

## MAPPING OVERVIEW

The five asset network maps illustrate the Wasatch Front's abundant green infrastructure resources, all of which are essential to the continued health, function, and livability of the region. Though the region currently boasts a wealth of green infrastructure assets, deliberate action must be taken to ensure the resources exist for future generations. The following bullets briefly describe the lands that make up the cores, hubs, and corridors of each asset network map.

## ECOLOGICAL ASSET NETWORK MAP

### ECOLOGICAL CORES

- Protected and public lands
- Wetlands
- Uplands
- Riparian areas
- Scrub and shrub areas
- Areas of critical environmental concern

### ECOLOGICAL HUBS

- Reservoirs
- Forest lands
- Habitat for upland animals
- Wildlife action areas
- Riparian areas
- Important bird habitat

### ECOLOGICAL CORRIDORS

- Streams
- Habitat connections
- Core and hub connections

## HYDROLOGICAL ASSET NETWORK MAP

### HYDROLOGICAL CORES

- Protected and restored areas
- High-quality reservoirs
- Rivers and streams
- Lakes
- Wetlands
- Floodplains

### HYDROLOGICAL HUBS

- Watershed restoration areas
- Groundwater discharge areas
- Aquifers
- Rivers and streams
- Wetlands
- Hyrdric soils
- Areas with shallow groundwater
- Riparian areas

### HYDROLOGICAL CORRIDORS

- Rivers
- Streams
- Irrigation canals

## RECREATIONAL ASSET NETWORK MAP

### RECREATIONAL CORES

- Regional trails
- Regional parks
- Regional natural lands
- Golf courses
- Marinas
- Ski hills
- Major waterways
- Permanent streams
- Lakes

### RECREATIONAL HUBS

- Protected and public lands
- Open space
- Intermittent streams
- Washes
- Canyons
- Popular game species habitat
- Cooperative wildlife management areas

### RECREATIONAL CORRIDORS

- Major trails
- Major rivers
- Scenic byways
- Transit lines and stops

## WORKING LANDS ASSET NETWORK MAP

### WORKING LANDS CORES

- Working lands on prime farmland soil
- Working lands on protected lands
- Ranching lands
- Grazing lands

### WORKING LANDS HUBS

- Prime soils
- Prime irrigated soils
- Soils of statewide and local importance
- Working lands not on prime soils
- Working lands not on protected lands
- Adjacent lands with related land cover

### WORKING LANDS CORRIDORS

- Irrigation canals
- Major roads

## COMMUNITY AND CULTURE ASSET NETWORK MAP

### COMMUNITY AND CULTURE CORES

- Protected lands
- Historic districts
- Historic easements
- Transit stops
- Parks and open space
- Major rivers
- Cemeteries
- The Great Salt Lake
- Libraries
- Zoos
- Schools

### COMMUNITY AND CULTURE HUBS

- State Institutional Trust Lands
- Bureau of Land Management
- Military Lands

### COMMUNITY AND CULTURE CORRIDORS

- Transit lines
- Highways
- Major roads
- Regional trails
- Irrigation canals

## MAPPING METHODOLOGY

Cores and hubs were spatially mapped using ESRI's 9.3.1 ArcGIS and ArcMap. For a list of the GIS data sources and detailed methodologies for each asset refer to Appendix C. This information can also be downloaded from the Center for Green Infrastructure Design's website, under "Regional Green Infrastructure Asset Criteria and Mapping Process" or visit *http://greeninfrastructuredesign.org/green-infrastructure*.

Corridors were mapped using a unique process of corridor identification and spatial modeling. Each corridor modeling and/or design process is explained in the methodology section for each asset. Later in the planning process, ESRI's 10 ArcGIS and ArcMap software was used to prepare the final asset maps.

***A comprehensive table of the green infrastructure asset network component criteria, including source and methodology, can be found in Appendix C.***

## ECOLOGICAL ASSET NETWORK MAP

### GOAL

To protect and enhance natural landscapes, ecosystems, and the biodiversity of the Wasatch Front Region. To provide habitat for plant communities, wildlife, and fisheries, and to include unique ecological communities for rare, threatened or endangered species; and areas of environmental concern.

### DEFINITION

The ecological asset network identifies the highest quality natural landscapes and most functional ecosystems including: forest lands, wetlands, riparian areas, scrub and shrub landscapes, desert lands, protected lands that include public lands and lands with conservation easements, important bird habitat areas, wildlife reserves, and wilderness areas.

Six "focal species" were selected that represented the region's biodiversity each with a range of habitat types. Focal species and species' requirements were used because of the impossibility of monitoring all animals within the Wasatch Front region. Areas of "critical environmental concern" were also selected and included as ecological cores. Refer to the ecological maps below as they illustrate the six focal species' locations and areas of environmental concern within the region and each of the five counties.

*FOCAL SPECIES* - **Black Necked Stilt**
*CORE:* Wetlands with at least a 50 m diameter
*HUB:* Reservoirs
*CORRIDORS:* Discharge areas | Hydric soils | Shallow aquifers

*FOCAL SPECIES* - **American White Pelican**
*CORE:* Wetlands with at least a 50 m diameter
*HUB:* Reservoirs
*CORRIDORS:* Discharge areas | Hydric soils | Shallow aquifers

*FOCAL SPECIES* - **Northern Goshawk**
*CORE:* Uplands
*HUB:* Breeding and foraging areas | Habitats that are predominantly made up of Aspen trees
*CORRIDOR:* Habitat connections between summer and winter ranges

*FOCAL SPECIES* - **Mule Deer**
*CORE:* Uplands
*HUBS:* Breeding and foraging areas | Habitats that are predominantly made up of Aspen trees
*CORRIDOR:* Habitat connections between summer and winter ranges

*FOCAL SPECIES* - **Bonneville Cutthroat Trout**
*CORE:* Riparian areas | Streams with a 50' buffer
*HUB:* Habitats that are predominantly made up of Aspen trees
*CORRIDORS:* Streams within cores and hubs | Connections between high-quality, woody, riparian vegetated streams

*FOCAL SPECIES* – **Greater Sage Grouse**
*CORE:* Habitats that predominantly include scrub and shrub lands
*HUB:* Sagebrush within 1 mile of masked species location
*CORRIDORS:* Habitat connections between summer and winter ranges | Connections between preferred habitats

*AREAS OF CRITICAL CONCERN* - **Bureau of Land Management Lands**
*CORES:* Bonneville Salt Flats | Horseshoe Springs
*HUB:* None identified
*CORRIDOR:* None identified

*AREAS OF CRITICAL CONCERN* - **Forestry, Fire, and State Lands**
*CORE:* None identified
*HUB:* FFSL high priority forest lands
*CORRIDOR:* None identified

*AREAS OF CRITICAL CONCERN* - **Division of Wildlife Resources Lands**
*CORE:* None identified
*HUBS:* Wildlife action areas | Important bird habitats | Areas of habitat biodiversity
*CORRIDOR:* None identified

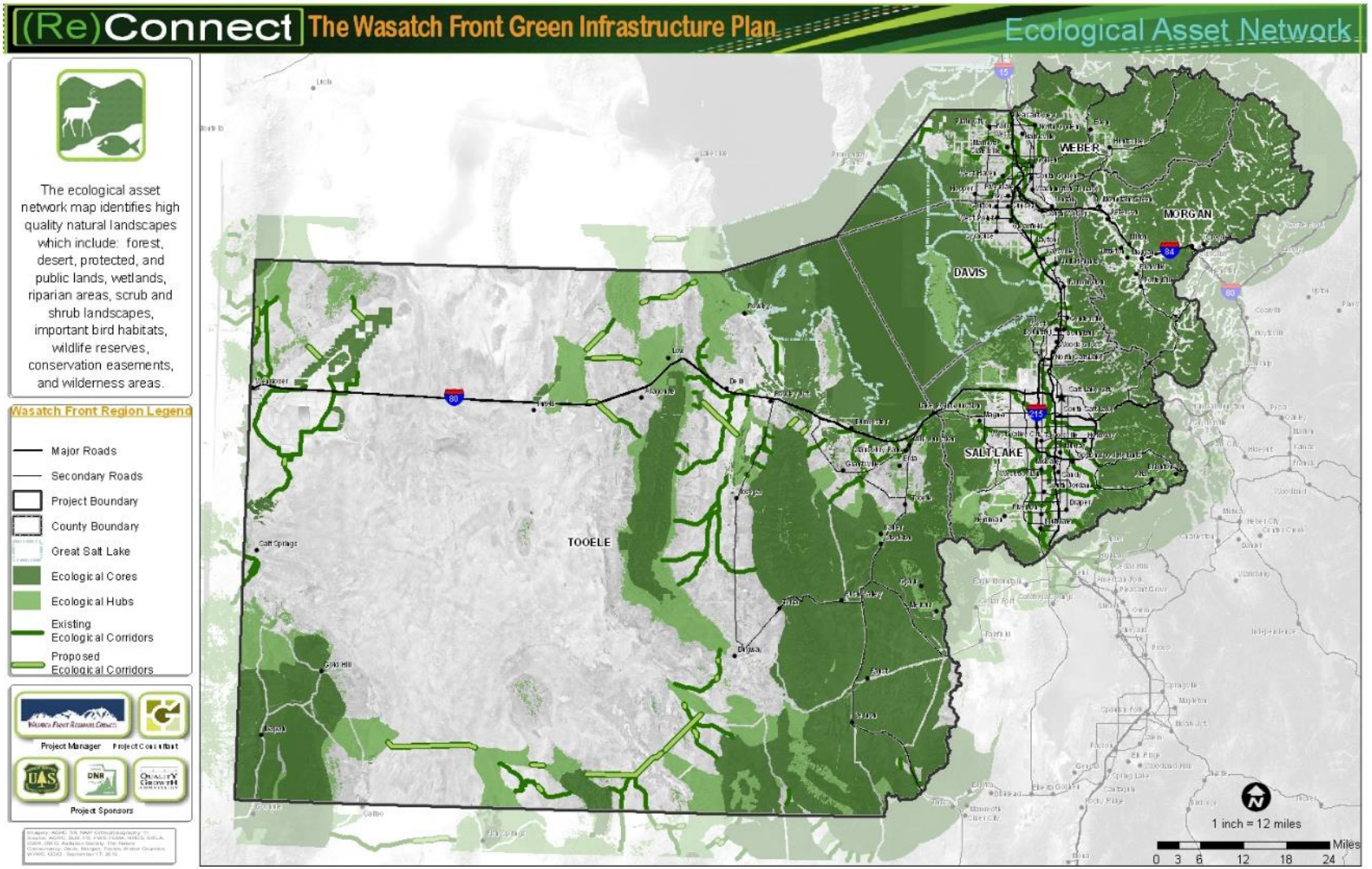
## UTILIZING THE ASSET NETWORK MAP

Asset network maps have been created for the region as a whole (Map 1) and for each of the counties (Maps 2-6). The ecological asset network maps can assist wildlife biologists and managers prioritize management actions and potential habitat restoration areas. The map can assist land use planners when making land management strategy decisions to improve, conserve, or connect ecological assets. Lastly, land managers can use the map to identify areas to promote biodiversity, sustain, or connect cores and hubs, and corridors. The existing corridors represent the most efficient riparian connections between core and hub areas. These can be seen as potential priority areas for enhancement and expansion.

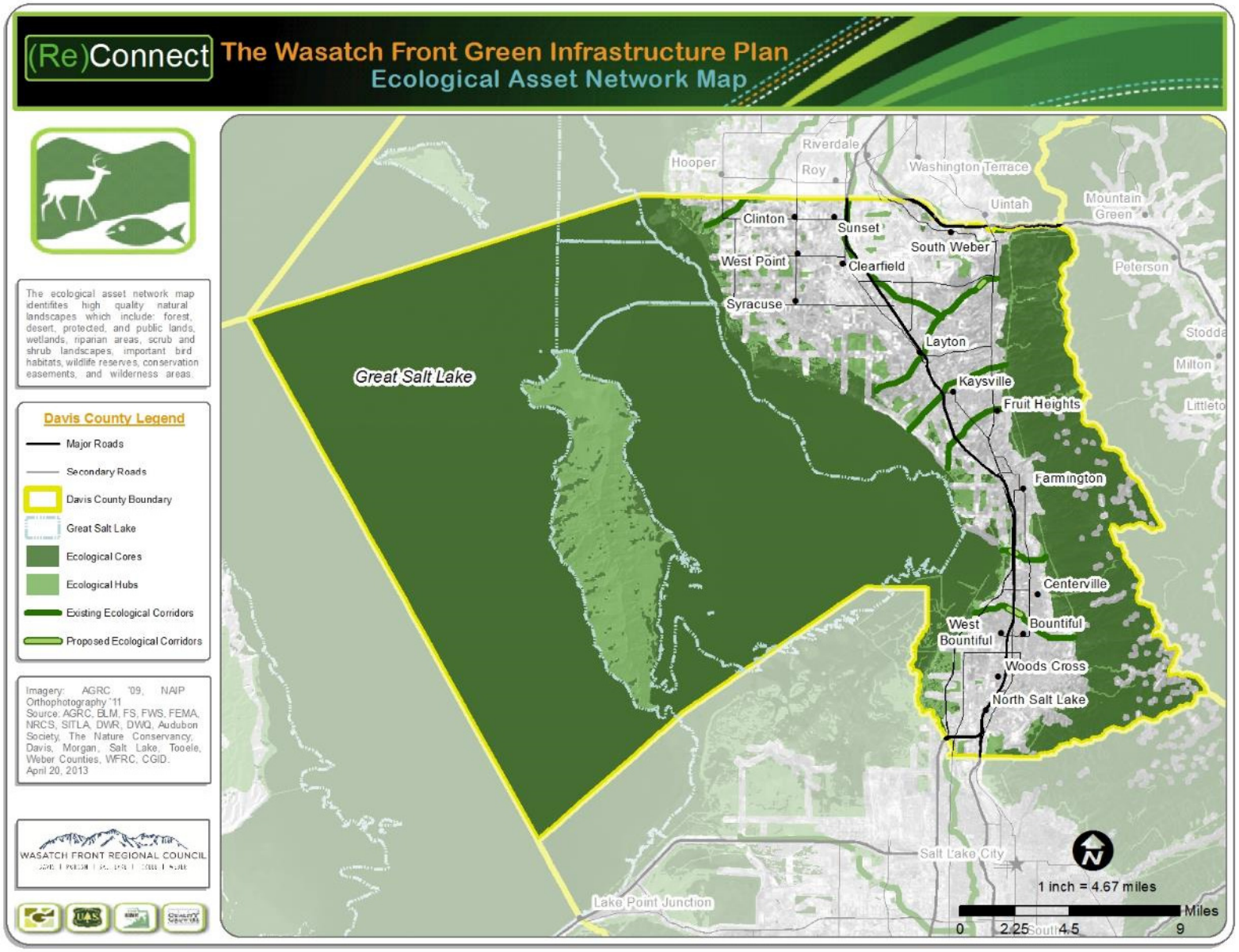
## METHODOLOGY

Refer to Appendix C for a complete description of the ecological network mapping methodology. The existing ecological corridors identified in this process include river and stream systems that most efficiently link ecological core and hub areas. Urban connections through parks and golf courses were prioritized (where appropriate) because these areas have the capacity to provide valuable urban wildlife habitat. Corridors connecting winter and summer ranges for various species were not included because it was beyond the scope of this project.

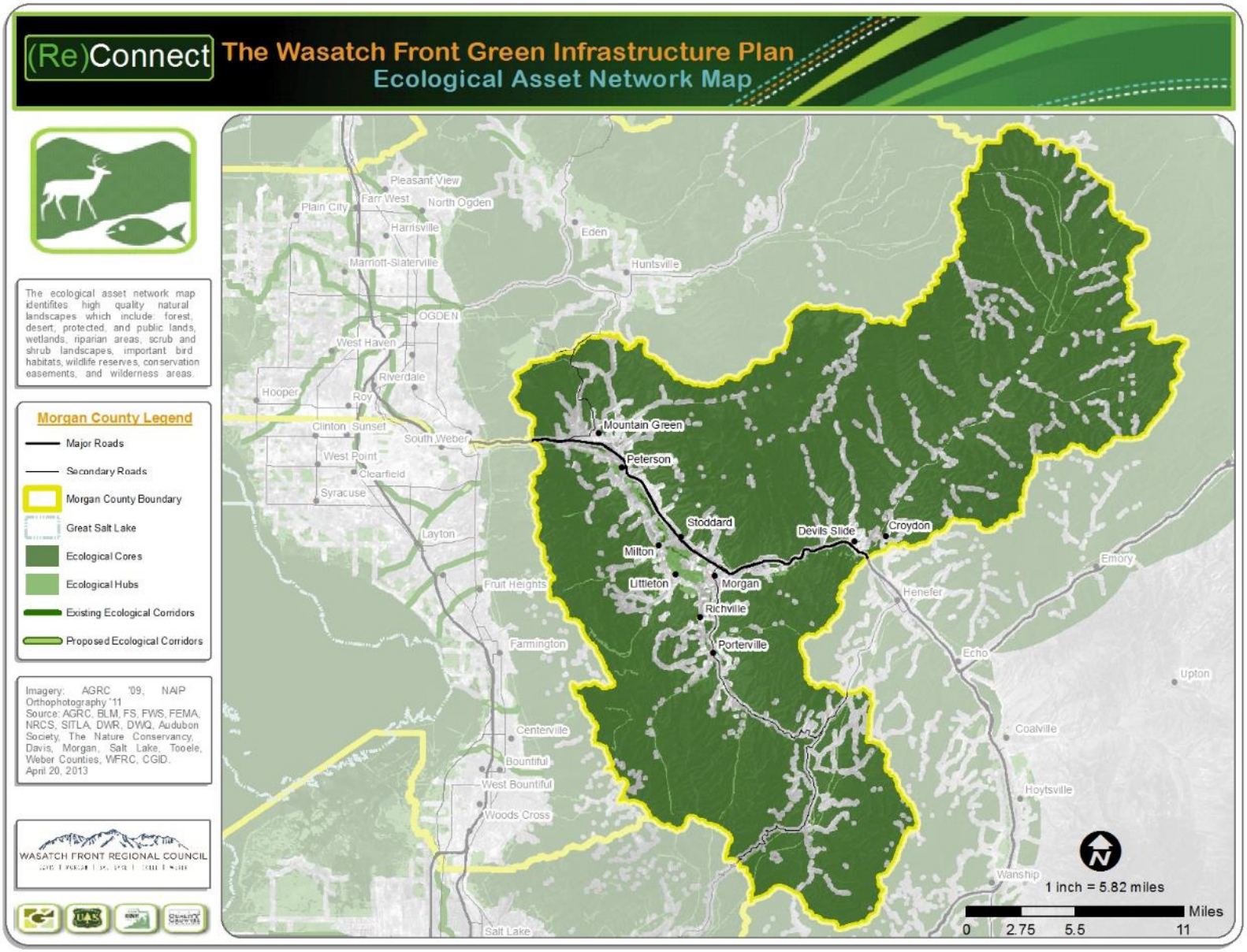
After the existing corridors were identified, the network was assessed for areas lacking connectivity. A specific GIS modeling technique, least cost path analysis (LCP), was utilized to assess paths of least resistance in the network. Least cost path models take into account the level of ease or difficulty with which movement occurs across a particular surface. A LCP model based on land cover typologies was generated for the network using ArcGIS software. The ecological LCP model assigned permeability values to various land cover types to assess paths of least resistance. These least cost paths were used to design connecting corridors between ecological core and hub areas with no existing connections and between disconnected linear elements, represented as 'proposed ecological corridors' on the map.



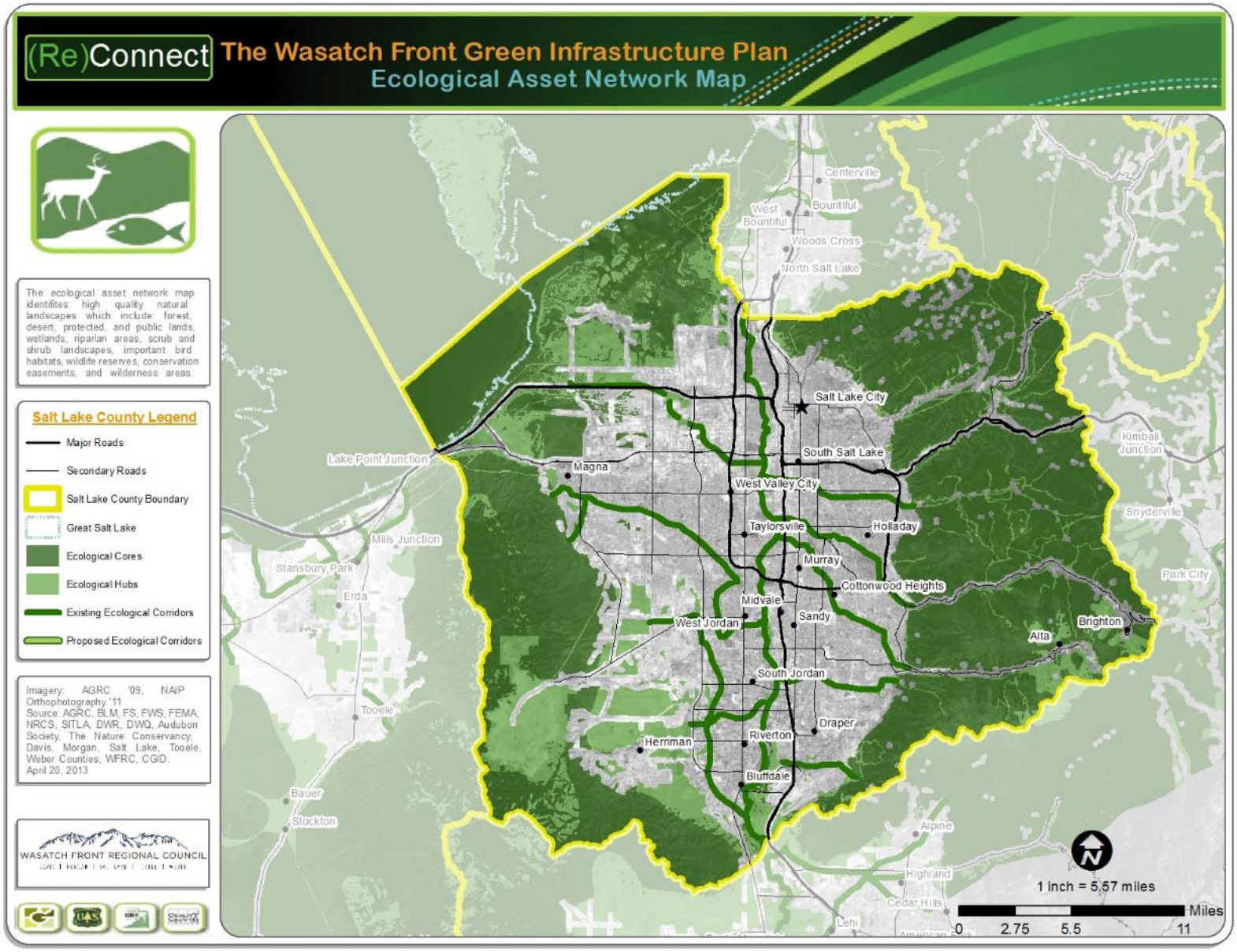

**Map 1 Wasatch Front Region Ecological Asset Network Map**



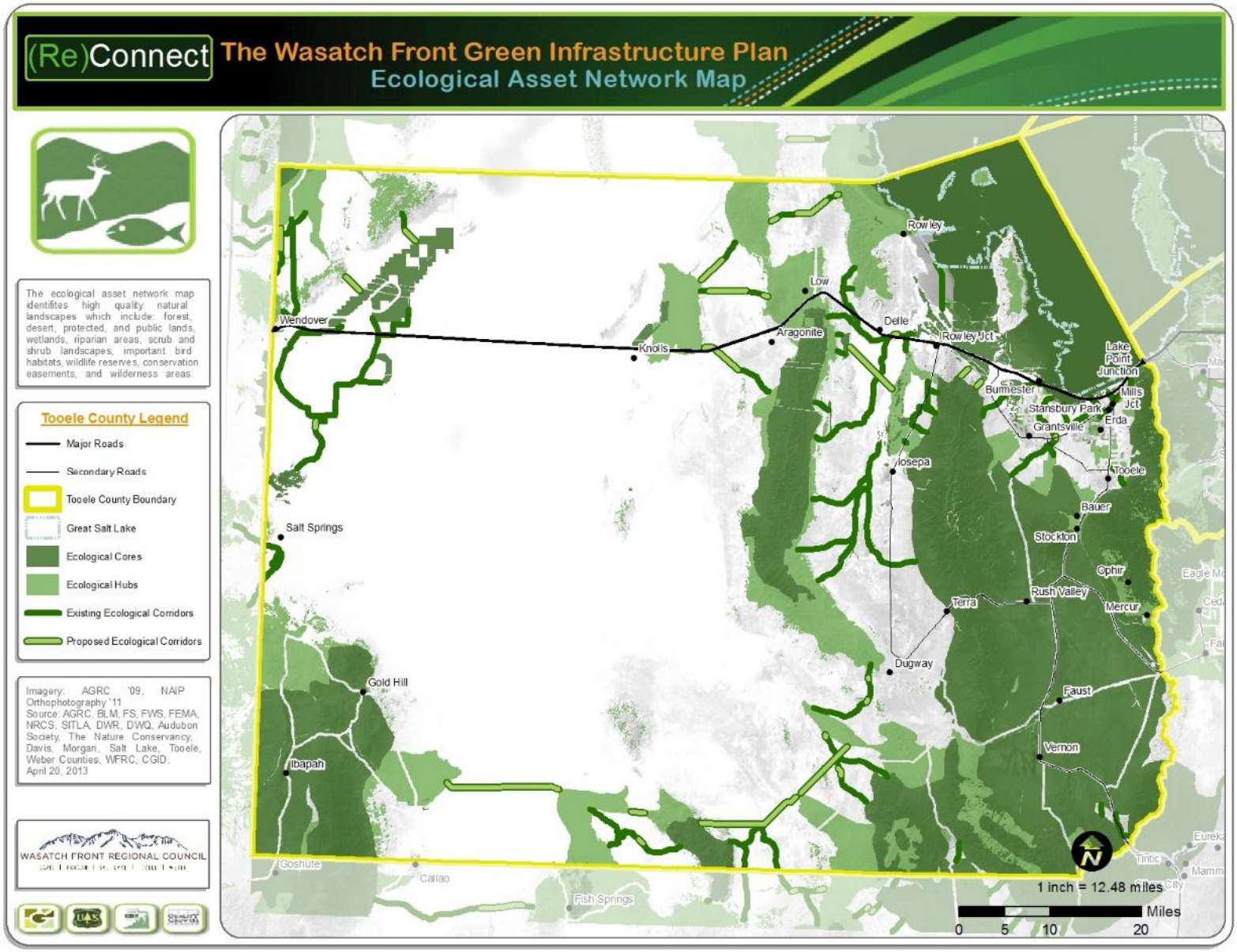

**Map 2 Davis County Ecological Asset Network Map**



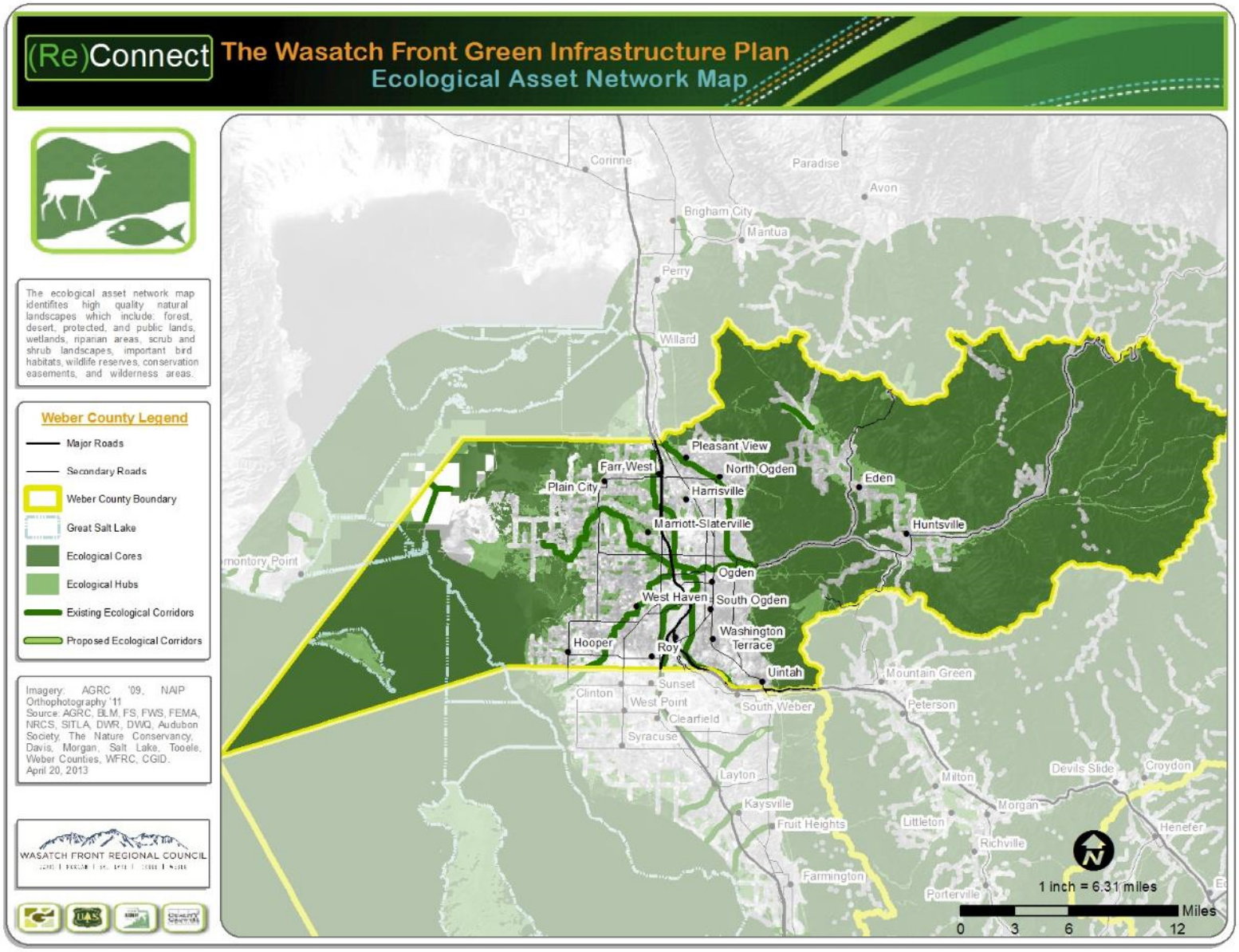

**Map 3 Morgan County Ecological Asset Network Map**




**Map 4 Salt Lake County Ecological Asset Network Map**




**Map 5 Tooele County Ecological Asset Network Map**




**Map 6 Weber County Ecological Asset Network Map**

## HYRDOLOGICAL ASSET NETWORK MAP

### GOAL

To protect and enhance the water resources of the Wasatch Front, including watersheds, wetlands, groundwater, and source water areas, to ensure water quality, and to provide a continually safe and abundant water supply. To promote a healthy hydrological system which encourages efficient flood control and water conveyance, while providing clean water, wildlife habitat, and recreational uses.

### DEFINITION

The hydrological green infrastructure asset network map identifies the healthy hydrological resources and landscapes that promote a clean and continuous water supply. These lands include wetlands, streams, lakes, reservoirs, conservation easements, groundwater, and source water areas.

#### HYDROLOGICAL AREA A

*CORE:* **Protected Lands with Hydrological Assets**
*HUB:* Watershed restoration areas
*CORRIDOR:* High-quality streams and rivers

#### HYDROLOGICAL AREA B

*CORE:* **High-Quality Water Bodies such as Reservoirs, Lakes, Rivers, Streams**
*HUBS:* Groundwater discharge areas | Aquifers | Drinking water protection zones | Major rivers with a 150’ buffer | Stream buffers of 50’ in urban areas
*CORRIDOR:* Irrigation canals

#### HYDROLOGICAL AREA C

*CORE:* **Wetlands**
*HUBS:* Wetland buffers | Urban area buffer of 50’ m | Non-urban area buffer of 100-300’m | Cutthroat Trout stream buffer of 30.5m
*CORRIDOR:* None identified

#### HYDROLOGICAL AREA D

*CORES:* **Floodplains in Weber County | Floodplains in Salt Lake County | Floodplains around the Great Salt Lake**
*HUB:* Riparian vegetation within 300m of the surrounding core
*CORRIDOR:* None identified

#### HYDROLOGICAL AREA E

*CORE:* **Restored Hydrological Assets in Salt Lake County**
*HUB:* Hydric soils
*CORRIDOR:* None identified

#### HYDROLOGICAL AREAS **EXCLUDED** FROM THE MAPS

*CORE:* **Impaired Waters (303(D) Listed Waters)**
*HUB:* Impervious areas greater than 25%
*CORRIDOR:* None identified

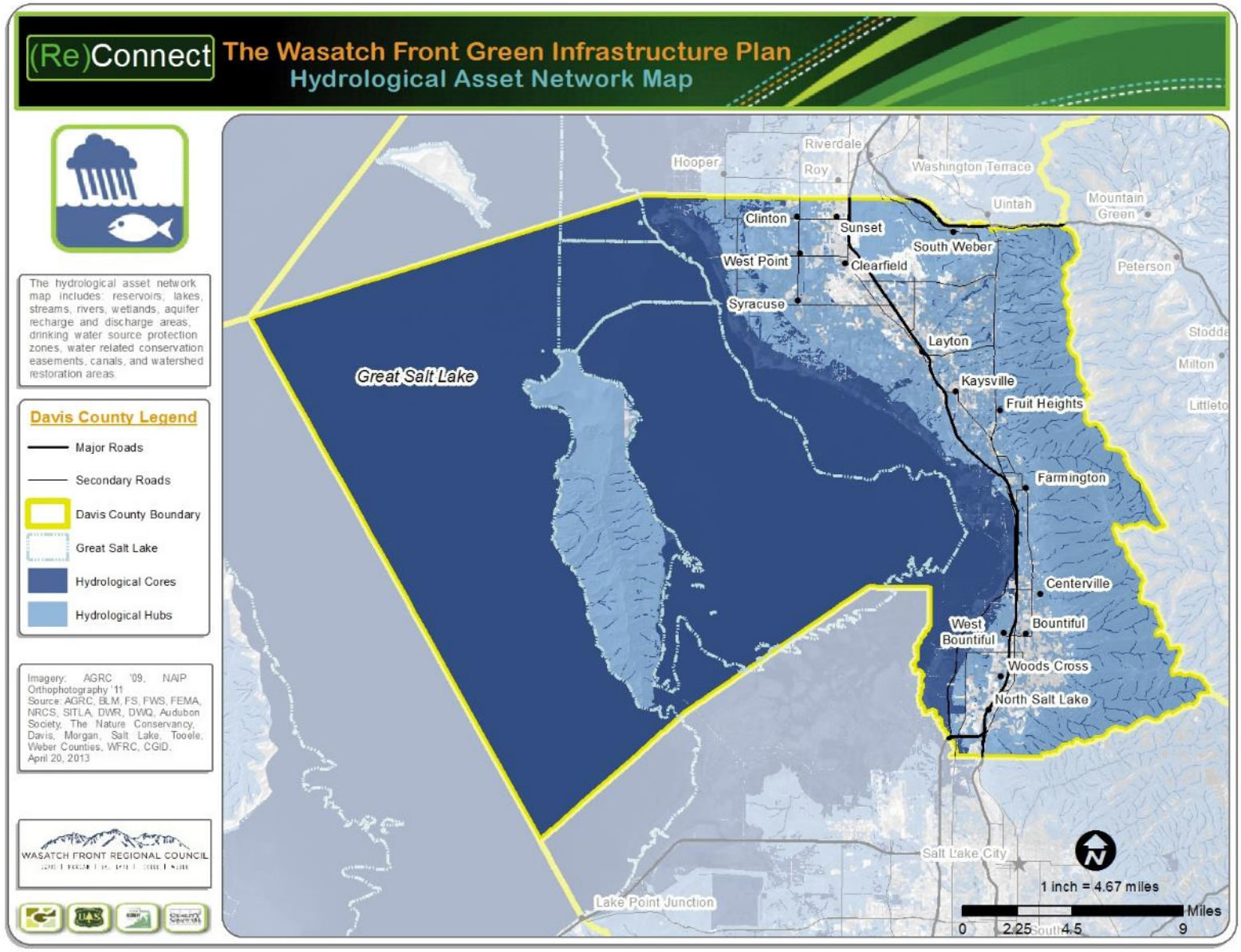
*CORE:* **Impervious Areas Greater than 10% such as Roads**
*HUB:* None identified
*CORRIDOR:* None identified

## UTILIZING THE ASSET NETWORK MAP

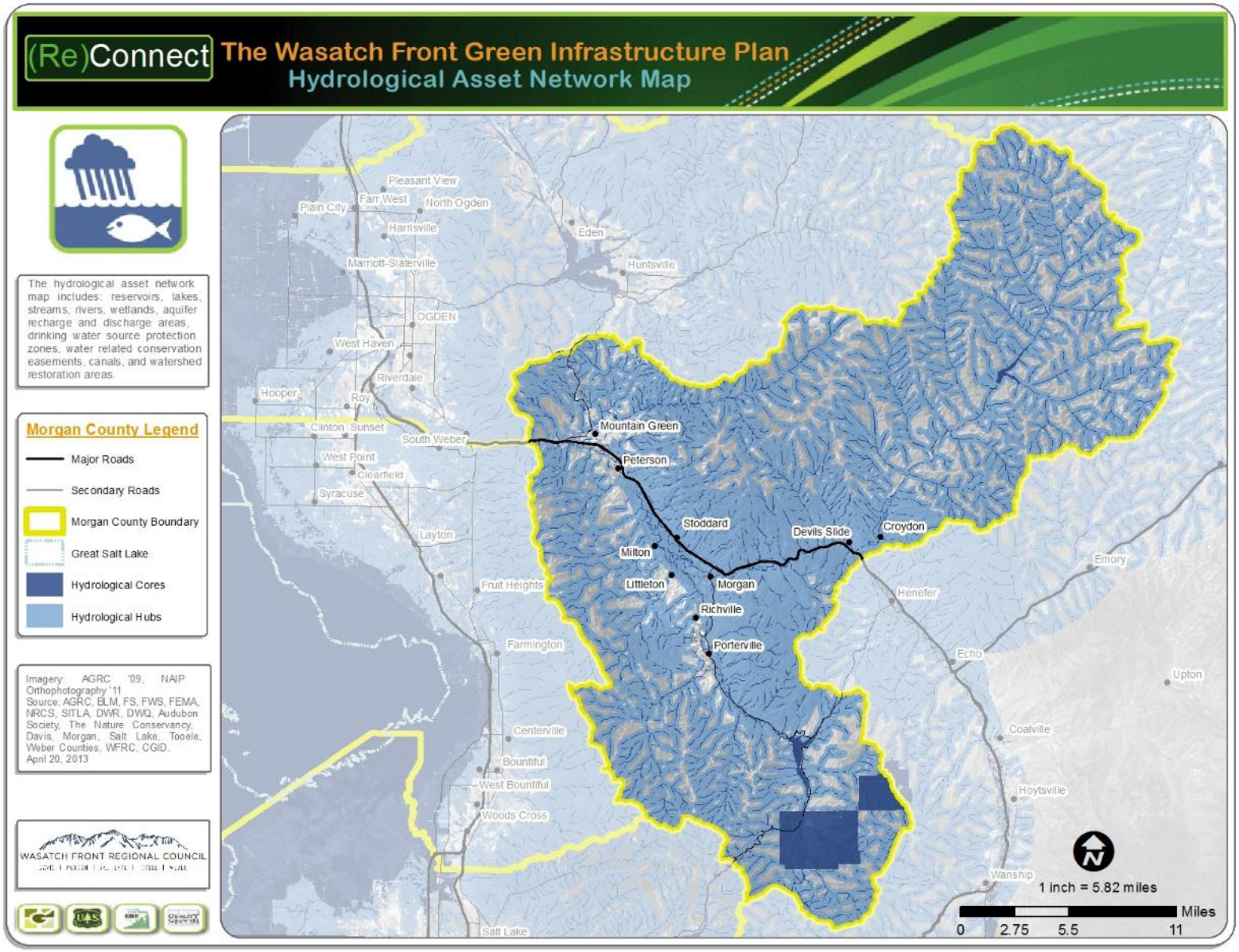
Asset network maps have been created for each of the counties (Maps 7-11). The maps identify lands that should be prioritized when it comes to management actions and restoration projects. For example, portions of the Jordan River are not defined as “core” areas due to the river’s impaired water quality. This indicates a need for restoration efforts along the river in order to improve water quality. Additionally, future land management actions could allow for a more coordinated effort. This could be between water quality specialists and biologists to identify best management practices for each asset. This allows land managers and planners to take into consideration the river’s multiple uses.

## METHODOLOGY

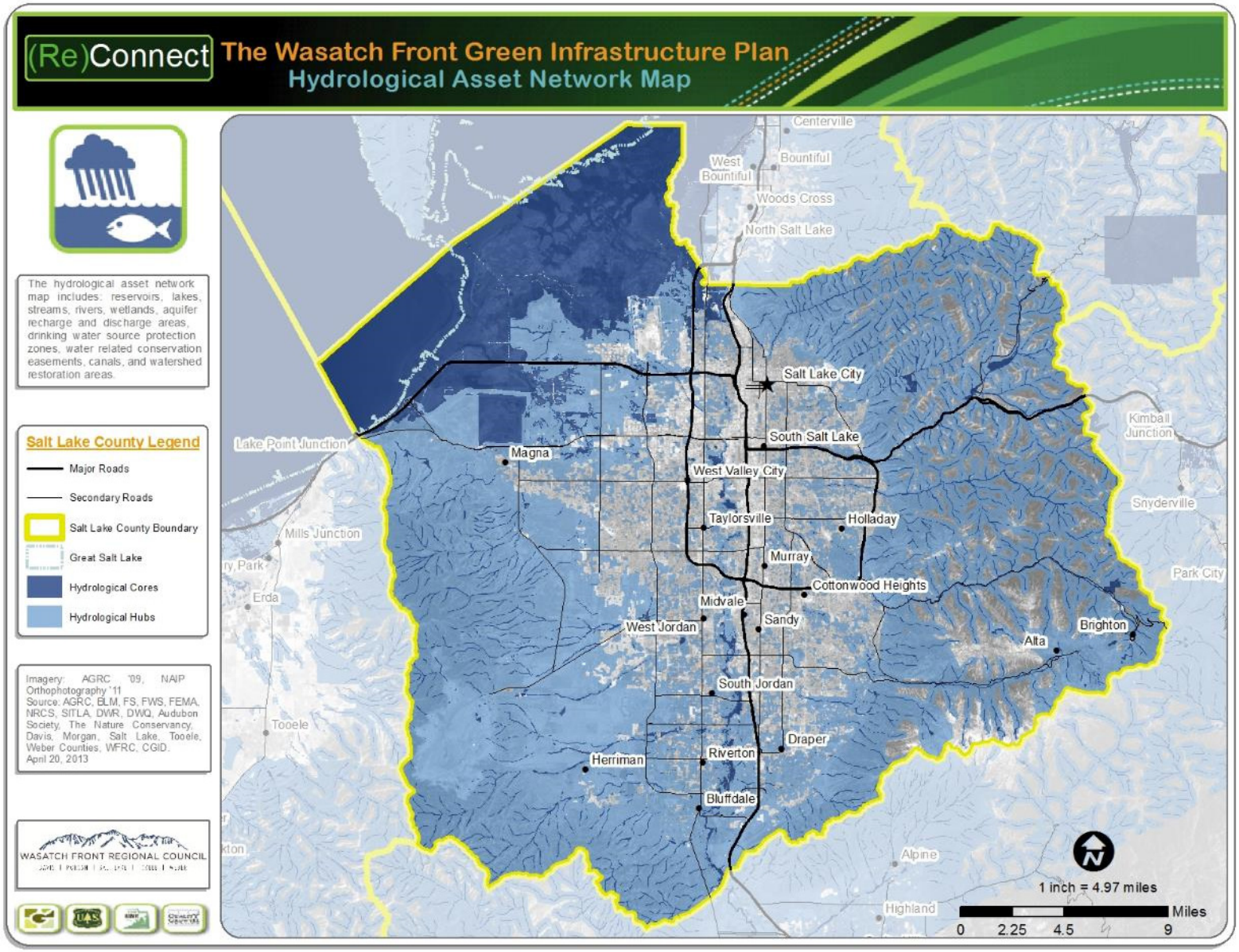
Refer to Appendix C for a complete description of the hydrological network mapping methodology. Hydrological corridors include existing linear features such as high-quality rivers, streams, creeks, irrigation canals, and drainages.



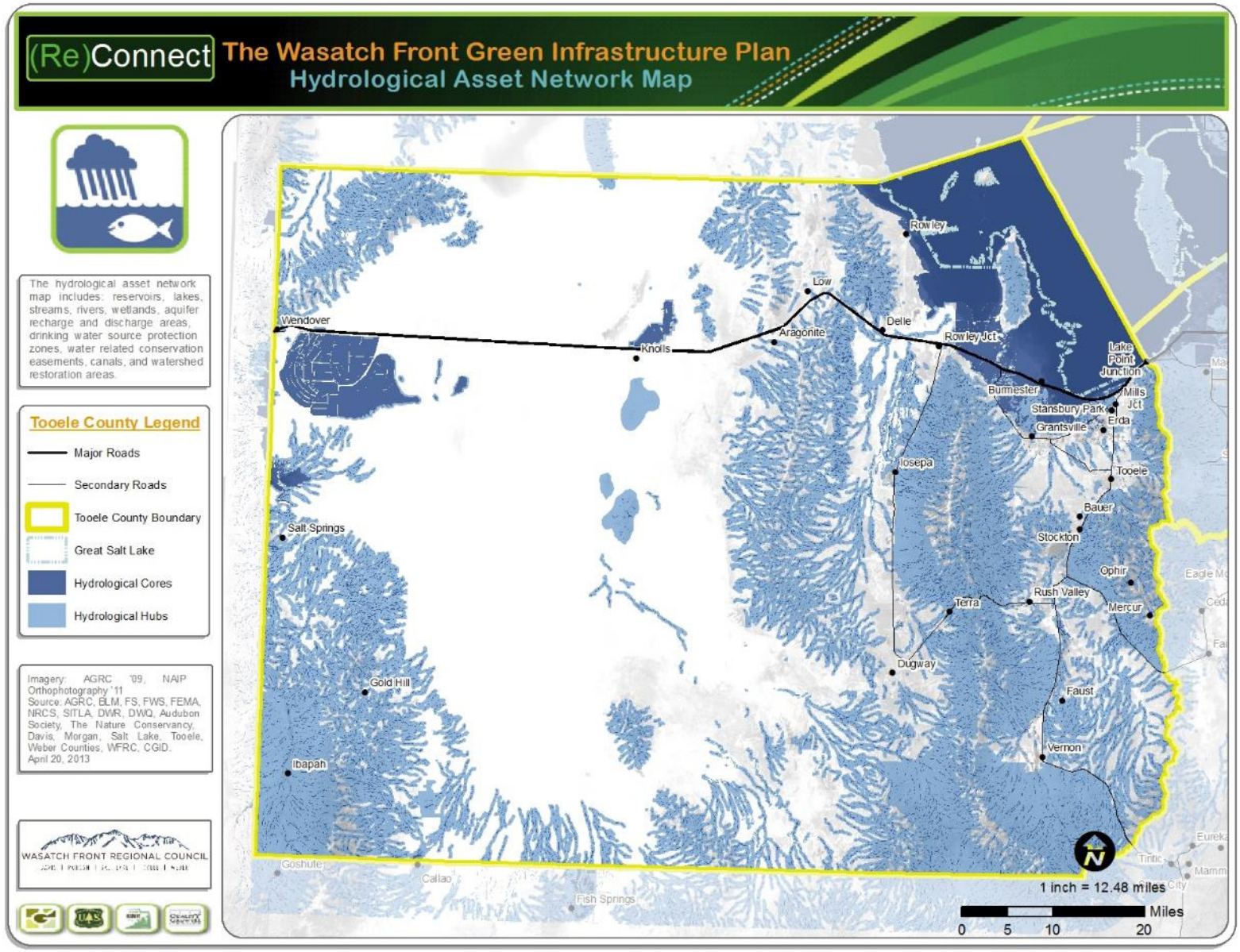

**Map 7 Davis County Hydrological Asset Network Map**



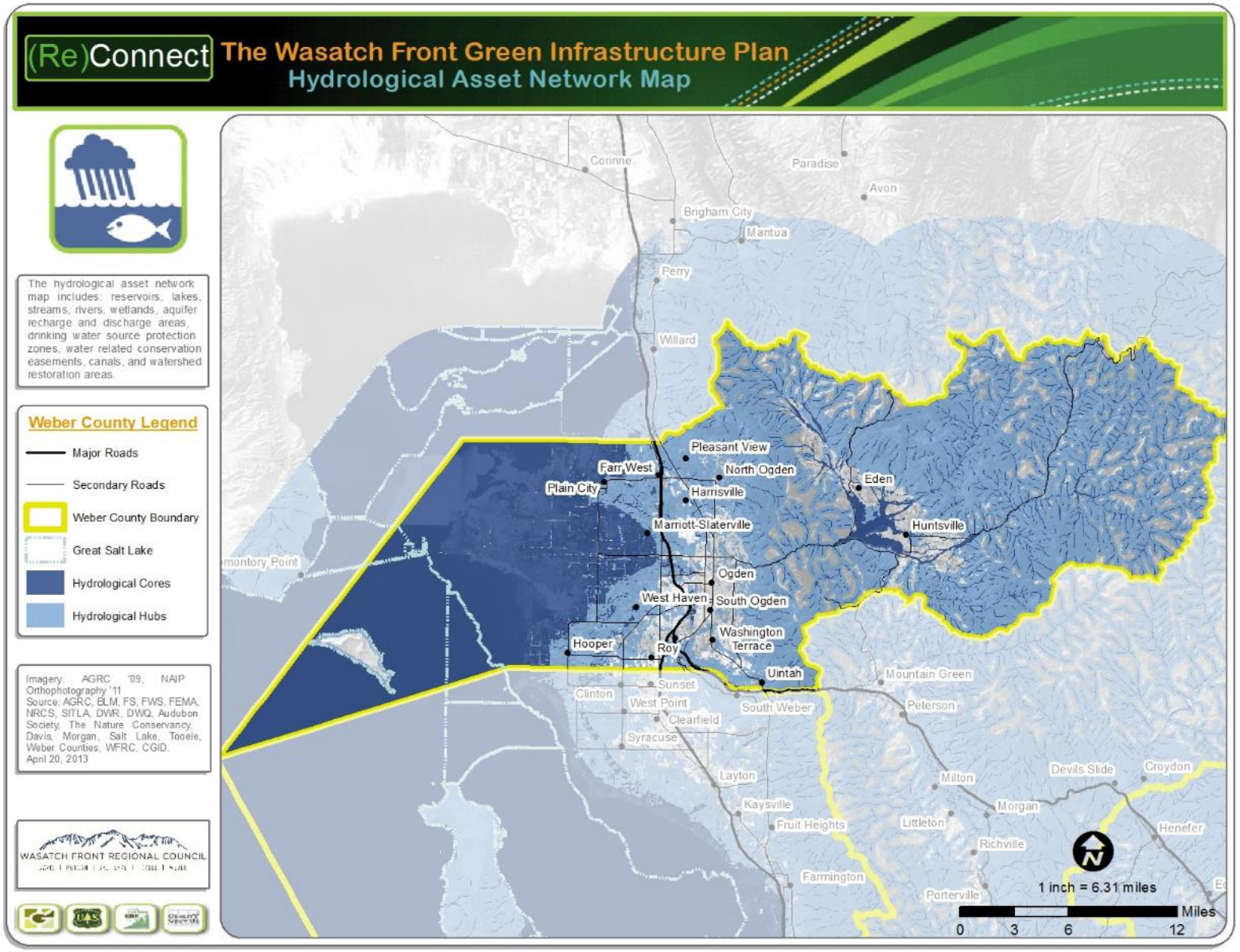

**Map 8 Morgan County Hydrological Asset Network Map**




**Map 9 Salt Lake County Hydrological Asset Network Map**




**Map 10 Tooele County Hydrological Asset Network Map**




**Map 11 Weber County Hydrological Asset Network Map**

## RECREATIONAL ASSET NETWORK MAP

### GOAL

To protect and enhance parks and open space of the Wasatch Front, to connect land and water corridors, to provide outdoor recreation opportunities such as fishing, hunting, wildlife viewing, paddling, camping, and trail-based activities. To strengthen the vibrant network of parks, trails, scenic qualities, recreational amenities, and natural lands in the Wasatch Front.

### DEFINITION

The recreational asset network map identifies regionally significant and high quality lands that provide recreational opportunities. These lands include areas that provide opportunities for skiing, fishing, hunting, hiking, wildlife viewing, camping, and water and trail-based activities.

#### RECREATIONAL AREA A

*CORES:* **Forest Service - Protected Lands with Public Access | Bureau of Land Management - Protected lands that allow for recreational uses | State owned lands that allow for recreational uses**
*HUBS:* Trails | Parks | Open spaces that connect cores
*CORRIDOR:* Regional trails

#### RECREATIONAL AREA B

*CORES:* **National Historic Trails and Trailheads: Great Western, Mormon Pioneer, Pony Express, Donner-Reed, Denver Rio Grande**
*HUBS:* Washes | Intermittent streams
*CORRIDOR:* Trails that connect public lands, open space, and parks

#### RECREATIONAL AREA C

*CORES:* **Trails and Trailheads: Jordan River, Bonneville Shoreline, Parley's Creek, Dimple Dell, Utah/Salt Lake Canal Trails, Decker Lake, Weber River, Legacy Parkway**
*HUB:* None identified
*CORRIDORS:* Waterways that connect recreational opportunities

#### RECREATIONAL AREA D

*CORES:* **Parks: Salt Lake Equestrian Park, West Jordan Soccer Complex, Big Cottonwood Park, South Cottonwood Park, Welby Park, Valley Park, Redwood Park, Sugarhouse Park, Parks with at least 20 acres in Davis, Morgan, Weber, and Tooele Counties**
*HUBS:* None identified
*CORRIDOR:* Major roads that connect recreational opportunities

#### RECREATIONAL AREA E

*CORES:* **Open Space and Other Natural Lands: Great Salt Lake, Jordan River, Ogden River, Antelope Island, Dimple Dell Park, Millcreek Canyon Park, Yellow Fork Canyon Park, Open space along the foothills, Golf courses, Ski resorts, Marinas**
*HUB:* None identified
*CORRIDORS:* Least cost path analysis between the cores

#### RECREATIONAL AREA F

*CORES:* **Major Waterways: Permanent streams, Lakes and reservoirs**
*HUBS:* None identified
*CORRIDORS:* None identified

### RECREATIONAL AREA G

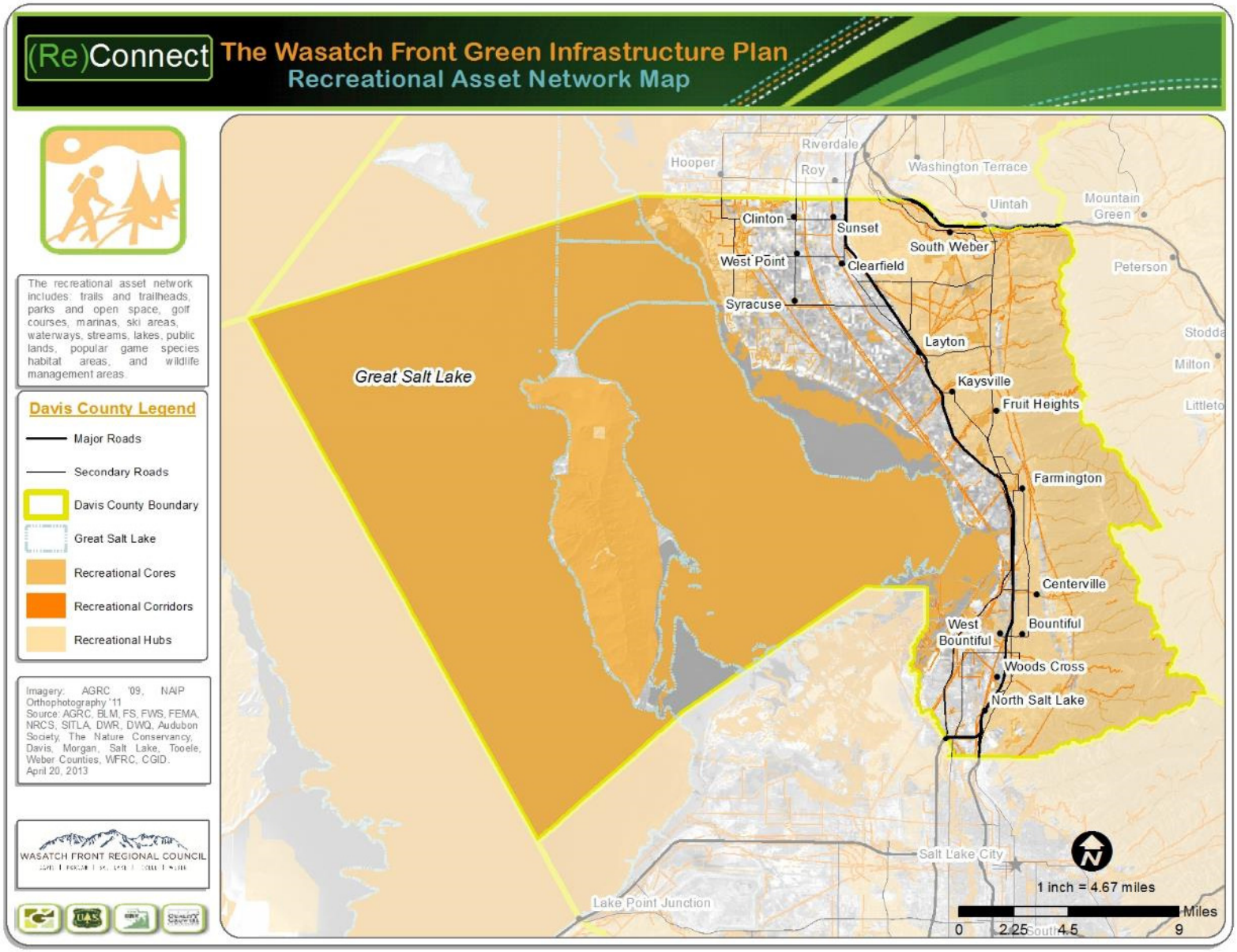
*CORES:* **Scenic Byways**
*HUBS:* None identified
*CORRIDORS:* None identified

## UTILIZING THE ASSET NETWORK MAP

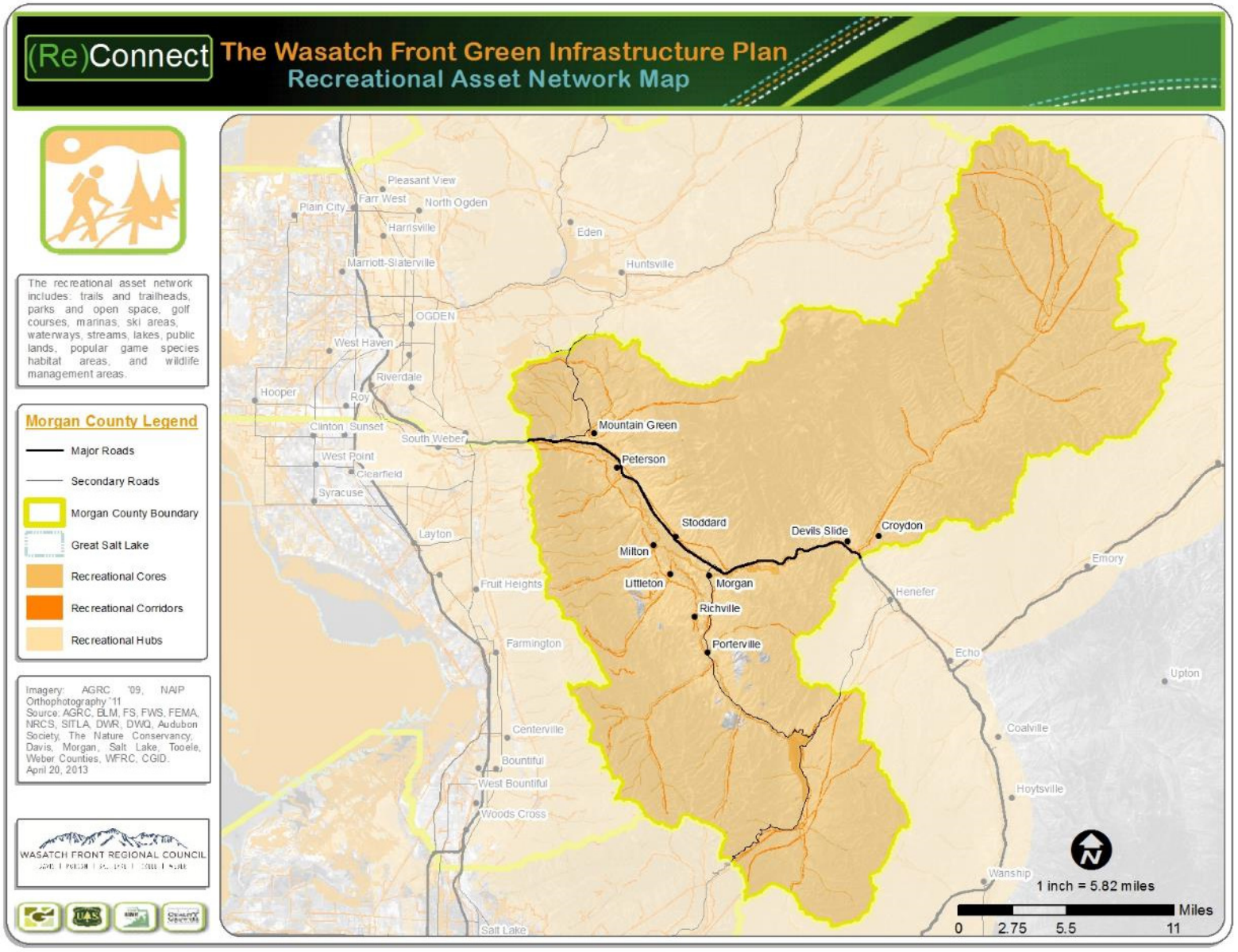
Asset network maps have been created for each of the counties (Maps 12-16). The maps will be useful to recreation managers, individuals involved in trail design, and wildlife managers. It will also assist individuals with conflicting interests coordinate efforts and arrive at mutually beneficial solutions associated with conservation and recreation.

## METHODOLOGY

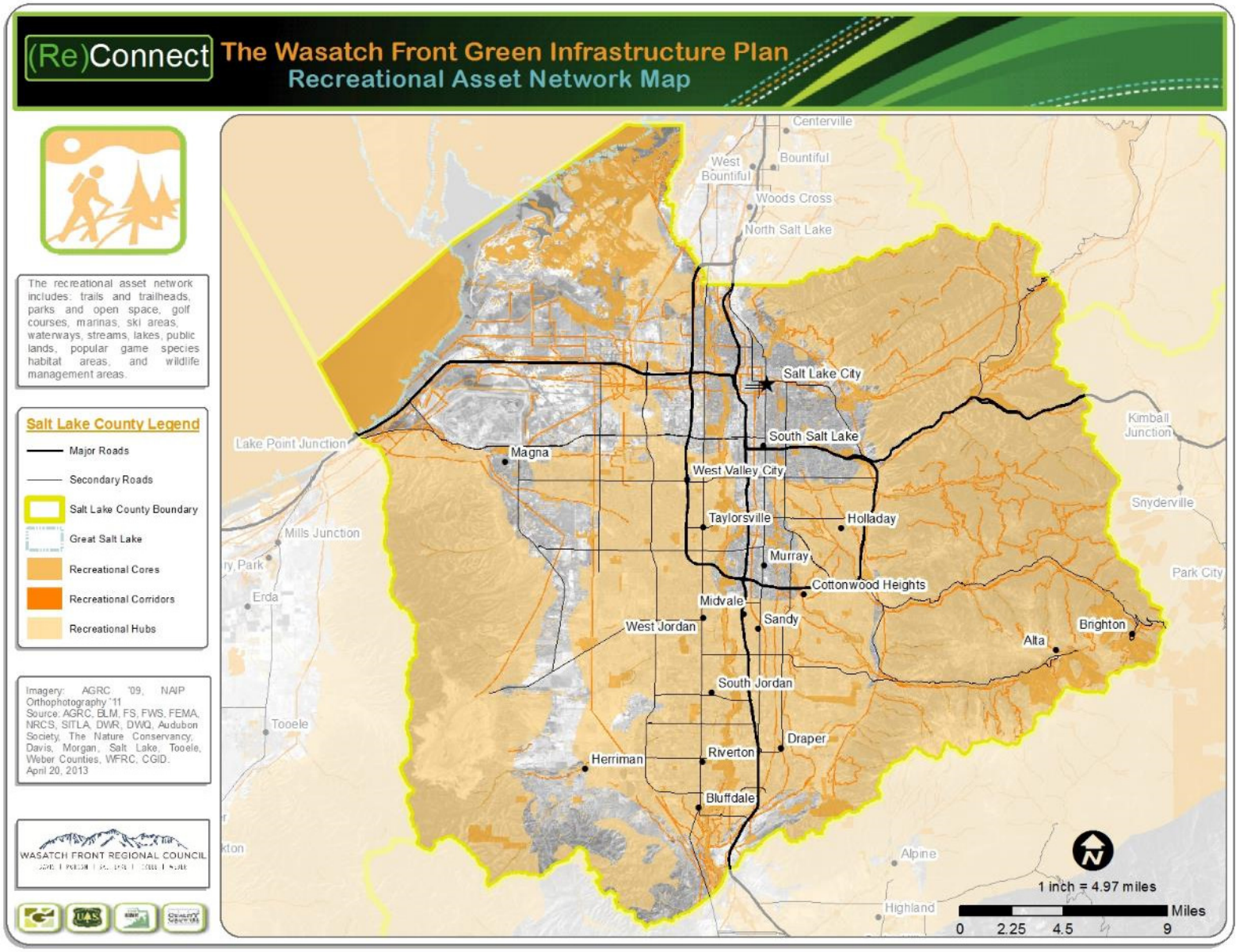
Refer to Appendix C for a complete description of the recreational network mapping methodology. Existing corridors were prioritized for the recreational network based on the most efficient corridor connections between the cores. Existing connections included trails, roads, and waterway routes. Not all trails, roads, and waterways were mapped due to the overwhelming quantity. Recreational corridors are intended to facilitate movement. Therefore, they link only the core areas (destinations) and not cores *and* hubs, as was done with the other asset network maps.



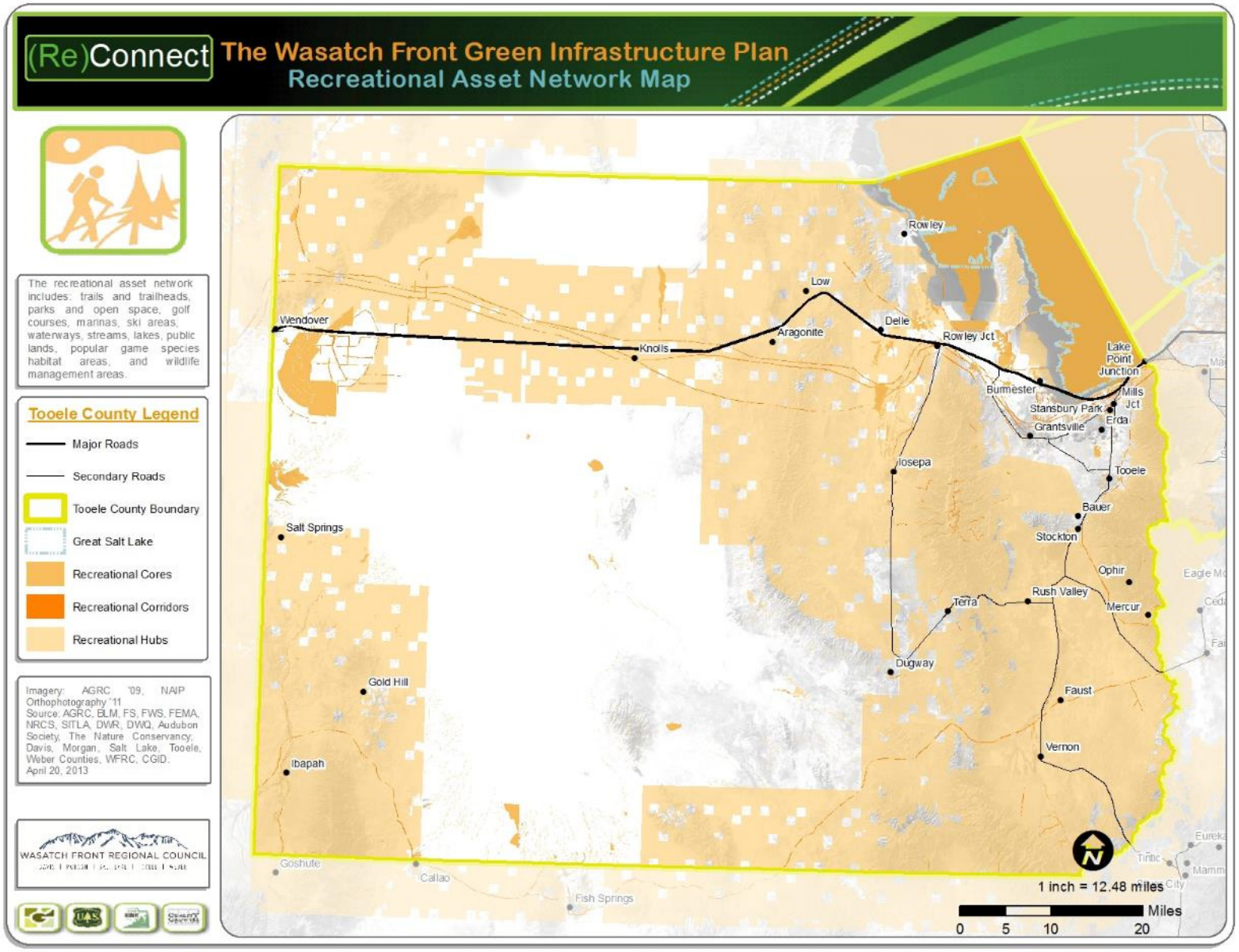

**Map 12 Davis County Recreational Asset Network Map**



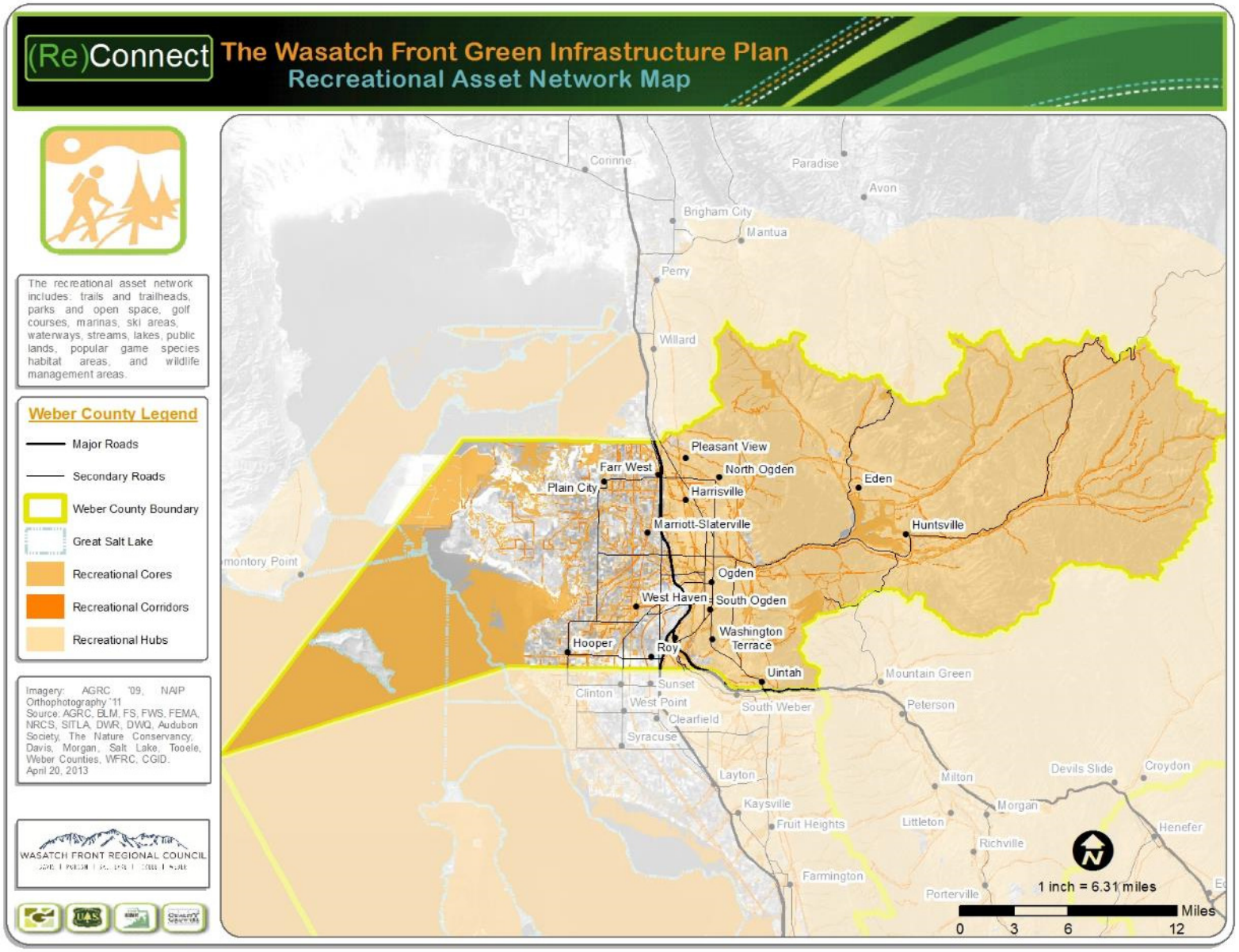

**Map 13 Morgan County Recreational Asset Network Map**




**Map 14 Salt Lake County Recreational Asset Network Map**




**Map 15 Tooele County Recreational Asset Network Map**




**Map 16 Weber County Recreational Asset Network Map**

## WORKING LANDS ASSET NETWORK MAP

### GOAL

To protect the working lands of the Wasatch Front which include forests, orchards, rangelands, and agricultural lands. To support the economic viability of working lands, maintain their benefits, and to retain the rural character of the region.

### DEFINITION

The working lands asset network map identifies the highest quality agricultural and rangelands, including: cultivated lands, areas of prime farmland soil, and grazing allotments. It also includes lands that promote agricultural health through pollination.

#### WORKING LANDS AREA A

*CORE:* **Protected Agricultural Lands in Tooele, Davis, and Weber Counties**
*HUBS:* All soils with statewide and local importance | Prime soils | Prime irrigated soils
*CORRIDOR:* Irrigation canals

#### WORKING LANDS AREA B

*CORE:* **Agricultural Conservation Easements**
*HUB:* Other working lands not on prime farmland soil
*CORRIDOR:* Major roads

#### WORKING LANDS AREA C

*CORE:* **Agricultural Lands on Prime Farmland Soil as Determined by the Natural Resource Conservation Society**
*HUB:* Other working lands not on irrigated agricultural lands
*CORRIDOR:* None identified

#### WORKING LANDS AREA D

*CORE:* **State Trust Grazing Lease Lands as Determined by the National Land Cover Database**
*HUBS:* Lands adjacent to working lands | Grasslands (support pollination and biodiversity) | Forests (provide soil stability and forestry related services)
*CORRIDOR:* None identified

#### WORKING LANDS AREA E

*CORE:* **Bureau of Land Management Grazing Lands**
*HUB:* None identified
*CORRIDOR:* None identified

#### AREAS **EXCLUDED** FROM THE WORKING LANDS MAPS

*CORE:* **Roads that Cut through Cores**
*HUB:* Working lands adjacent to aquifer discharge areas
*CORRIDOR:* None identified

*CORE:* **Unmanaged and Unused Working Lands**
*HUB:* Forest lands within the Wildland Urban Interface
*CORRIDOR:* None identified

*CORE:* **Working Lands next to Noxious Weeds**
*HUB:* None identified
*CORRIDOR:* None identified

*CORE:* **Saline Soils**
*HUB:* None identified
*CORRIDOR:* None identified

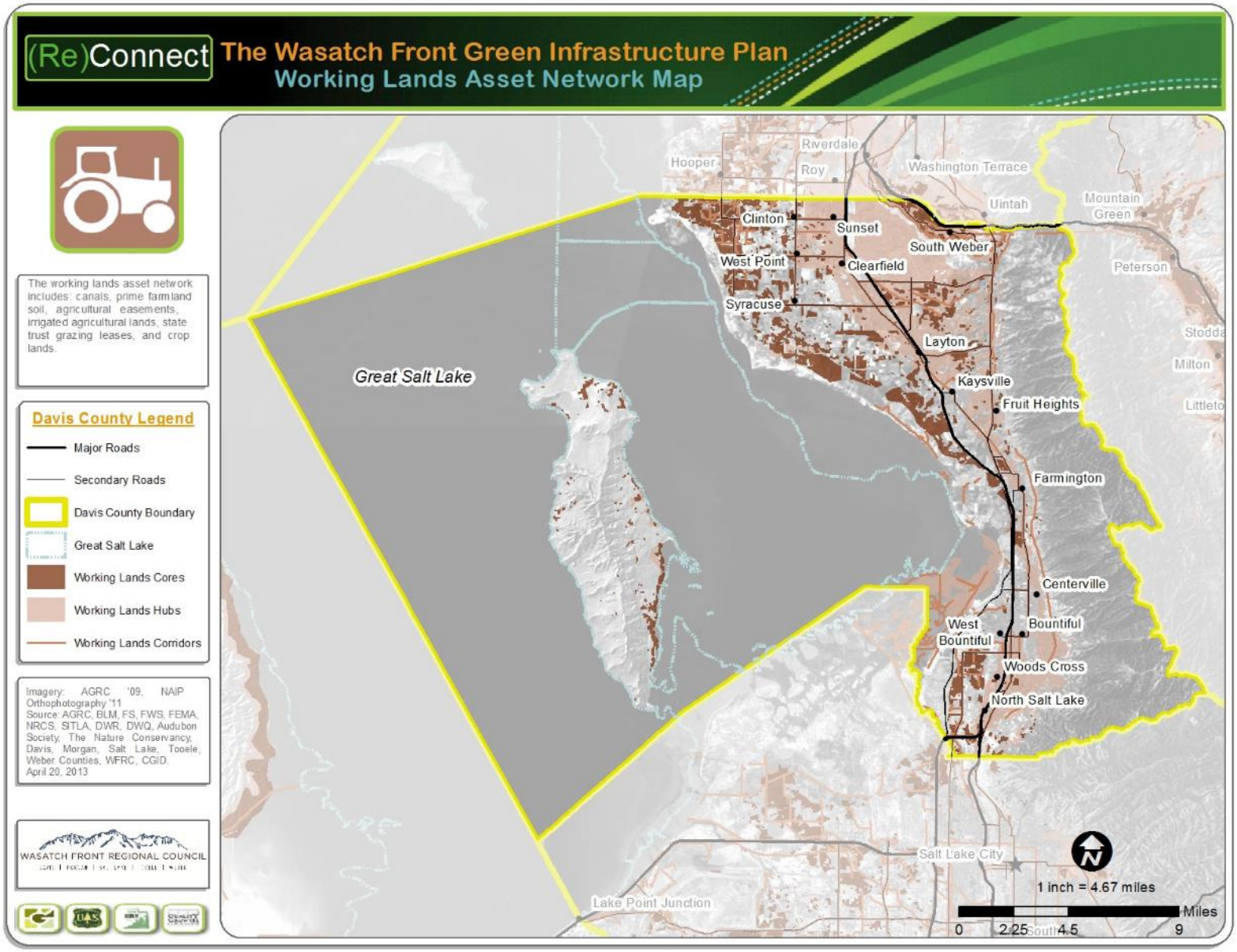
*CORE:* **Working Lands near Hydrological Cores**
*HUB:* None identified
*CORRIDOR:* None identified

## UTILIZING THE ASSET NETWORK MAP

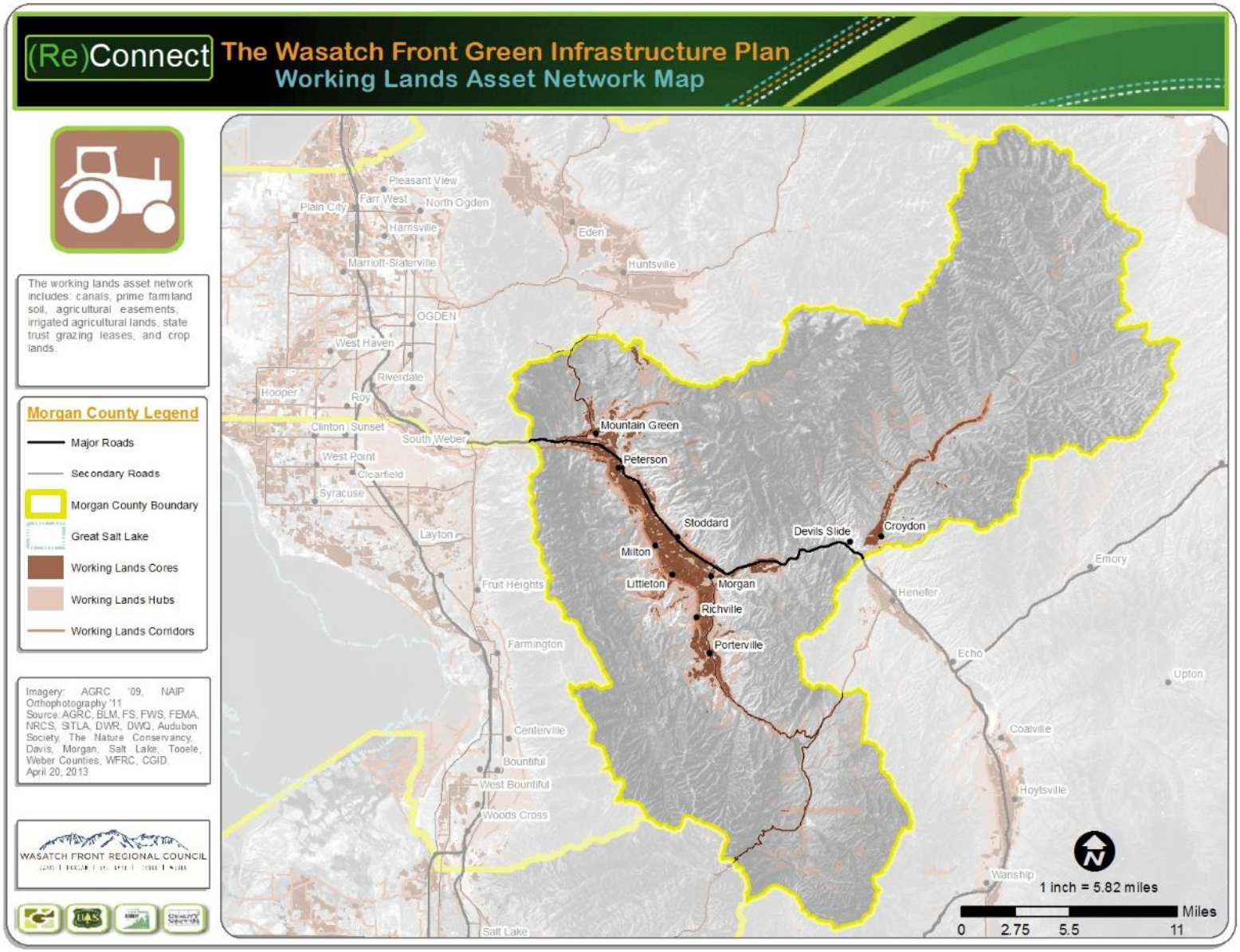
Asset network maps have been created for each of the counties (Maps 17-21). The maps can benefit range managers, farmers, the United States Department of Agriculture, foresters and stakeholders interested in the preservation of agricultural lands for production and protection of rural character. It can also be a tool for individuals that have traditionally conflicted with preservation of agricultural and ranching lands by helping identify that lands best suited development, soil conservation, or agricultural preservation.

## METHODOLOGY

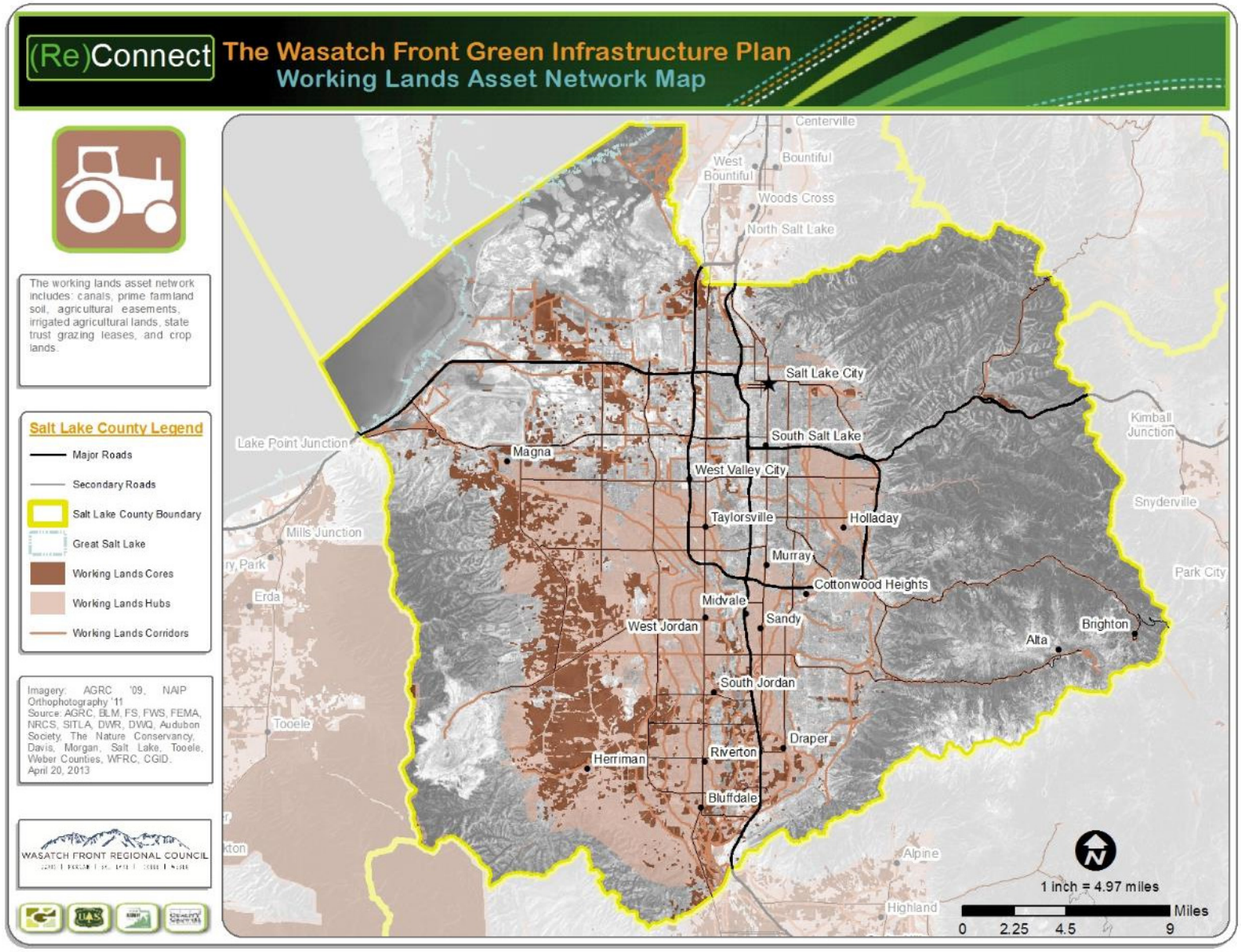
Refer to Appendix C for a complete description of the working lands network mapping methodology. While there is merit in identifying land cover suitability for the promotion of pollination, neither plants nor pollinators, were included as they do not move according to least cost paths. The working lands corridors include irrigation canals and major roads. Both sustain the health, functionality, and economic integrity of working lands systems. Irrigation canals increase working land productivity through hydrological connectivity. Major roads (interstate and state highways as determined by Utah's Department of Transportation) facilitate the movement of agricultural and ranching products.



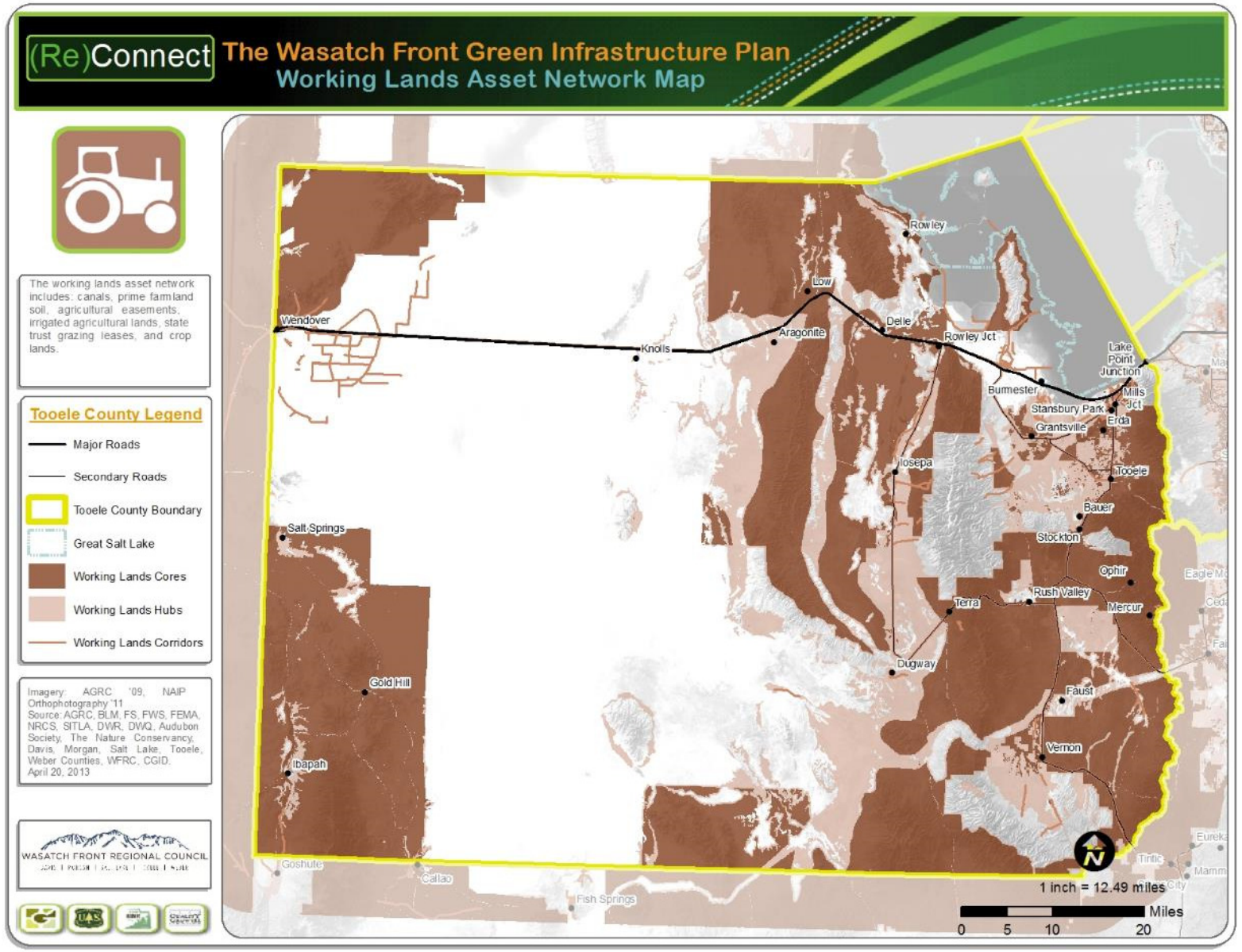

**Map 17 Davis County Working Lands Asset Network Map**



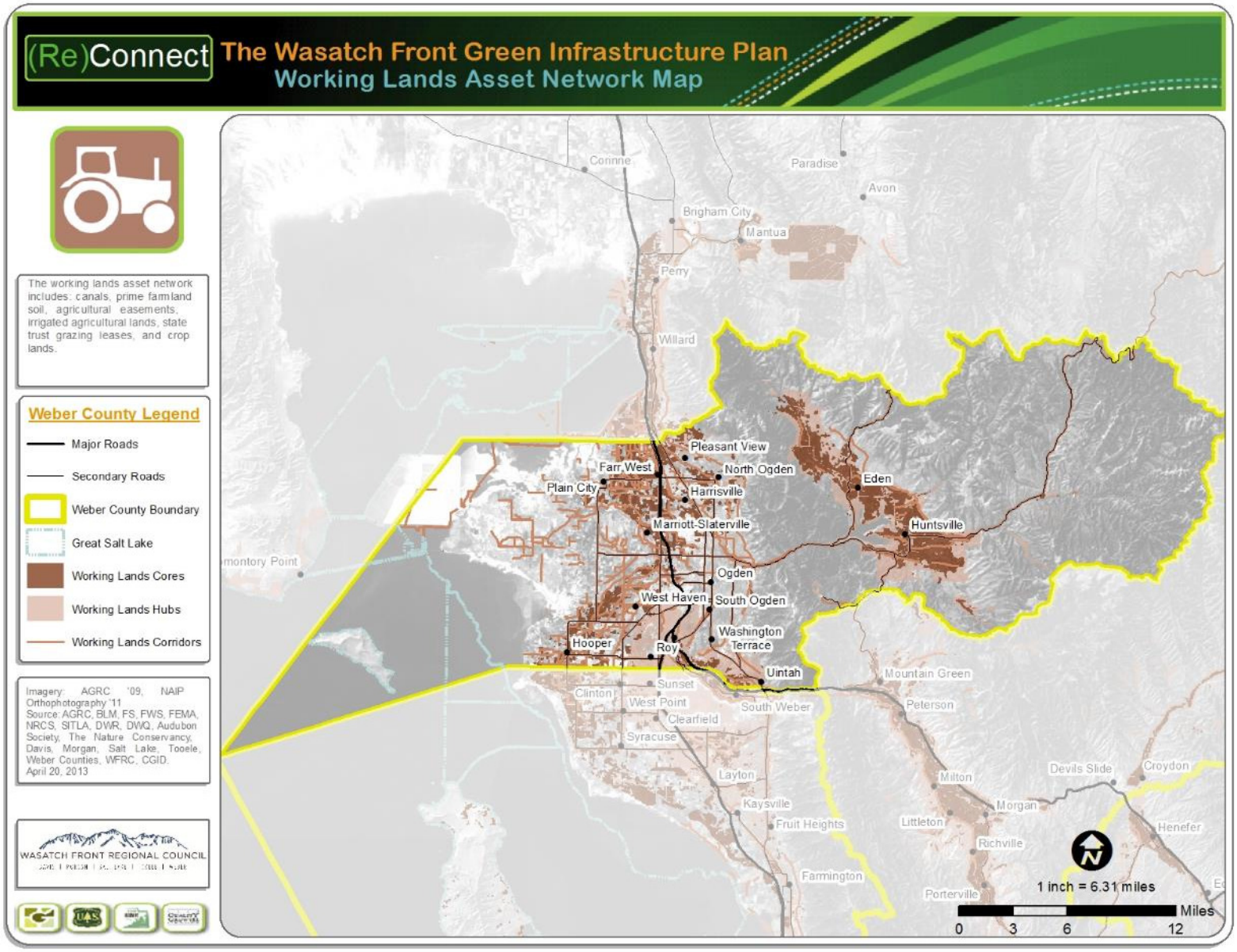

**Map 18 Morgan County Working Lands Asset Network Map**




**Map 19 Salt Lake County Working Lands Asset Network Map**




**Map 20 Tooele County Working Lands Asset Network Map**




**Map 21 Weber County Working Lands Asset Network Map**

# COMMUNITY AND CULTURE ASSET NETWORK MAP

## GOAL

To promote the development of healthy communities, places we live, work, and gather. To preserve and strengthen cultural resources, places of heritage, and economic health.

## DEFINITION

The community and culture asset network map identifies elements that promote healthy lifestyles and those that are of historical, cultural, and economic significance. These areas include tribal lands, historic districts and trails, transit stops and routes, railroads, cemeteries, parks, trails, and open space, and community facilities.

### COMMUNITY AND CULTURE AREA A

*CORE:* **Hill Air Force Base**
*HUB:* None identified
*CORRIDOR:* Major roads

### COMMUNITY AND CULTURE AREA B

*CORE:* **Tribal Lands**
*HUB:* None identified
*CORRIDORS:* Transit | TRAX light rail routes | Front Runner commuter rail routes

### COMMUNITY AND CULTURE AREA C

*CORES:* **Historic Areas such as Historic Districts, Easements, and Trails**
*HUB:* None identified
*CORRIDOR:* Canals

### COMMUNITY AND CULTURE AREA D

*CORES:* **TRAX Light Rail and Front Runner Commuter Rail Routes**
*HUB:* None identified
*CORRIDOR:* None identified

### COMMUNITY AND CULTURE AREA E

*CORES:* **Parks, Open Space, Rivers, Cemeteries**
*HUB:* None identified
*CORRIDOR:* None identified

### COMMUNITY AND CULTURE AREA F

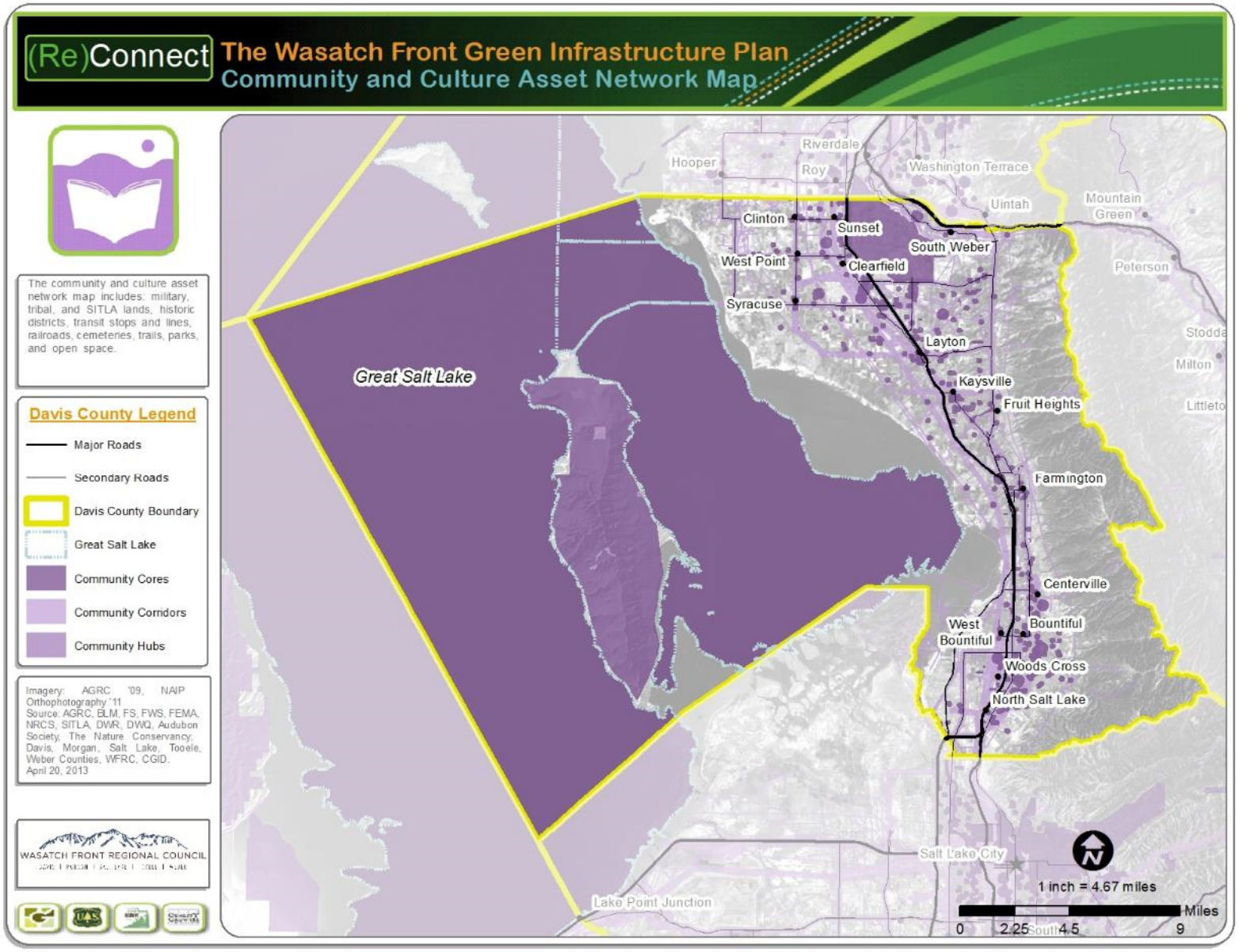
*CORES:* **Community Facilities: Red Butte Arboretum, Hogle Zoo, Ogden Nature Center, Faith Based Centers, Universities, Libraries, Schools, Hospitals, Elderly Care Facilities**
*HUB:* None identified
*CORRIDOR:* None identified

## UTILIZING THE ASSET NETWORK MAP

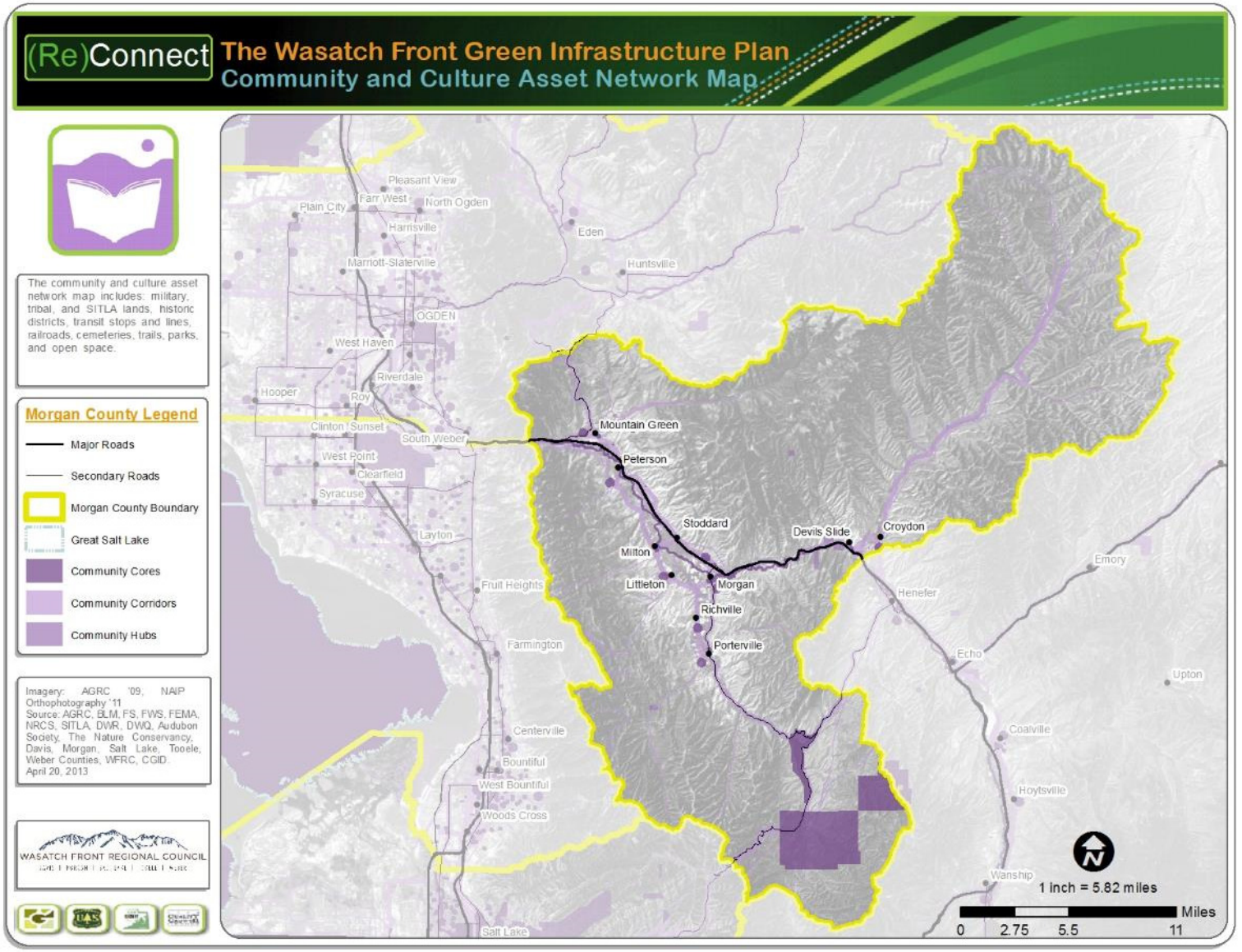
Asset network maps have been created for each of the counties (Maps 22-26). The maps will be useful tools for transportation and community planners, sociologists, economic analysts, historic preservationists, and others to assess connectivity and potential improvements.

## METHODOLOGY

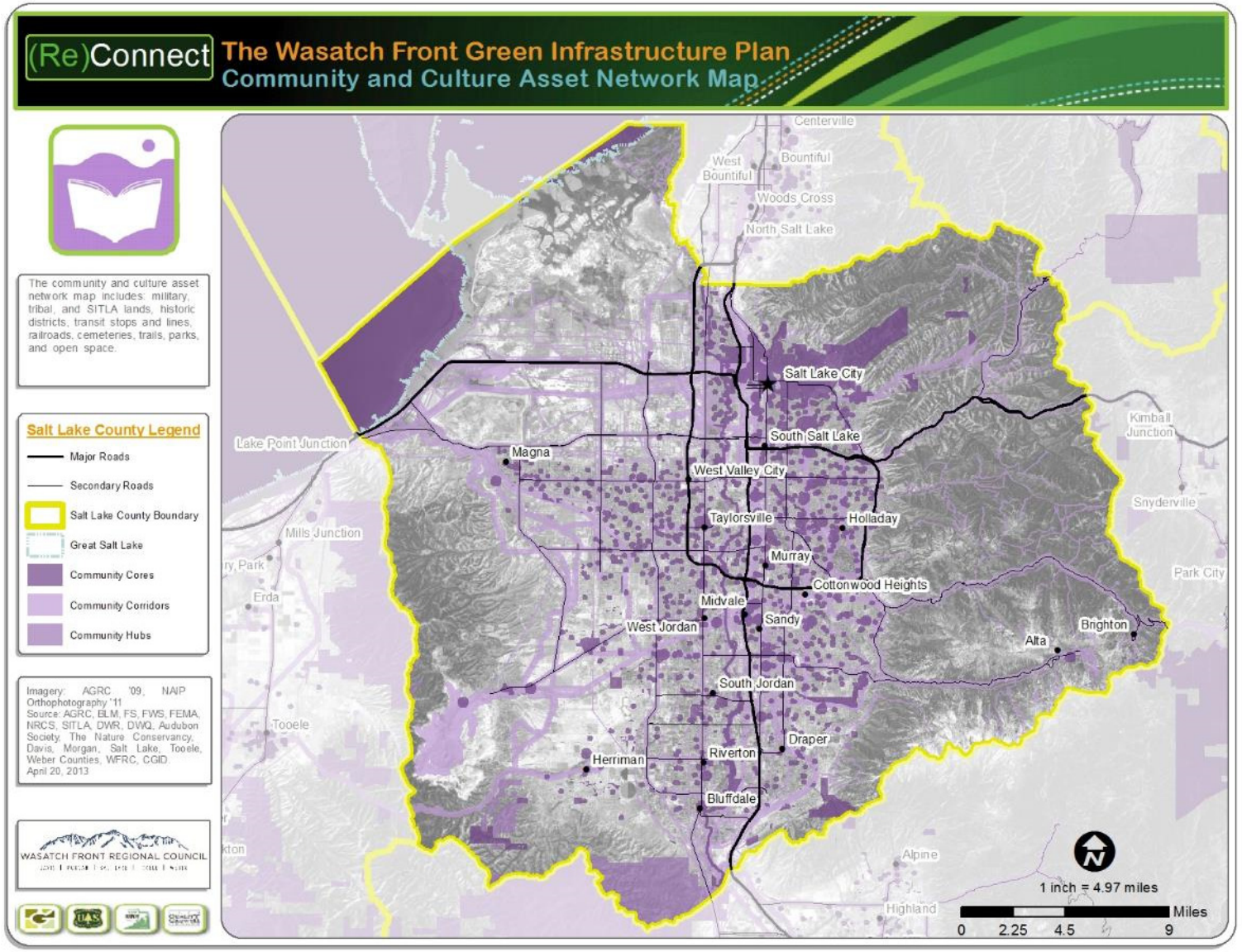
Refer to Appendix C for a complete description of the community and culture asset network mapping methodology. Community corridors include linear elements that facilitate human mobility, such as transit lines, major roads, and trails. Canals are included because they offer opportunities for trail system expansion. The corridors did not undergo a design process.



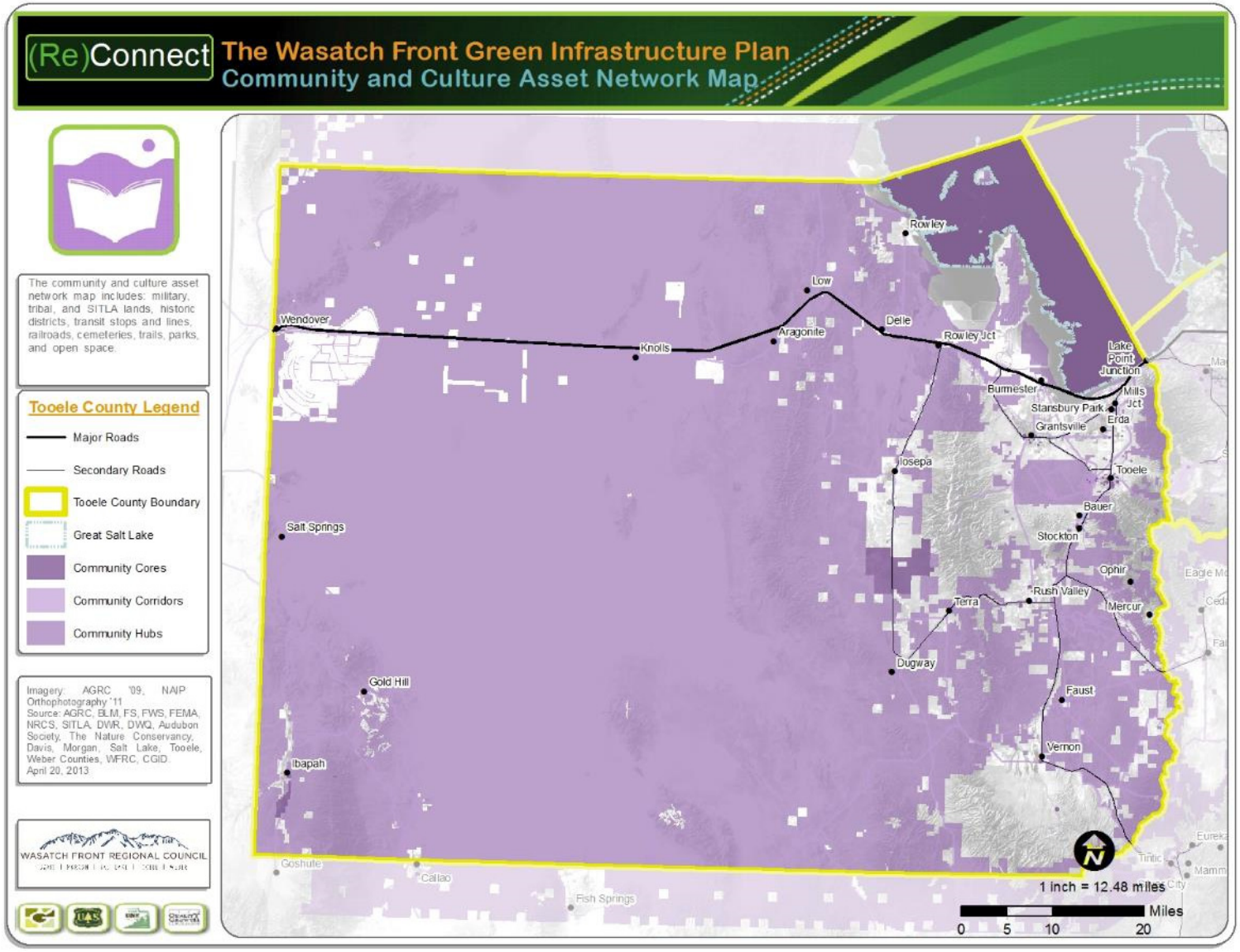

**Map 22 Davis County Community and Culture Asset Network Map**



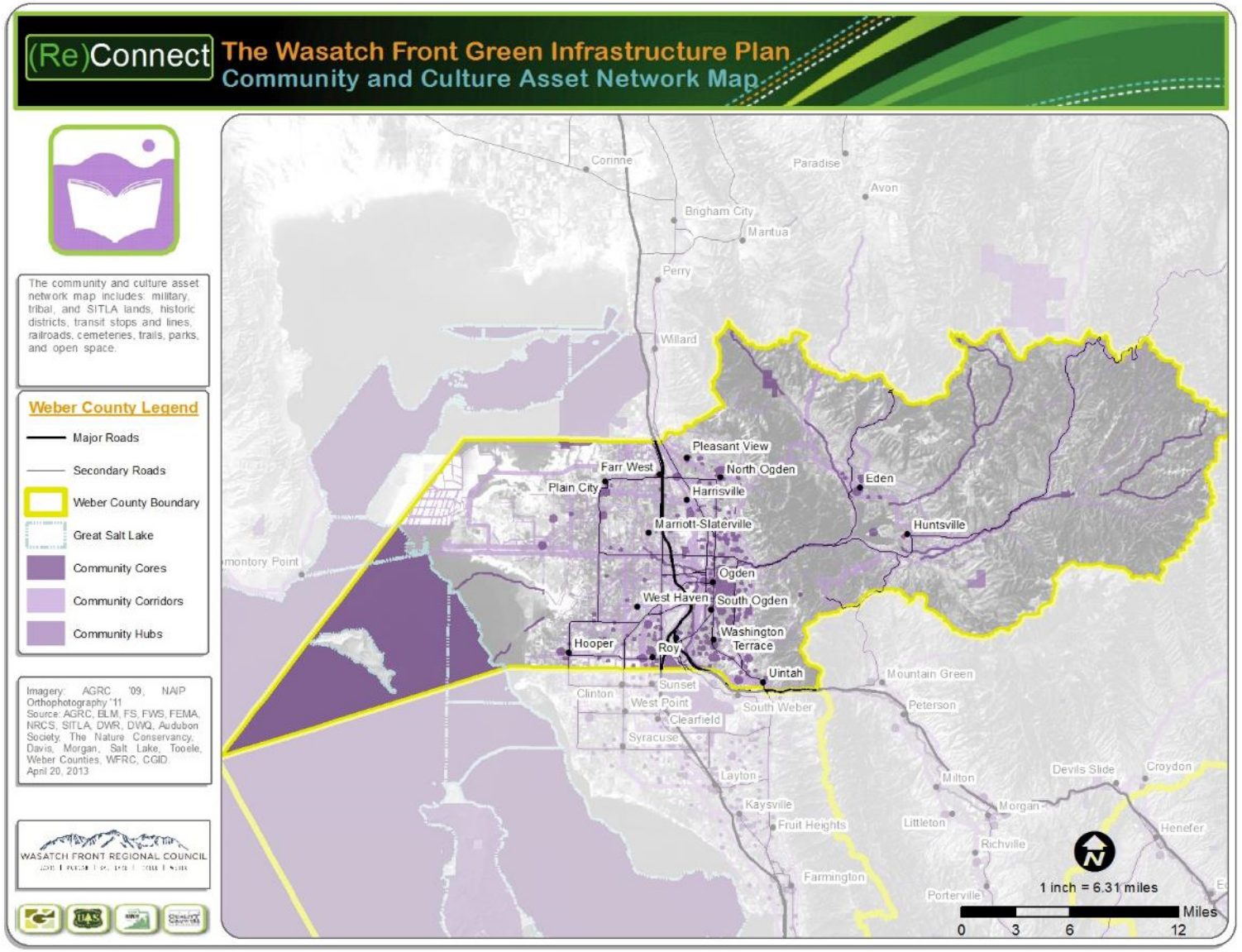

**Map 23 Morgan County Community and Culture Asset Network Map**




**Map 24 Salt Lake County Community and Culture Asset Network Map**




**Map 25 Tooele County Community and Culture Asset Network Map**




**Map 26 Weber County Community and Culture Asset Network Map**

## COMBINED ASSET NETWORK MAPS

Effective green infrastructure planning relies on an understanding that the benefits and functions of assets are enhanced significantly when planned as an integrated whole. The connectivity of green infrastructure systems makes the green infrastructure approach an important part of land use planning. Therefore, two combined asset network maps have been created, referred to as the *Natural* Green Infrastructure Network and the *Social* Green Infrastructure Network. These maps assess the relationships of four assets: ecological, hydrological, recreational, and working lands. The community and culture asset, comprised predominately of built infrastructure, was not incorporated into the composite maps.

**Natural Green Infrastructure Network Map** combines the ecological and hydrological assets.

**Social Green Infrastructure Network Map** combines the recreational and working lands assets as these assets represent human values.

Natural and social systems are not mutually exclusive. These networks can benefit one another. Through thoughtful planning and design, opportunities can arise to simultaneously increase both systems. The intent is to identify and preserve ecosystem services that benefit people, wildlife, and natural resources. When the lands are developed independently, insensitive development patterns and over-consumption of resources can result. Aldo Leopold's book titled, "Land Ethic", explains that humans are part of the natural environment rather than separate from it. *(Re)Connect* encourages and exemplifies this concept through the inclusion of social resources in the planning process.


*The Green Infrastructure Spectrum: Green infrastructure resources in the Wasatch Front fall along a spectrum between natural and social values. The resources listed on the left are highly valued for natural system functionality, those on the right are important to human systems, and those in the middle are valuable to both natural and social systems.*

*(Re)Connect* incorporates social resources in its planning framework for two reasons. The first, the goal of the asset-based approach is to be as comprehensive as possible. There are many social resources that provide recreational, psychological, economic, and public health benefits. The green infrastructure methodology used in the process of social resource classification, further substantiates their characterization as social green infrastructure. Second, the plan promotes the understanding that social systems need to be viewed inherently with natural systems. Human land-use patterns often conflict with the natural systems which are why human-affected landscapes are so ubiquitously regarded as separate and distinct.

# NATURAL GREEN INFRASTRUCTURE NETWORK MAP

## DEFINITION

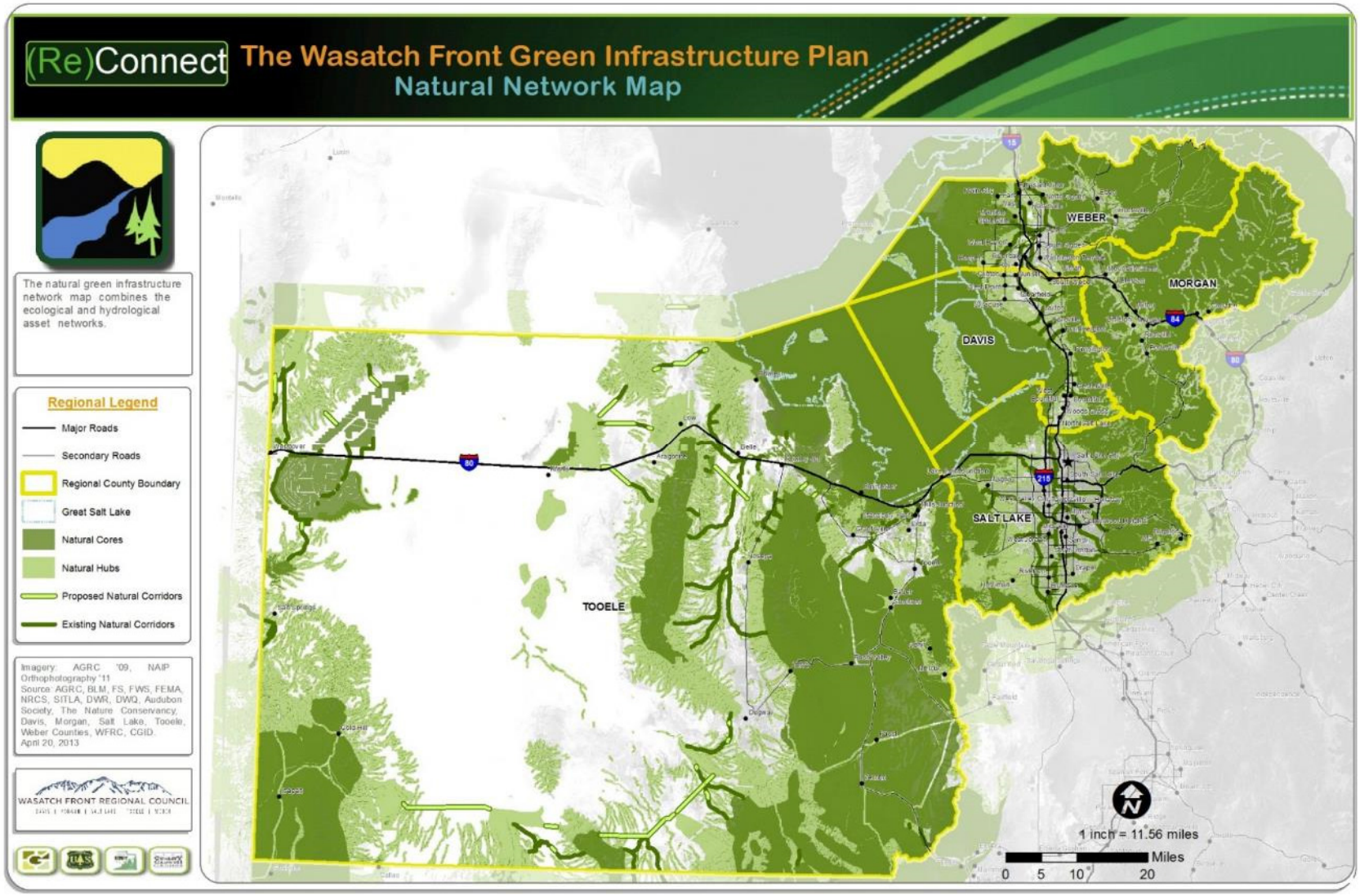
The Natural Green Infrastructure Network Map illustrates the highest quality existing natural lands. It combines the ecological and hydrological asset networks and provides a regional perspective of the integrity of the natural network.

## UTILIZING THE ASSET NETWORK MAP

A regional natural green infrastructure network map has been created (Map 27). The cores or hubs should have a substantially higher priority in terms of conservation, acquisition, maintenance, preservation, or enhancement decisions. Additional data collection and mapping may be necessary to establish site-specific priorities as this map is intended to be a regional planning tool. For this reason, individual land ownership and jurisdictional boundaries are not illustrated.

## METHODOLOGY

Cores and hubs are identified by overlaying the ecological asset and hydrological asset cores and hubs. In areas that returned both cores and hubs, cores are given priority and the overlapping areas are removed as hubs. The corridors are also the product of an additive process. The corridors are the same as those illustrated in the ecological corridor design process, removing hydrological cores and hubs from natural corridors to eliminate overlap. These linkages are not the only corridor connections between cores and hubs; they simply represent the most efficient connections.




**Map 27 Regional Natural Green Infrastructure Asset Network Map**

## SOCIAL GREEN INFRASTRUCTURE NETWORK MAP

### DEFINITION

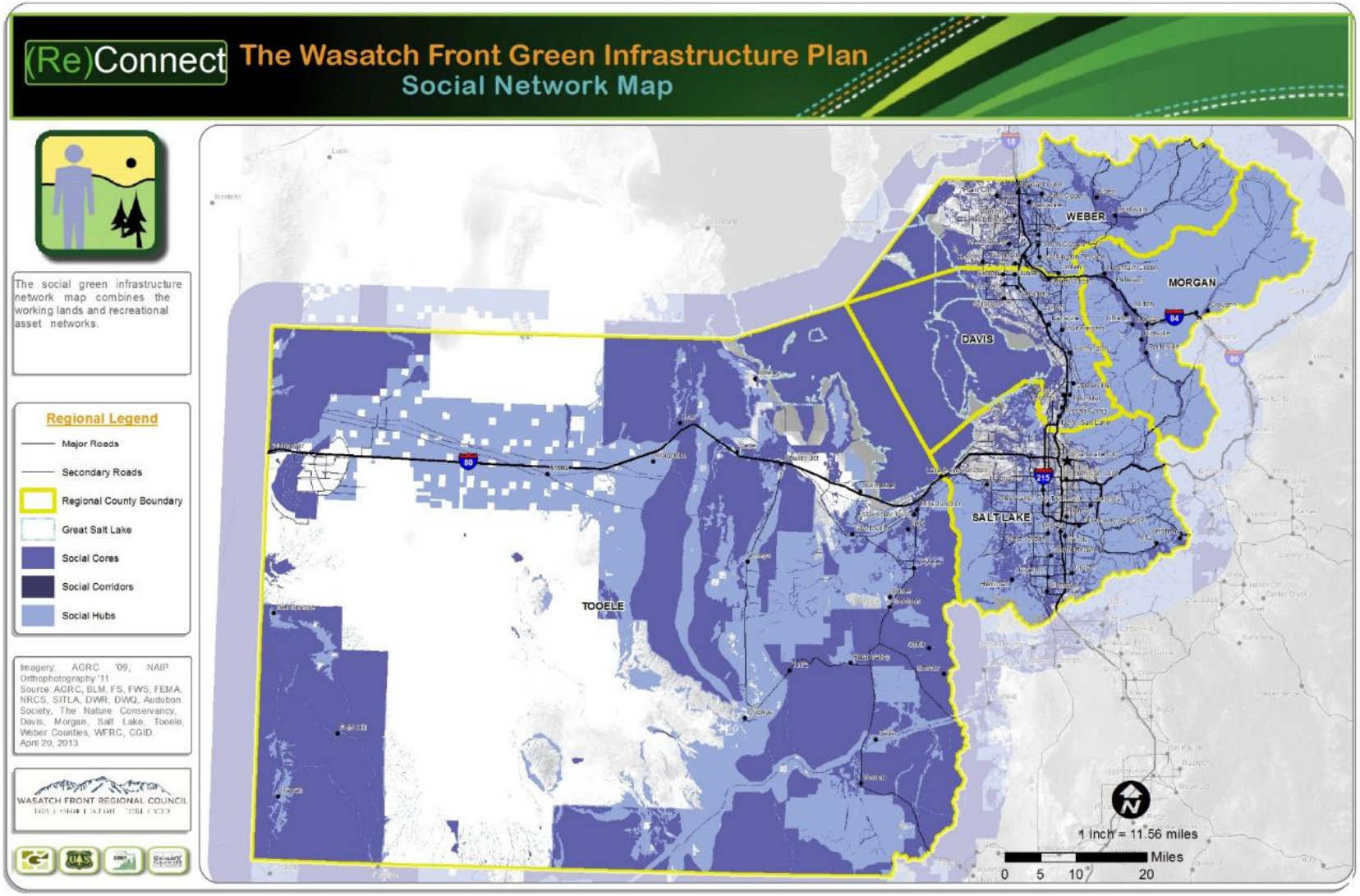
The Social Green Infrastructure Network Map illustrates the highest quality existing lands. It combines the recreational and working land cores, hubs, and corridors. The social green infrastructure network lands can be thought of as 'open lands' or 'undeveloped lands' that support recreational activities and/or working lands functions.

### UTILIZING THE ASSET NETWORK MAP

A regional social green infrastructure network map has been created (Map 28). The cores or hubs should have a substantially higher priority in terms of conservation, acquisition, maintenance, preservation, or enhancement decisions. Additional data collection and mapping may be necessary to establish site-specific priorities as this map is intended to be a regional planning tool. For this reason, individual land ownership and jurisdictional boundaries are not illustrated.

### METHODOLOGY

Cores and hubs are identified by overlaying the recreational and working lands asset cores and hubs. In areas that returned both cores and hubs, cores are given priority and the overlapping areas are removed as hubs. The corridors are also the product of an additive process. The corridors are the same as those illustrated in the recreational and working lands corridor design process. These linkages are not the only corridor connections between cores and hubs; they simply represent the most efficient, existing connections.




**Map 28 Regional Social Green Infrastructure Asset Network Map**

# 6. IMPLEMENTING A NETWORK DESIGN

A network design combines, weighs, and evaluates green infrastructure to help one make educated land use and management decisions. Designing a regional green infrastructure network is equally an objective and subjective process. Though most decisions can be made through empirical and science-based rationale, it is the quality of 'design' or combining, weighing, and evaluating various criteria and data layers that requires human judgment and experience. The stewardship actions identified in the plan are potential options and serve as general rationale for design decisions and land planning actions.

Many green infrastructure plans utilize a ranking system for identifying priority "action areas", however, this methodology is strongly based on ecological network design and is not applicable to *(Re)Connect's* comprehensive approach. With further research and in-depth priority development, a ranking for the Wasatch Front's green infrastructure networks could be generated and specific sites or lands identified.

## CONCEPTUAL NETWORK DESIGN

Design criteria have been created based on the experience and judgment of environmental planners to adapt green infrastructure planning and design principles to land use planning requirements. Many of the criteria are based on ecological network principles. Further research and evaluation is recommended when making any land planning or site evaluation decision. The criteria are general, not comprehensive, and are for planning purposes only (Table 2).

**Table 2 Conceptual Network Design Criteria – High Priority/Rank**

| Asset | Description |
|---|---|
| Ecological | Lands with considerable urban forests |
| | Streams and rivers with association riparian areas and wetlands |
| | Lands designated as "at-risk" or provide important wildlife and plant habitats |
| Hydrological | Streams and rivers with associated riparian areas and wetlands |
| | Areas associated with aquifer recharge and discharge |
| | Contiguous and unmodified wetlands |
| Recreational | Areas that serve as entrances or gateways |
| | Areas that serve as links or corridors |
| | Connections between medium to high density areas with public lands |
| Working Lands | Large, un-fragmented, irrigated lands |
| | Large, un-fragmented areas with prime soils |
| | Existing agricultural, farmlands, and ranchlands |
| Community and Culture | Lands that provide efficient regional and municipal infrastructure and services |
| | Lands with important heritage such as historic districts and trails |
| | Lands of significant public safety risk near developed areas such as earthquake faults, erodible soils, or fire hazards |
| | Existing connected green infrastructure landscapes |
| | Lands that are planned for re-development |
| | Lands that are contiguous to existing development |

| Table 2 Conceptual Network Design Criteria – High Priority/Rank | |
|---|---|
| **Asset** | **Description** |
| Combined - Natural | Lands that contribute to the region's biodiversity |
| | Lands that contribute to the region's ecosystem services |
| | Lands given federal, state, and agency importance such as at-risk wildlife habitat or watershed restoration areas |
| | Lands undergoing restoration efforts |
| | Areas adjacent to public, managed, or protected lands |
| | Lands that are prime for restoration efforts |
| | Lands that offer potential corridors or linkages |
| | Large, contiguous lands for examples forests with at least 250 acres |
| | Lands that serve as existing links or corridors for nature |
| Combined – Social | Lands that add to the region's identity or character |
| | Lands that link social network cores and hubs |
| | Lands that add to the public's health |
| | Lands that add to a community's livability or sustainability |
| Combined – Natural and Social | Lands that provide both human, plant, and animal services such as reservoirs, rivers, and agricultural areas |
| | Lands that can fill-in existing gaps within the green infrastructure network |
| | Existing managed or protected lands |
| | Lands that increase the success of the Wasatch Choice for 2040 |

# PLANNING OBJECTIVES

In order to facilitate implementation, *(Re)Connect* identified a set of regional planning objectives that reflected the Project's Mission Statement, Goals, and tenets of stewardship. These objectives attempt to address known planning challenges. The objectives include planning strategies, implementation actions, and potential funding sources.

## REGIONAL PLANNING OBJECTIVES

The four regional planning objectives are:

1. **Regional leadership**
2. **Stakeholder communication and cooperation**
3. **Coordinated resource management and stewardship**
4. **Management plan and policy updates**

## REGIONAL LEADERSHIP

Strong regional leadership is needed to champion the benefits of a green infrastructure planning approach as well as bring together the goals of numerous stakeholders and management objectives in the Wasatch Front. The Wasatch Front Regional Council has been a leader in land use planning and development in the Wasatch Front for nearly forty-five years.

The *Wasatch Choice for 2040* planning document provides an integrated conservation, transportation, and land-use planning vision for the region.[43] The Wasatch Front Regional Council can offer further technical assistance to communities seeking to implement green infrastructure principles.

## STAKEHOLDER COMMUNICATION AND COOPERATION

The implementation of *(Re)Connect* will rely on the support, communication, and collaboration of the region's organizations and agencies, particularly city and county governments. Other stakeholders include: federal, state, and local agencies, land trusts, conservation districts, and non-governmental organizations, charitable foundations, philanthropic organizations, and private landowners. A successful approach to comprehensive regional planning and implementation is dependent upon dedicated stakeholders driven toward achieving a common goal. *(Re)Connect* offers a framework to achieve this goal. The plan will be available to all stakeholders in the Wasatch Front.

There is a strong history of inter-agency and stakeholder cooperation in the Wasatch Front. Agencies and other stakeholders have come together in the past to deal with critical regional problems such as watershed quality and sensitive species habitat[44] and in recent years, a number of regional and state-wide planning efforts began to look at the Wasatch Front's green infrastructure network assets and components. These efforts include *Wasatch Choices for 2040*[45], *Blueprint Jordan River*[46], and *Wasatch Canyons Tomorrow*[47]. For instance, both *Wasatch Canyons Tomorrow* and *Blueprint Jordan River* advocate for land conservation projects, contributing to a connected system of natural lands, criteria well-aligned with *(Re)Connect*.

> ***"Collaboration is the key that helps green infrastructure move forward. It's the building block. You need a lot of people to collaborate on how you're going to implement programs, how you're going to pay for these programs and what the priorities will be."*** [48]

## COMMUNICATION AND COOPERATION BETWEEN AGENCIES

Resource managers often have different objectives based on their resource expertise. Therefore a cooperative, interdisciplinary approach to resource management would allow communication and cooperation among agencies. This could result in agencies arriving similar goals and objectives that strengthen multiple resources resulting in a stronger, healthier green infrastructure network.

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[43] Envision Utah. (2010). *Wasatch Choices 2040: A four county land-use and transportation vision*. Retrieved from http://www.wfrc.org/cms/publications/wasatchchoices2040report.pdf

[44] Envision Utah. Governor's Office of Planning and Budget, Utah Quality Growth Commission. (2008). The *2008 Utah baseline report: Current conditions, trends, and projections*. Retrieved from website: http://utah.ptfs.com/awweb/awarchive?type=file&item=13593

[45] See Reference 2

[46] Envision Utah. (2008). Blueprint Jordan River. Retrieved from blueprintjordanriver.slco.org/pdf/BlueprintJordanRiver.pdf

[47] Envision Utah (2010). Wasatch Canyons Tomorrow. http://www.wasatchcanyons.slco.org/

[48] NOAA. National Oceanic and Atmospheric Administration, Coast Services Center. (2009).*Coming to terms with green infrastructure*. Retrieved from website: http://www.csc.noaa.gov/magazine/2009/03/article2.html

## COMMUNICATION AND COOPERATION BETWEEN THE SCIENTIFIC COMMUNITY AND LAND MANAGERS

Scientists and land managers, despite common goals may have disparate approaches or objectives as a result of a lack of interdisciplinary knowledge. [49] Academic opportunities could be expanded to promote interdisciplinary learning, hands-on experience, and opportunities for continuing education.

## COMMUNICATION AND COOPERATION BETWEEN LANDOWNERS

There are as many opinions concerning the best way to manage private land as there are landowners. Objectives may differ dramatically, making coordination and cooperation difficult. However, a number of success stories do exist; a Neighborhood Wildlife Habitat Program initiated by a Vermont non-profit in 1997 has been highly successful in promoting landowner cooperation and habitat condition improvement. [50] Their case studies can be viewed from http://www.yellowwood.org/case.pdf.

Cross-jurisdictional management of private lands can result in improved quality and connectivity of wildlife habitat, improved scenic quality, and increased landscape level benefits such as water quality and overall ecosystem health. It has been shown that landowners who are knowledgeable of ecosystem functions are more likely to become involved in conservation efforts[51] and more likely to cooperate with adjacent landowners.[52]

## COMMUNICATION AND COOPERATION BETWEEN PUBLIC AND PRIVATE STAKEHOLDERS

Coordinated investments in land management will be necessary. Planning entities will need to look outside their normal jurisdictional boundaries in order to conserve and enhance potential green infrastructure lands. Federal and state agencies, conservation districts, municipalities, and private funders should all prioritize land planning actions such as conservation, restoration, preservation, acquisition, maintenance, and enhancement within the identified green infrastructure network, specifically for green infrastructure network lands not owned by public land agencies.

[49] Ewel, K.C. (2001). Natural resource management: The need for interdisciplinary collaboration. Ecosystems, 4, 716-722.

[50] National Community Forestry Center Northern Forest Regio. , & Vermont Coverts, U.S. Department of Agriculture, Cooperative State Research, Education, and Extension Service. (2001).*Community forestry made real: Case studies in landowner cooperation* (No. 9936200-870). Retrieved from website: www.yellowwood.org/case.pdf

[51] Gobster, P.H. & Barro, S.C. (2000). *Restoring Nature: Perspectives from the Social Sciences and Humanities*. Washington, D.C., Covelo, CA: Island Press.

[52] Allred, S.B., Goff, G.R., Luo, M.K., & Wetzel, L.P. (2010). *Woodland Owner Cooperation*. Cornell University Human Dimensions Research Unit, HDRU Outreach Series Publication No. 10-3.

## COORDINATED RESOURCE MANAGEMENT AND STEWARDSHIP

Coordinated Resource Management and Planning (CRMP) is an approach used by local, state, and federal agencies to reduce conflicts between interest groups, landowners, land users and resource managers. The approach is designed to identify and implement mutually agreeable management strategies.[53] It is important to bring all stakeholders to the table to discuss needs and objectives, to establish and implement mutually satisfactory solutions, and to monitor project success.

Coordinated resource management strategies must become more inclusive and iterative of a green infrastructure network approach, particularly on the region's public lands where coordinated strategies are currently being implemented. When these strategies incorporate the values of stewardship, the coordinated planning, design and management of the region's resources can result in enduring, resilient, and regenerative green infrastructure.

## MANAGEMENT PLAN AND POLICY UPDATES

Public land agencies should refine their management practices to reflect a green infrastructure methodology. Each management plan should be updated with a green infrastructure section that includes essential practices for the maintenance of an enduring, resilient green infrastructure network. These practices should improve ecological and biological health and maximize community and regional benefits. Agencies involved in grey infrastructure planning, such as transportation and housing would benefit from incorporating green infrastructure into their plans and projects just as much as agencies involved in natural resource management. The tenets of green infrastructure can help urban planners more fully understand the benefits of an integrated planning approach. In other words, green infrastructure and urban systems function together; they are inherently connected and planners should be able to draw from both fields to understand the complexities of the network and the potential benefits afforded by increased connectivity.

The 'natural' areas in the Wasatch Front's urban corridor, such as parks, preserves, lakes and rivers, are often designed and intensively managed. Their characteristics are different from their exurban counterparts; therefore, their management strategies must be different. Management strategies should account for a variety of scales and site characteristics in order to be effective. These variables should be tailored to each management plan's objectives and reflected in the green infrastructure component of updated plans and studies.

Now that the network has been identified, Wasatch Front communities should consider the green infrastructure plan and network design when updating their comprehensive plans, zoning, or ordinances.

[53] California Coordinated Resource Management & Planning Council. CRMP Handbook. Retrieved from http://twiki.sacriver.org/pub/Main/CoordinatedResourceManagementHandbook1996/CRMPHandbook_CARCD.pdf

## REGIONAL IMPLEMENTATION STRATEGIES

The stakeholders of the Wasatch Front require a set of planning strategies and implementation actions to realize the regional planning objectives. The implementation of *(Re)Connect's* regional planning strategies will provide for mutually satisfactory solutions and a means to monitor project success at many scales.

### REGIONAL PLANNING STRATEGY 1

### INCREASE THE REGION'S AWARENESS OF STEWARDSHIP AND THE MULTIPLE BENEFITS OF A GREEN INFRASTRUCTURE NETWORK.

**IMPLEMENTATION ACTION 1.1**

Expand the education and outreach process regarding the Wasatch Front's comprehensive and strategic approach to green infrastructure planning. A multi-faceted approach is required to ensure continued support of this study. This can include workshops and outreach sessions to the public and NGOs, the creation of demonstration projects, and urban forestry community programs.

**IMPLEMENTATION ACTION 1.2**

Increase the participation of private land owners in green infrastructure planning and conservation activities. The land planning actions and stewardship of privately owned lands are important to achieving the goals of *(Re)Connect*. Both federal and state agencies, as well as municipal governments, should provide incentives in order to achieve private landowner collaboration and green infrastructure improvements on private lands. Incentives could include expanded tax credits and streamlined conservation easement processes to increase donations. Private owners could enter a state-sponsored Voluntary Stewardship Program whereby enrollment provides $1/acre property tax assessment by following a determined management plan that reflects *(Re)Connect's* goals and objectives.

**Primary Implementers**

*Federal:* EPA

*State:* DNR, UDOT, DEQ, DAF, GOPB

*Regional/Municipal:* WFRC, MAG, COGs, Local governments, Service districts

*Other:* Land trusts, conservation districts, charitable foundations, philanthropic organizations, private landowners, companies, and universities

### REGIONAL PLANNING STRATEGY 2

### BUILD THE REGIONAL CAPACITY FOR GREEN INFRASTRUCTURE CAPABILITY

**IMPLEMENTATION ACTION 2.1**

Refine *(Re)Connect's* green infrastructure network criteria. A more detailed analysis of the scientific issues is required to refine green infrastructure priorities for the Wasatch Front. For example, is it more important to concentrate land planning actions on expanding existing cores and hubs or on linking existing cores and hubs? This question, and others, may be answered by consulting with specific asset resource managers or researching scientific studies and public land agency plans.

**Primary Implementers**

*Federal:* BLM, FS, FWS, DOD, ACE, EPA, HUD, DOT

*State:* DNR, UDOT, DEQ, DAF, DCC, DAS, DH, SITLA, Office of Tourism, GOPB

*Regional/ Municipal:* WFRC, MAG, COGs, local governments, service districts

*Other:* Land trusts, conservation districts, charitable foundations, and philanthropic organizations

**IMPLEMENTATION ACTION 2.2**

Refine *(Re)Connect's* regional data to be more inclusive of all scales. Incorporating updated and refined data into *(Re)Connect* will help inform land use actions and stewardship in the Wasatch Front. Emphasis should be placed on the urbanized areas of the region, including Salt Lake City. All green infrastructure network components must be identified at a finer scale to help guide local development and infrastructure planning.

**Primary Implementers**

*State:* DNR, UDOT, DEQ, DAF, DCC, DAS, DH, SITLA, Office of Tourism, GOPB

*Regional/Municipal:* WFRC, MAG, COGs, Service Districts, NGOs

*Other:* Land trusts, conservation districts, charitable foundations, and philanthropic organizations

**IMPLEMENTATION ACTION 2.3**

Provide a comprehensive toolkit and data bank to all agencies and communities. The Wasatch Front Regional Council's green infrastructure GIS database is available by request for communities to begin to update their datasets and refine their network identification. Future data-sharing and accuracy standards must be developed to ensure the continuation of data sharing between stakeholders and municipalities. The Wasatch Front Regional Council also has an online library of many completed green infrastructure projects and case studies for review.

**Primary Implementers**

*Regional/Municipal:* WFRC, MAG, COGs, Service Districts, NGOs

**IMPLEMENTATION ACTION 2.4**

Focus technical assistance efforts on communities that show interest in green infrastructure planning. Technical assistance should be evaluated on a community's level of interest and commitment to meeting *(Re)Connect's* objectives. The Wasatch Front Regional Council could target communities that are more proactive. Agencies and municipalities could train personnel focused on green infrastructure planning and stewardship to engage in technical assistance. In addition, NGO, non-profit and private organizations in the land conservation field should be educated and supported on *(Re)Connect's* approach.

**Primary Implementers**

*Regional/Municipal:* WFRC, MAG, COGs, Service Districts, NGOs

**IMPLEMENTATION ACTION 2.5**

Periodically review and assess the status of *(Re)Connect*, including its implementation, every two years. Review policy and management plans, implemented green infrastructure projects, and the status of green infrastructure-oriented partnerships to evaluate their influences on Wasatch Front green infrastructure resources. Use the Utah Population and Environment Coalition's Genuine Progress Indicator (GPI) framework as an outline of applicable indicators.[54]

**Primary Implementers**

*Regional/Municipal:* WFRC, MAG, COGs, Service Districts, NGOs

**IMPLEMENTATION ACTION 2.6**

Stimulate regional volunteerism and non-traditional staffing. Stakeholders and public land agencies should partner with conservancies, the public, and other agencies and non-profits to reduce the cost burden of salaries, program fees, and maintenance. Outreach and the inclusion of volunteers can provide education to stakeholders and help monitor implementation.

**Primary Implementers**

*Federal:* EPA

*State: D*NR, DOT, DEQ, DAF, GOPB, DCC, DAS, DH, SITLA

*Regional/Municipal:* WFRC, MAG, COGs, Local governments, Service districts, NGOs

*Other:* Land trusts, conservation districts, charitable foundations, philanthropic organizations, private landowners, companies, and universities

**IMPLEMENTATION ACTION 2.7**

Develop a Regional Action Committee to oversee *(Re)Connect's* strategic implementation. A regional coalition of regional councils, government units, businesses, institutions, and non-profits should focus on *(Re)Connect's* objectives. This body could assess implementation processes, identify deficiencies in capacity, provide assistance where needed, and promote success and collaboration.

*State:* DNR, DOT, DEQ, DAF, GOPB, DCC, DAS, DH, SITLA

*Regional/Municipal:* WFRC, MAG, COGs, Local governments, Service districts, NGOs

*Other:* Land trusts, conservation districts, charitable foundations, philanthropic organizations, private landowners, companies, and universities

## REGIONAL PLANNING STRATEGY 3

## PRIORITIZE THE PLANNING, DESIGN, AND MANAGEMENT OF THE WASATCH FRONT'S GREEN INFRASTRUCTURE NETWORKS.

The following 6 general land planning actions achieve *(Re)Connect's* objectives, strategies, and implementation efforts: conservation, restoration, preservation, acquisition, enhancement, and management

[54] Berik, G. & Gaddis, E. (2011). The Utah Genuine Progress Indicator (GPI), 1990 to 2007: A report to the people of Utah. A Vital Signs Project of the Utah Population & Environment Coalition. Retrieved from http://www.utahpop.org/gpi.html

**IMPLEMENTATION ACTION 3.1**

Limit infrastructure expansion within the green infrastructure network, especially in the urban corridor. Stakeholders, including federal and state agencies, regional councils, and conservation districts should adopt and periodically update management and acquisition plans. A parcel within the green infrastructure network should have higher priority for acquisition, preservation, enhancement, conservation, or restoration than a parcel outside the network. Furthermore, land adjacent to a publicly-owned parcel should also have higher priority, as this would create a stronger, more connected, more resilient network. Land trusts, other NGOs, or agencies should consider whether an acquisition or donation opportunity is within the green infrastructure network before agreeing to take ownership and/or management/stewardship of the land.

**Primary Implementers**

*Federal:* BLM, FS, FWS, EPA, FHA, BLM, DOD, EPA, FHA, USACE, Tribal

*State:* DNR, UDOT, DEQ, DAF, DCC, DAS, DH, SITLA, Office of Tourism, GOPB

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions, school districts, park districts, service districts

*Other:* Land trusts, conservation districts, NGOs, charitable foundations, philanthropic organizations, private landowners, individuals, companies, universities and other non-public agencies

**IMPLEMENTATION ACTION 3.2**

Sewer services and other types of traditional "grey" infrastructure should not be permitted within any of the green infrastructure network cores or proposed corridors that connect the core areas. Rather, encourage development in existing communities, where infrastructure to support communities is already present. If growth and expansion should occur within the green infrastructure network, local governments should enhance livability through compact, mixed-use, and infill development. Communities should also prioritize transit access.

Sixty-one percent of the cores in the natural green infrastructure are protected from various degrees of development. This is mainly due to most of the lands being owned publicly. The cores should be further refined within the next decade, after which they should be excluded from expanded services and facility planning. That it unless stewardship and sensitive design actions that maintain and enhance the ecosystem services can be ensured.

**Primary Implementers**

*Federal:* BLM, FS, FWS, FHA, DOD, EPA, ACE

*State: D*NR, UDOT, DEQ, DAF, SITLA, GOPB

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions, school districts, park districts, service districts

*Other: P*rivate landowners - individuals, companies, universities and other non-public agencies

**IMPLEMENTATION ACTION 3.3**

Incorporate green infrastructure network planning and connectivity into regional programs. Regional grant programs should emphasize those lands or parcels in the green infrastructure network, which strengthen the existing green infrastructure network and its connectivity. Connectivity in green infrastructure planning is crucial and serves as a direct means to enhance and restore existing network lands. Open space grant programs, prevalent in the Wasatch Front, do not often recognize green infrastructure network lands or the linear corridors linking landscapes as important components. Grants and acquisition priority should be given to network corridors. Private organizations and non-profits that fund traditional open space conservation should make green infrastructure network status (core/hub/corridor) part of their prioritization metrics.

**Primary Implementers**

*Federal:* BLM, FS, FWS, FHA, DOD, EPA

*State:* DNR, UDOT, DEQ, DAF, DCC, DAS, DH, SITLA, GOPB, Office of Tourism

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions, school districts, park districts, service districts

*Other:* Land trusts, conservation districts, other NGOs – charitable foundations, philanthropic organizations

## REGIONAL PLANNING STRATEGY 4

## MAINTAIN AND IMPROVE THE BIODIVERSITY, INTEGRITY, AND RESILIENCE OF THE GREEN INFRASTRUCTURE NETWORKS – INCLUDING THE PROCESSES THAT SUSTAIN ECOLOGICAL, SOCIAL, AND ECONOMIC SYSTEMS

**IMPLEMENTATION ACTION 4.1**

Refine land planning actions and management practices to reflect a green infrastructure methodology. Each management plan should be revised or updated to include a green infrastructure component and related stewardship practices for the maintenance of enduring, resilient green infrastructure networks. These practices should improve ecological and biological health and maximize community and regional benefits. Acquisition plans should be updated to reflect the 'gaps' needed to 'fill in' the green infrastructure network.

**Primary Implementers**

*Federal:* BLM, FS, FWS, FHA, EPA

*State:* DNR, UDOT, DEQ, DAF, DCC, DAS, DH, SITLA, GOPB, Office of Tourism

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions, school districts, park districts, service districts

*Other:* Land trusts, conservation districts, other NGOs – charitable foundations, philanthropic organizations

**IMPLEMENTATION ACTION 4.2**

Establish a prioritization procedure for restoration actions within the green infrastructure networks. Ecosystem restoration will significantly improve the integrity and resilience of the Wasatch Front's green infrastructure networks. Preserving biodiversity and protecting water resources through restoration and enhancement efforts are important strategies to ensure long-term benefits of these green infrastructure networks. Regional leaders and agencies must work together to identify restoration priorities for the strengthening of the regional green infrastructure networks, not individual assets. Restoration projects and funding can be based on this agreed upon ranking and prioritization. Green infrastructure network lands, with overlapping restoration plans, should be a priority.

**Primary Implementers**

*State*: DNR, UDOT, DEQ, DAF

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions, school districts, park districts, service districts

*Other:* Land trusts, conservation districts, other NGOs – charitable foundations, philanthropic organizations

**IMPLEMENTATION ACTION 4.3**

Prioritize the development of greenways, trails, eco-bridges, and corridors with FHA, namely FHA's Transportation Enhancement Program. Transportation infrastructure is a significant cause of fragmentation to green infrastructure lands as it can reduce the networks' resilience and ability to provide services and benefits. Green infrastructure network lands should be protected from transportation corridors and grey infrastructure expansion. An example of an effective use of transportation funds is through the establishment of multi-use, off-street greenway trails that can serve as multi-functional corridors into the green infrastructure network. A multi-purpose eco-bridge should be considered to re-connect the significant cores on and near the Great Salt Lake's western lands.

**Primary Implementers**

*Federal:* BLM, FS, FWS, FHA, EPA

*State:* DNR, FWS, UDOT

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions

## REGIONAL PLANNING STRATEGY 5

## CREATE A REGIONAL GREEN INFRASTRUCTURE POLICY AND FUNDING FRAMEWORK

**IMPLEMENTATION ACTION 5.1**

Adopt progressive policy and ordinance revisions that prioritize the planning, design, and management of the Wasatch Front's green infrastructure network.

**Primary Implementers**

*Federal:* BLM, FS, FWS, DOD, DOT, EPA, ACE, HUD

*State:* DNR, FWS, UDOT, DEQ, DCC, DAS, DH, SITLA, Office of Tourism

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions, park districts, service districts, school districts

*Other:* Land trusts, conservation districts, other NGOs – charitable foundations, philanthropic organizations

**IMPLEMENTATION ACTION 5.2**

Federal investment in green infrastructure and land conservation must increase. Encourage HUD, DOT, EPA, FTA, and other federal agencies to expand federal programs that support land conservation, preservation, and related activities such as the federal Sustainable Communities Initiative Program.

**Primary Implementers**

*Federal:* HUD, EPA, DOT, BLM, FS, FWS, FTA, DOD

*State:* GOED, GOPB, EPA, UDOT

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions

**IMPLEMENTATION ACTION 5.3**

Align regional funding towards green infrastructure plan implementation and policy updates. Coordinate regional funding programs to finance local plans and ordinances that reflect a green infrastructure approach or that implement the goals and objectives identified in *(Re)Connect*. This funding program could subsidize the cost of ordinance changes, policy updates, plan and data preparation or refinement, and other similar activities. Philanthropic as well as other public and private sources can help supplement the program.

**Primary Implementers**

*State:* DNR, FWS, UDOT, DEQ, DCC, DH, GOED, GOPB, SITLA, Office of Tourism

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards, commissions, park districts, service districts, school districts

*Other:* Land trusts, conservation districts, other NGOs – charitable foundations, philanthropic organizations

**IMPLEMENTATION ACTION 5.4**

Update and include model ordinances, codes, and other general planning information that reflect *(Re)Connect's* green infrastructure approach and stewardship. Communities can protect their green infrastructure assets by planning for them. Whereas traditional conservation design principles seek to preserve and restore ecological function solely within that parcel, a green infrastructure approach to conservation design seeks to reclaim and enhance those valuable benefits for the larger, regional landscape.

Zoning updates and overlays offer the ability to specify the types of green infrastructure lands a community would like to conserve or protect. To do this sample ordinances and codes should be created that can be easily modified and inserted into a community's planning and policy documents. Some examples include: Best Management Practices (BMP's), water conservation ordinances, compact development guidelines, conservation easements and tax structures, and a green infrastructure element to general plans, comprehensive plans, management plans, and other regulations. Additionally, communities can incorporate form-based code and similar approaches that acknowledge structure, form, and function over conventional zoning approaches. Lastly, education and technical assistance may be necessary to ensure effective implementation.

**Primary Implementers**

*Regional/Municipal: W*FRC, MAG, city and county councils, boards, and commissions, COGs

**IMPLEMENTATION ACTION 5.5**

Work with local business owners to develop policies that conserve and enhance their economic assets. The *Supporting Sustainable Rural Communities: Partnership for Sustainability* study shows that policies that promote environmental quality improve economic growth and development.

**Primary Implementers**

*Regional/Municipal:* WFRC, MAG, city and county councils, boards, and commissions, COGs

**IMPLEMENTATION ACTION 5.6**

Establish regional green infrastructure funding programs to focus on the acquisition, management, and implementation of the green infrastructure network. Funding for green infrastructure must come from a variety of sources. These include traditional methods such as open space grants and bonds. Additionally, tax increment financing, often used for economic development, can be used to generate tax revenues for green infrastructure investments. Government sponsored low-interest loans can be used to acquire easements. Pilot programs could be created to begin funding implementation activities. Increase involvement of private landowners in conservation and management activities through incentives such as tax credits and easement access opportunities.

**Primary Implementers**

*State:* EPA, HUD, DNR, FWS, UDOT, DEQ, DCC, DH, GOED, GOPB, SITLA, Office of Tourism

*Regional/Municipal:* WFRC, MAG, county councils, COGs, city boards and commissions

# 7. FUNDING GREEN INFRASTRUCTURE PLANNING EFFORTS

A green infrastructure planning approach can identify and increase opportunities for meaningful conservation and restoration of these valuable lands. *(Re)Connect's* regional green infrastructure planning strategies and implementation actions will require funding sources if they are to be accomplished. Implementing these objectives and strategies will require a thorough and multi-level funding structure. Stakeholder cooperation, streamlined administration, and effective decision-making. Additionally, it is critical to make sure authorizing statutes are not unduly limiting the ability for land management agencies to raise revenue.

Managing public lands has proven difficult in the Wasatch Front, as funding is in short supply. Many significant green infrastructure lands are becoming more expensive to safeguard due to developmental pressures. The green infrastructure network lands identified by *(Re)Connect* should be a priority for public agencies when making critical decisions about land use. It is crucial to develop stable sources of funding for actions that promote the goals and objectives identified in this Plan.

## COORDINATE INVESTMENTS

A successful green infrastructure approach transcends jurisdictional boundaries. Accomplishing *(Re)Connect's* objectives, strategies and implementation actions will require collaborative management, as well as refinement in the way investment decisions are coordinated across all sets of government.

A single agency, community, or level of government cannot solve the Wasatch Front's land use planning concerns alone. Regional leaders and stakeholders will have to work together and across borders to facilitate a beneficial green infrastructure network and promote stewardship of the region's resources.

The Wasatch Front's federal and state agencies should use *(Re)Connect* and *Wasatch Choices for 2040* to guide investment decisions, to incentivize and empower regional recommendation-making, and to support the comprehensive green infrastructure approach to planning. The regional planning strategies outlined herein foster inter-jurisdictional collaboration, instigate regional actions to acquire funding, and advance cooperative decision-making.

Furthermore, federal and state agencies must collaborate to modify funding formulas, project selection criteria, and grant requirements that possibly cause unexpected results. Policy decisions and capital investments reflecting a comprehensive approach will increase overall administrative efficiency.

## REGIONAL FUNDING APPROACH

The greater Salt Lake metropolitan region, which firmly anchors the Wasatch Front, receives a significant amount of federal funding, but state and local governments decide how the monies are utilized In order to appease the many constituents, these funds are often spread both widely and thinly, reducing the overall effectiveness and implementation of plans. *(Re)Connect's* green infrastructure approach mobilizes–federal funding and initiatives towards shared goals and benefits, maximizing economic impacts.

In addition, a regionally dedicated source of green infrastructure funding should be created to assist in updating municipal plans and implementing green infrastructure projects. This green infrastructure fund should enable ordinance changes, and updates to local programs or policies, for green infrastructure plan preparation. It can include bonds and other measures and should be supplemented with philanthropic and/or other public and private sources when possible. Implementing green infrastructure improvements at county and municipal levels will likely require the leveraging of existing funds through the restructuring of current capital resources and programs.

## GUIDE INVESTMENT DECISIONS

*(Re)Connect* provides strategies to better link federal and state programs to Wasatch Front priorities and reduce bureaucratic inefficiency. The green infrastructure framework provides common goals, performance criteria, and efficient use of capital, and stakeholders must work together to streamline funding and grant requests.

Funding from several existing sources (e.g. federal, state) should be identified to support community planning, with particular focus on updating ordinances and public policy and other development regulations which incorporate green infrastructure principles and sustainable planning practices to housing, transportation and development.

## INCREASE COMPETENCIES

State, federal, and local government agencies and organizations must perform more efficiently. The Wasatch Front's outdated policies and numerous administrations have led to higher governmental costs, and reduced accountability and oversight. Wasatch Front stakeholders must rethink and realign their policies, programs, and funding. As there are hundreds of different government and stakeholder components in the Wasatch Front, maximizing efficiency will require increased coordination, communication, and effective consolidation of services.

Local municipalities in the Wasatch Front should consider coordinating or consolidating services through collaborative decision-making. Regional councils can analyze the fiscal impacts – the benefits and potential consequences – of sharing or consolidating services, reducing environmental impacts and providing monies for green infrastructure land use actions.

Tax policies in the Wasatch Front, though not discussed in detail, are implicit in financial aid investment decisions. State and local revenue sharing should reflect *(Re)Connect's* approach to land use decisions. The Wasatch Front's urban and suburban landscape is primarily shaped by the local governments' land use decisions, often motivated by local fiscal needs and priorities. *(Re)Connect* and *Wasatch Choices for 2040* provide tools and a vision to address and guide these local decisions.

Technical assistance should be made available by regional leaders and agencies. Local plans should be reviewed every two years and a regional compendium of plans should be created to monitor not only success and green infrastructure implementation, but to target planning and technical assistance where needed. Communities interested in implementing green infrastructure strategies should be identified early.

Planning commission and commissioner workshops should be provided throughout the region. Workshops will present topics such as the economic benefits of green infrastructure, consistency of local ordinances with comprehensive green infrastructure planning policy, the benefits of updating comprehensive plans with green infrastructure specific language, making defensible land use decisions in the context of the regional green infrastructure network, and the roles planning commissions should play in implementing a green infrastructure network approach. These workshops can be supplemented with special topics of interest, such as transportation, housing or growth principles, presented by the Wasatch Front Regional Council and their partners.

## COLLABORATIVE MANAGEMENT

Collaborative management, specific to funding and investment decisions, is key to implementing *(Re)Connect's* comprehensive objectives and strategies. Collaborative management of fiscal resources will reduce financial burdens of individual stakeholders as well as conflicts between interest groups, landowners, agencies and stakeholders.

## EFFICIENT ADMINISTRATION AND EFFECTIVE DECISION-MAKING

Efficient and effective decision making by all the regional stakeholders, including the federal and state agencies, municipal governments, conservation districts, NGO's, charitable foundations and private landowners, is necessary to implement the objectives and strategies of *(Re)Connect* and fulfill its mission and goals. *(Re)Connect's* regional planning objectives and implementation strategies will be enhanced and become more implementable though an efficient and effective approach to its funding.

### GREEN INFRASTRUCTURE FINANCING SUMMARY

In order for the Wasatch Front to meet the mission and goals of (Re)Connect, it will require a framework or 'implementation quilt' that assesses available funding programs and coordinates them to meet the various needs of the regional green infrastructure networks. The federal government offers many project funding programs which apply to *(Re)Connect*'s green infrastructure goals as well as financial resource finding assistance. A myriad of funding mechanisms can be employed to begin to accomplish the planning objectives, strategies and implementation actions of *(Re)Connect*. Wasatch Front residents expect transparency and efficiency when local governments subsidize and utilize their tax dollars. Wasatch Front stakeholders and decision makers need to coordinate actions and investments strategically to maximize the benefits that communities and the region realize from these public investments.

(Re)Connects integrated planning approach is appropriate for coordinating investments and facilitating matching-share funding. Partnership-based funding or collaborative partnership funding will maximize the benefits achieved as multiple stakeholders or agencies share values over the same land parcel. Funding-based partnerships will also enable the implementation of *(Re)Connect*'s regional planning objectives and strategies. Public-private partnerships and inter-agency partnerships should be explored and facilitated by regional leaders and decision makers. Integrating green infrastructure with programs that focus on growth, development and environmental quality will have significant impact on the health of the region.

# 8. STEWARDSHIP

Cooperation between stakeholders, including inter-agency and public/private coordination, will be required to enable stewardship actions in the Wasatch Front region. To improve the social and natural green infrastructure networks, planning, design, and management efforts among public and private stakeholders as well as other organizations and agencies should be coordinated. This can be achieved when stakeholders approach land management activities through a stewardship lens. In the context of *(Re)Connect*, stewardship refers to activities that prompt relationships and outcomes that benefit the region's green infrastructure. For example, social and natural green infrastructure networks are inherently connected. Hydrological and ecological management strategies will improve both networks. Similarly, recreational and working lands management strategies can enhance both social and natural networks as well.

Maintaining and enhancing green infrastructure resources cannot be accomplished by any single agency or organization, it requires collaboration and leadership from all major land management agencies. Many agencies are responsible for land use practices in the Wasatch Front region. These agencies can be viewed as stewards and include:

- U.S. Forest Service (FS)
- Bureau of Land Management (BLM)
- Utah Department of Natural Resources (DNR)
- State and Institutional Trust Lands Administration (SITLA)
- U.S. Fish and Wildlife Service (FWS)
- Utah Department of Transportation (UDOT)
- Municipalities
- Other agencies and organizations that manage land easements

Private landowners also have stewardship responsibilities as they protect and improve the green infrastructure resources within their property boundaries. Site specific actions can contribute significantly to the integrity of the larger network, especially when private landowners come together to promote and implement green infrastructure improvement projects.

***Stewardship provides the means of attaining this project's planning goal which is: To plan, design, and manage an interconnected network of regionally significant landscapes that retain ecological functions, maintain or improve water quality and habitat, provide recreational opportunities, preserve working land productivity, and sustain the high quality of life of the Wasatch Front for present and future generations.***

## BENEFITS OF STEWARDSHIP

Behind the multiple functions and benefits that green infrastructure networks provide is the concept of ecosystem services. Ecosystem services provide direct economic benefit, clean the water, reduce erosion, and cool the air. The Wasatch Front's health and well-being depends on the range of services provided by its green infrastructure.

*(Re)Connect* takes a proactive planning approach, which allows resource planners and land managers to assess the region's assets to ensure that economic development and growth can move forward without compromising valuable natural and social green infrastructure networks.

## STEWARDSHIP ACTIONS

Stewardship actions include any activity that furthers the maintenance, improvement, and/or connectivity of the region's green infrastructure. These activities may include restoration, acquisition, conservation, management, and sensitive development. The following are a few actions that can promote stewardship in the Wasatch Front.

### CONSERVATION

- Link existing green infrastructure network lands
- Conserve lands adjacent to green infrastructure network areas
- Conserve existing high quality network areas

### RESTORATION

- Restore potential corridors between green infrastructure network core areas
- Restore green infrastructure quality in areas that have been degraded
- Restore green infrastructure quality in hub areas to achieve core status

### PRESERVATION

- Preserve corridors which currently link green infrastructure network areas
- Preserve existing high quality green infrastructure areas
- Preserve existing cores within lands owned by public land agencies

### ACQUISITION

- Acquire lands that provide or promote linkages
- Acquire lands in core areas that add to existing high quality network areas
- Acquire lands in core areas that link green infrastructure network areas
- Acquire lands with a core status to be owned or managed by public land agencies

### MAINTENANCE

- Maintain existing green infrastructure lands to assure continued hub or core status
- Maintain lands to elevate hub or core status
- Maintain corridor functionality and interconnectivity

### ENHANCEMENT

- Enhance lands to elevate status from a hub to a core
- Enhance lands adjacent to high quality green infrastructure areas
- Enhance green infrastructure quality in areas that have been degraded
- Enhance corridor functionality and interconnectivity

### EDUCATION

- Educate and inform land management agencies, conservation organizations, and educational institutions on the merits of stewardship and land management sensitivity

## STEWARDS OF THE NATURAL GREEN INFRASTRUCTURE NETWORK

Stewardship of the natural green infrastructure network requires planning, design and management of those lands that provide multiple and diverse ecosystem services, such as watersheds and forest lands.

### NATURAL GREEN INFRASTRUCTURE NETWORK AND PUBLIC LANDS

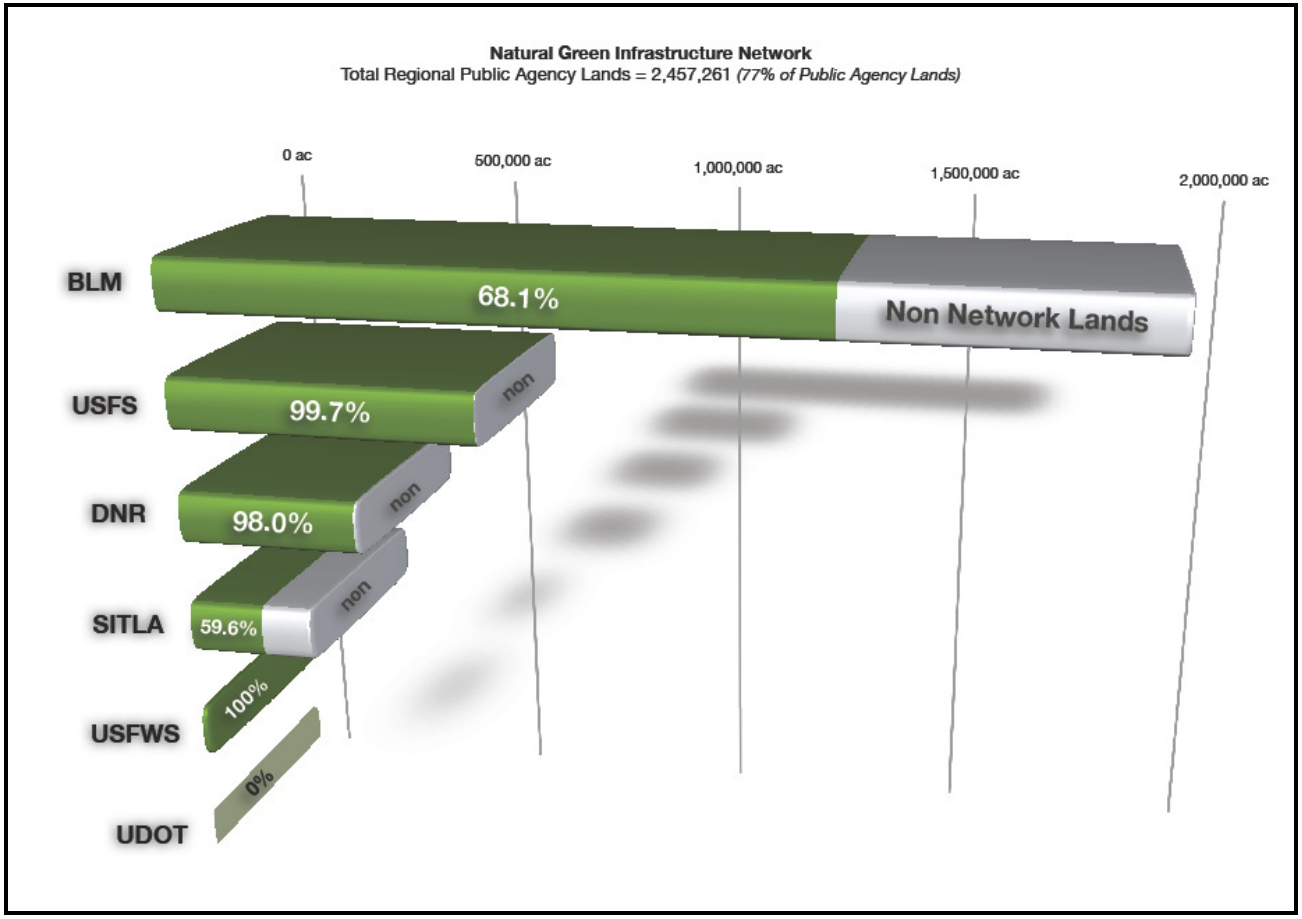
In order to facilitate stakeholder cooperation, the Natural Green Infrastructure Network Map was overlaid with a land ownership map. This illustrates the quantity of natural green infrastructure lands that could be comprehensively managed through coordinated efforts.

Nearly 2.5 million acres, or 61%, of the natural green infrastructure network is located within public lands. This network acreage also makes up 39% of the total land within the five-county area. Of the more than 1.9 million acres of BLM lands within the project area, 1.3 million acres or 68%, are within the natural green infrastructure cores or hubs categories. Utah's Department of Natural Resources owns and manages 625,775 acres. Of that, 623,701 acres, or 99.7%, are within the natural green infrastructure network. The U.S. Forest Service holds 374,340 acres, 366,890, or 98%, of which are natural cores or hubs. Of the 258,114 acres of SITLA lands within the project area, 153,797 acres, or 60%, are natural cores or hubs, and all of the 12,618 acres of U.S. Fish and Wildlife Service lands are considered natural green infrastructure. Utah's Department of Transportation owns 32 acres within the project boundary, and none of their lands were found to be natural cores or hubs. Refer to graphic 13 for more information.

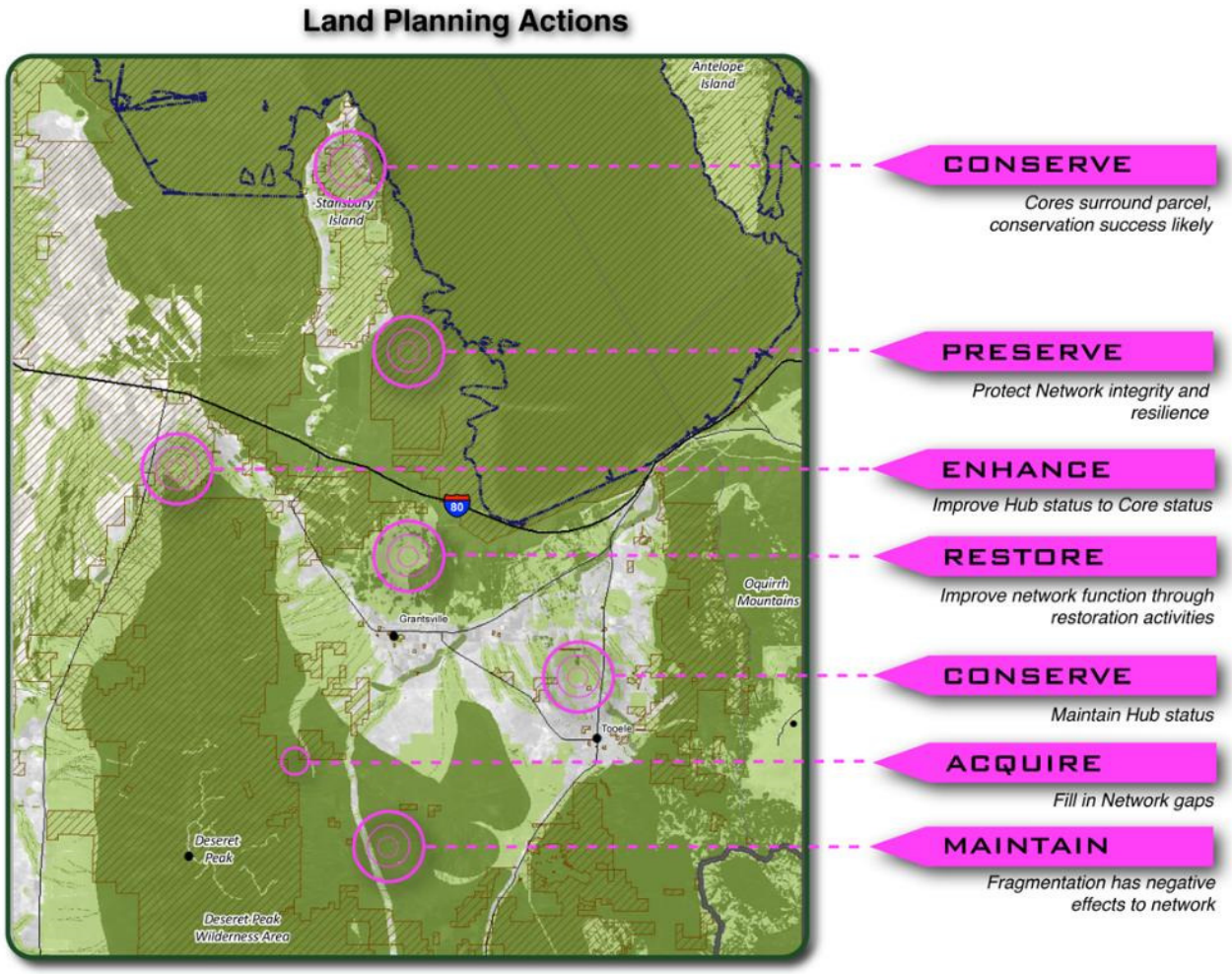
Graphics 13-14 demonstrate how stewardship can be accomplished within the natural green infrastructure network.

***Of the 3.2 million acres of public lands in the Wasatch Front region, 78% are within the natural green infrastructure network - 52% are within cores and 26% are within hubs.***

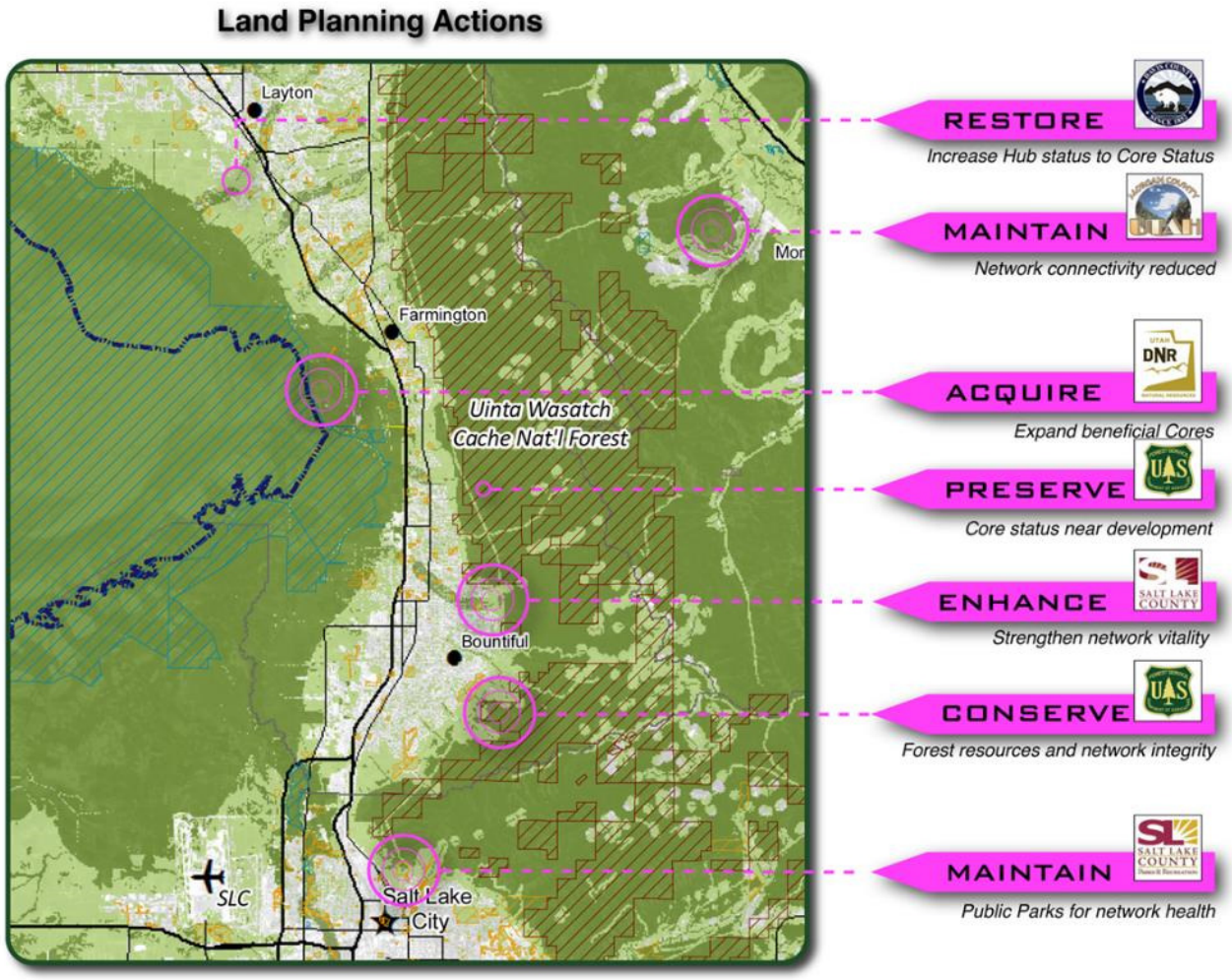
**Graphic 11 Wasatch National Forest**




Graphic 12 Public Lands Ownership and the Natural Network




**Graphic 13 Natural Network Stewardship Opportunities**




Graphic 14 Natural Network Stewardship Opportunities for Public Land Owners

### NATURAL GREEN INFRASTRUCTURE NETWORK AND PRIVATE LANDS

Privately owned lands are intertwined with the region's natural green infrastructure network. It is generally more difficult to promote stewardship on private lands, yet, there are still many actions that can be taken to improve the value of natural resources within private property boundaries. The impact of these actions can be amplified when multiple landowners come together to achieve commonly held goals.

Private landholdings account for 1.6 million acres within the Wasatch Front region. There are more than 4 million acres of natural green infrastructure lands in the project area. Over 1.3 million acres, or 32%, of this network is located within private lands. In other words, private landowners are responsible for one-third of the natural green infrastructure resources in the Wasatch Front region. Despite the stewardship actions of some of these landowners, it will be a challenge to maintain the natural green infrastructure resources on a majority of these privately held properties.

***Of the 1.6 million acres of private lands in the Wasatch Front region, 82% are within the natural green infrastructure network - 56% are cores and 26% are hubs.***

## STEWARDS OF THE SOCIAL GREEN INFRASTRUCTURE NETWORK

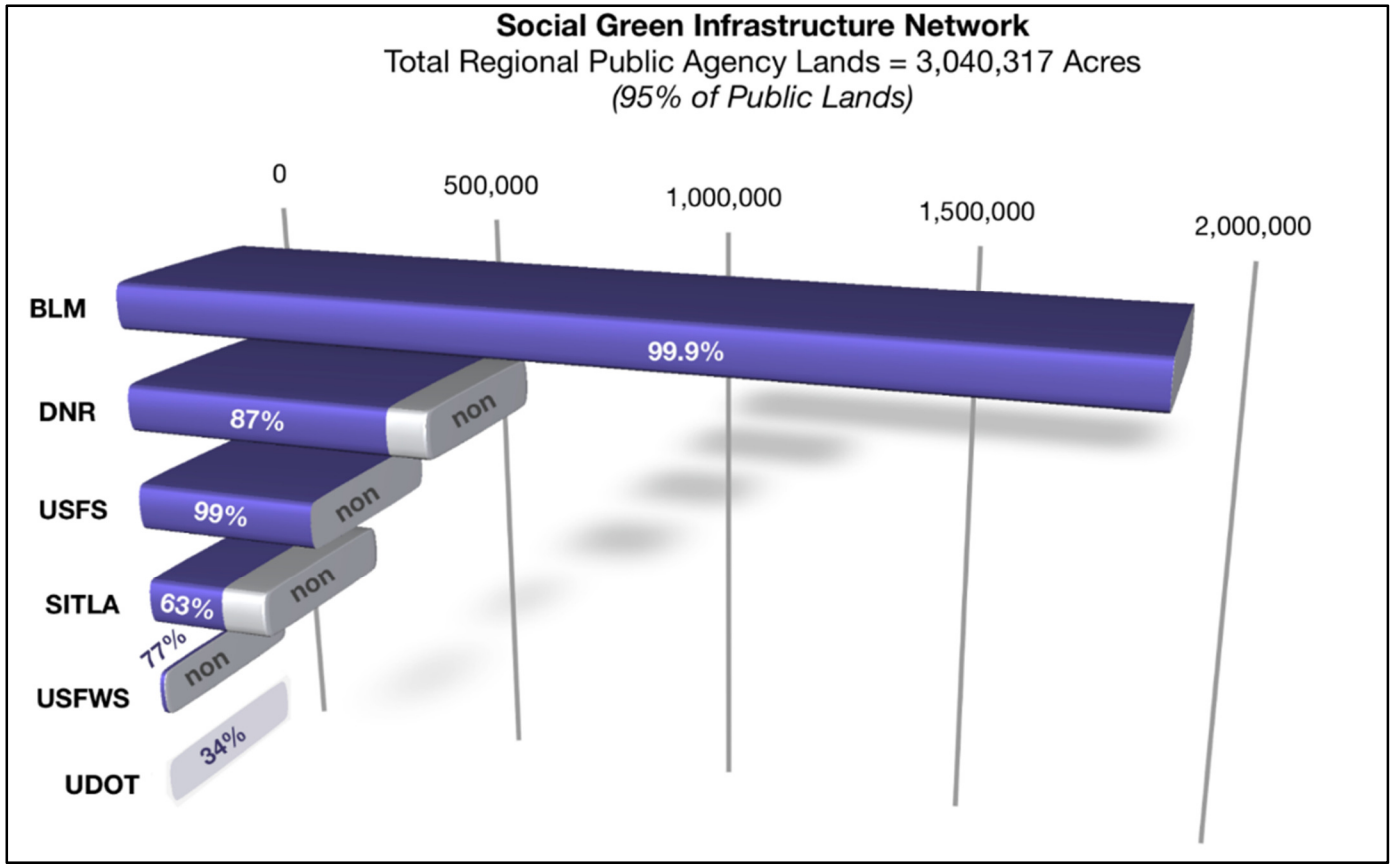
Stewardship of the social green infrastructure network requires the planning, design, and management of those lands that provide ecosystem services. Stewardship also requires strengthening lesser quality social resources to improve their capacity to provide services. Finally, regional stewardship involves improving the network's connectivity to facilitate mobility, access, and overall system functionality.

### SOCIAL GREEN INFRASTRUCTURE NETWORK AND PUBLIC LANDS

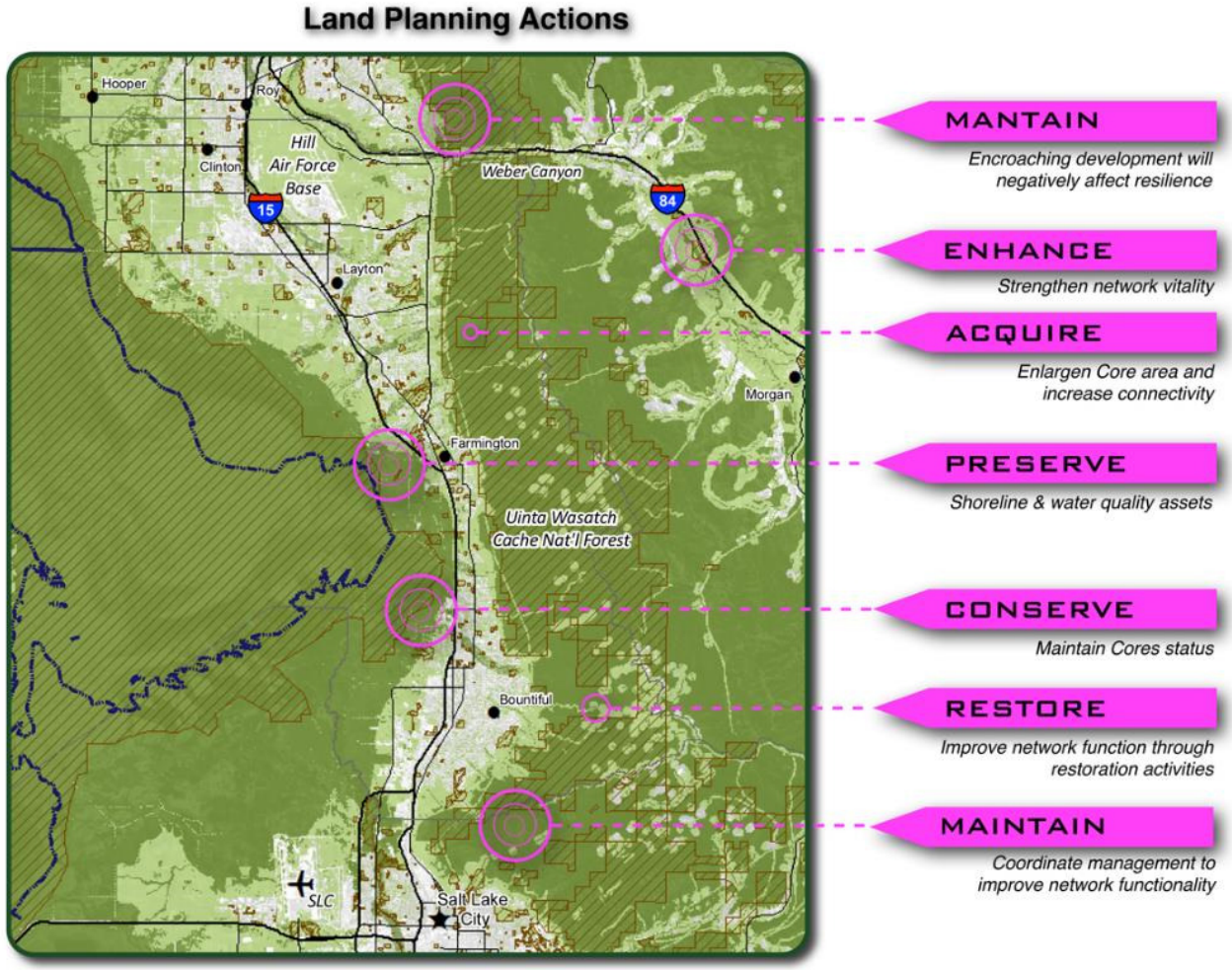
In order to facilitate stakeholder cooperation, the Social Green Infrastructure Network Map was overlaid with a public land ownership map to illustrate the quantity of social green infrastructure lands that can be managed comprehensively if the public land agencies coordinate their efforts.

Nearly 2.5 million acres, or 67%, of the social green infrastructure network is located within public lands. This network acreage also makes up 71% of the total land within the project boundary. Of the 1.9 million acres of BLM lands within the project area, nearly 100% are within the social network's core or hub categories. Utah's Department of Natural Resources owns and manages 625,775 acres, 545,628 (87%) of which are within the social green infrastructure network. The U.S. Forest Service holds 374,340 acres, almost all of which are social cores or hubs. Of the 258,114 acres of SITLA lands within the project area, 163,327, or 63%, are within the social network, and 9,761, or 77% of the 12,618 acres of U.S. Fish and Wildlife Service lands are considered social green infrastructure. Utah's Department of Transportation owns 32 acres within the project boundary, 11 acres (34%) of which were found to be social cores or hubs. Refer to graphic 16 for more information.

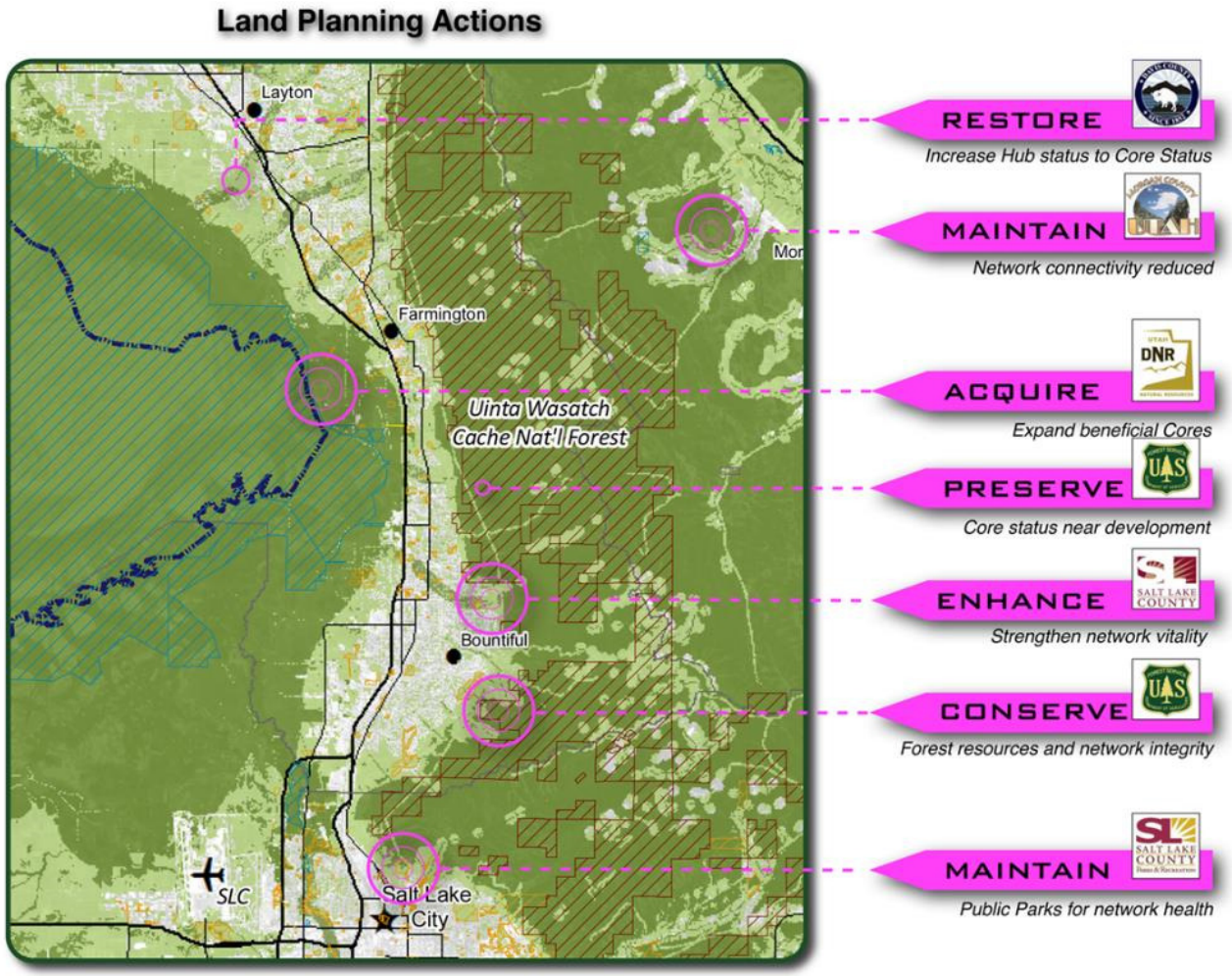
Graphics 16-17 demonstrate how stewardship can be accomplished within the natural green infrastructure network.




Graphic 15 Public Lands Ownership and the Social Network




**Graphic 16 Social Network Stewardship Opportunities**




**Graphic 17 Social Network Stewardship Opportunities for Public Land Owners**

## SOCIAL GREEN INFRASTRUCTURE NETWORK AND PRIVATE LANDS

Privately owned lands are intertwined with the region's social green infrastructure network. While it can be difficult to ensure the stewardship of social green infrastructure resources on private lands, there are many actions that can be taken by private landowners to improve the value of social resources within their property boundaries. For example, the stewardship of recreational destinations does not fall to private landowners as they generally do not want their lands open to public recreational activities. However, lands that do support recreation can be improved by private landowners. Additionally, the stewardship of working lands such as grazing, ranching, and farmland will primarily be undertaken by private stakeholders.

Opportunities and strategies exist to not only maximize their profitability and land health, but to also support biodiversity, water quality, and other *(Re)Connect* goals. The impact of these actions can be amplified when multiple landowners come together to achieve commonly held goals.

Private landholdings account for 1.6 million acres, or 25% of *(Re)Connect's* project boundary. There are over 4.5 million acres of social green infrastructure lands in the project area. Over 1.3 million acres, or 30%, of this network is located within private lands. In other words, private landowners are responsible for almost one-third of the social green infrastructure resources in the Wasatch Front. Despite the stewardship actions of some of these landowners, it will be a challenge to maintain the social green infrastructure resources on a majority of privately held properties.

## STEWARDSHIP OPPORTUNITY MAP

Stewardship actions should be employed within all natural or social green infrastructure lands, not just those shown on the map. The opportunity map simply illustrates the areas where community resources are concurrent with green infrastructure resources, where community systems have the potential to significantly impact, positively or negatively, green infrastructure. As such, they can be viewed as potential areas of opportunity for stewardship. The stewardship opportunity map is one of many possible maps that can be generated using the data synthesized by *(Re)Connect*. In no way should the opportunity map be considered a final map illustrating the highest priority areas for planning, design, or management.

The opportunity map proactively addresses potential impacts to ecosystem services and quality of life in the Wasatch Front Region. Some of the areas illustrated may be identified as priorities for conservation through acquisition or easements. This type of protection would ensure communities are less capable of producing undesirable impacts on the green infrastructure resources in that area. Other areas may be optimal for low impact development or ecological design projects in which community systems are integrated into the natural landscape in a way that does not compromise the integrity of the green infrastructure. Still other areas may be in need of restoration as a result of previous disturbances to green infrastructure.

The stewardship map highlights areas that will require collaboration and cooperation between stakeholders. The map can be used as a resource to encourage these actions and other appropriate land planning strategies. No single planning or management strategy is appropriate for all resources within the areas illustrated.

The incorporation of site-specific data will be required to identify the most appropriate strategies for each location. Refer to Map 29.

## EXAMPLES OF OTHER POSSIBLE OPPORTUNITY MAPS

These mapping examples, and others, are useful tools to assist Wasatch Front stakeholders in making the best possible decisions regarding stewardship of the lands and resources for which they are responsible.

### AREAS WITHIN SOCIAL AND NATURAL NETWORKS THAT OVERLAP

Stewardship and sensitive design strategies should be employed in these areas. Such improvements can affect ecological health and water quality, increased ecosystem services, enhanced recreational opportunities, and strengthened landscape productivity.

### AREAS WITHIN WORKING LANDS AND ECOLOGICAL ASSET NETWORKS THAT OVERLAP

These are zones where suitable agricultural and grazing practices should be employed to simultaneously support working lands productivity and maintain and enhance ecosystem health and integrity.

### AREAS WITHIN RECREATIONAL AND HYDROLOGICAL ASSET NETWORKS THAT OVERLAP

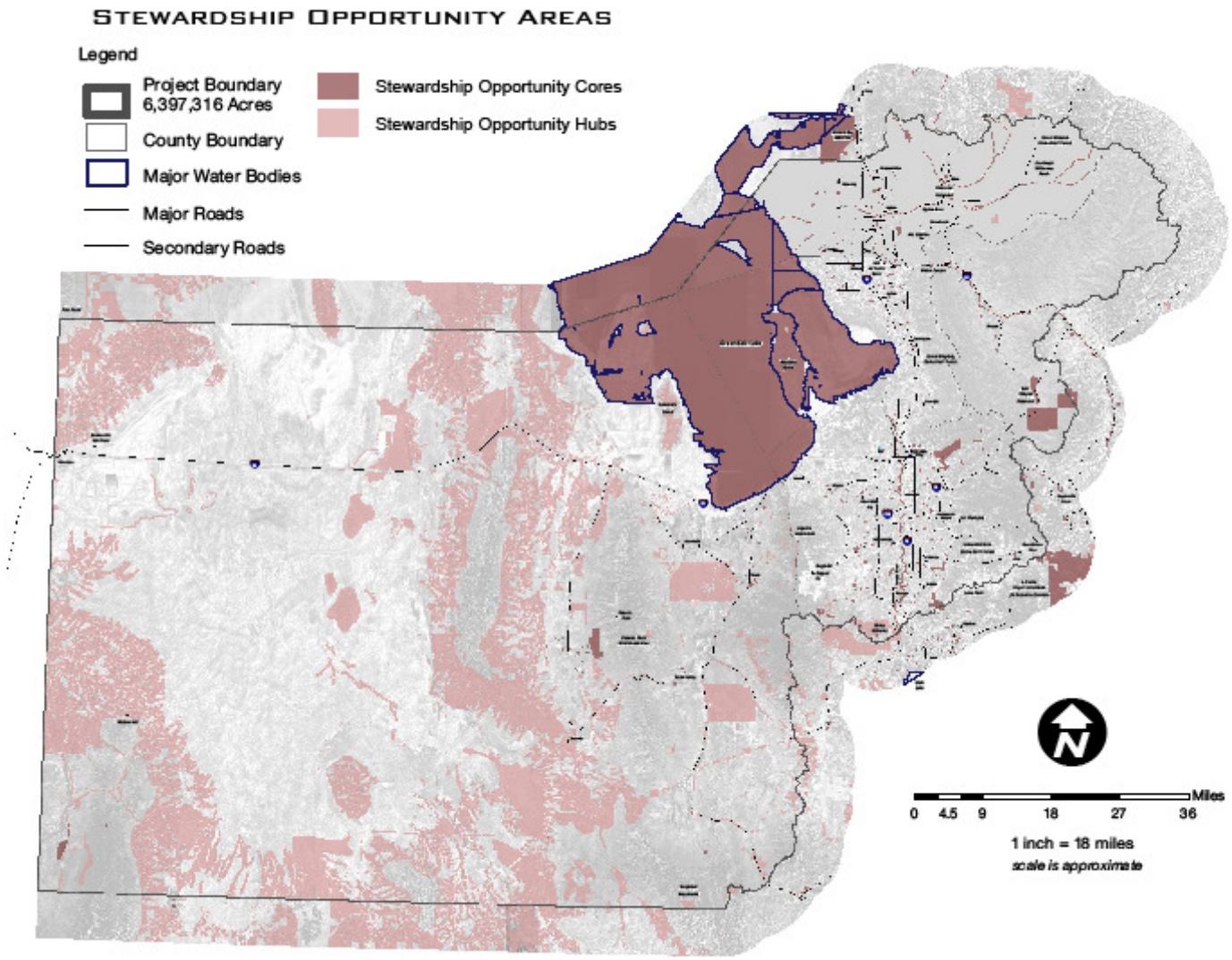
These are areas where design and management strategies affect ecology, water quality, and recreation. These areas may include hiking or biking trails along streams or drainages.

### SOILS OF STATEWIDE IMPORTANCE AND DEVELOPED LANDS

These areas help identify which lands are most appropriate for urban farming or preservation of urban interface zones.

### AREAS WITHIN THE NATURAL NETWORK AND NATURAL HAZARDS THAT OVERLAP

These areas illustrate lands that developers should avoid and/or lands that would be good to conserve due to a lack of suitability for development.




Map 29 Regional Stewardship Opportunity Map

# 9. VISION

The Wasatch Front will continue to change over time. The regional landscape in 2040 will be markedly different than it is today and likely dissimilar from any traditionally formulated land use plan. *(Re)Connect's* planning approach views the Wasatch Front's green infrastructure networks as evolving systems of interconnected resources.

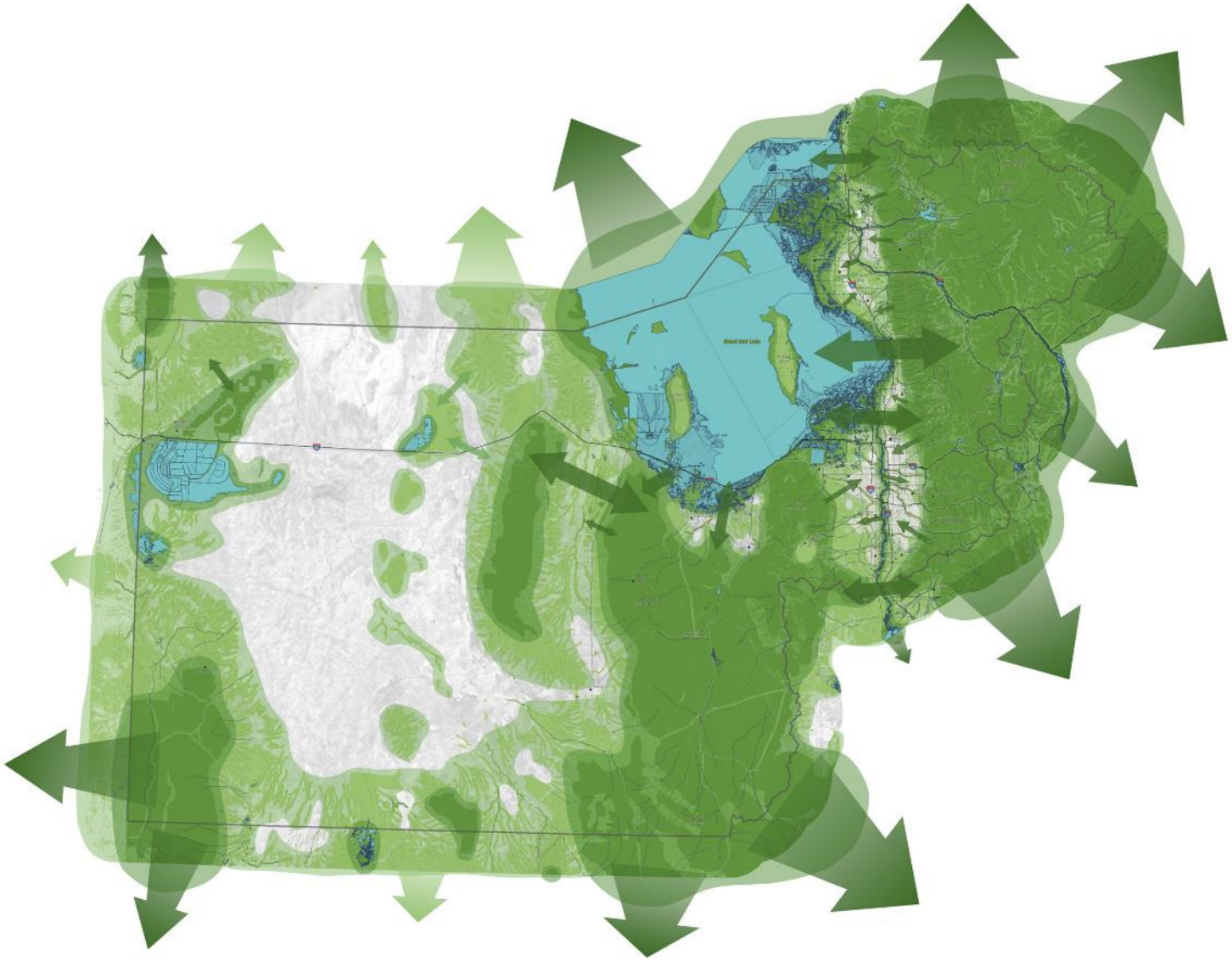
The Regional Green Infrastructure Network Vision Maps are 'loose' and conceptual in their illustration and purposefully do not provide a predisposed or rigid spatial 'form' for future land use patterns to achieve within the Wasatch Front. Rather, *(Re)Connect's* green infrastructure framework and planning methodology, which include the tenets of stewardship, will enable effective decision making and strategic planning to not only maintain the region's composition, but to increase the benefits provided to the greatest number of people. The maps illustrate *(Re)Connect's* vision for these regional networks. The Natural and Social Green Infrastructure Network Vision Maps present simplified, diagrammatic representations of future expanded and connected green infrastructure networks in the Wasatch Front. The maps begin to more accurately identify areas in need of land planning actions to achieve *(Re)Connect's* goals and objectives, and allow stakeholders to better predict and assess their cumulative potential impacts to the region's green infrastructure. Refer to Maps 30 and 31.

The project team also deemed it imprudent to provide 'land conservation' acreage numbers or 'green infrastructure network' land requisites as *(Re)Connect* values and prioritizes the quality of the network lands over the quantity.

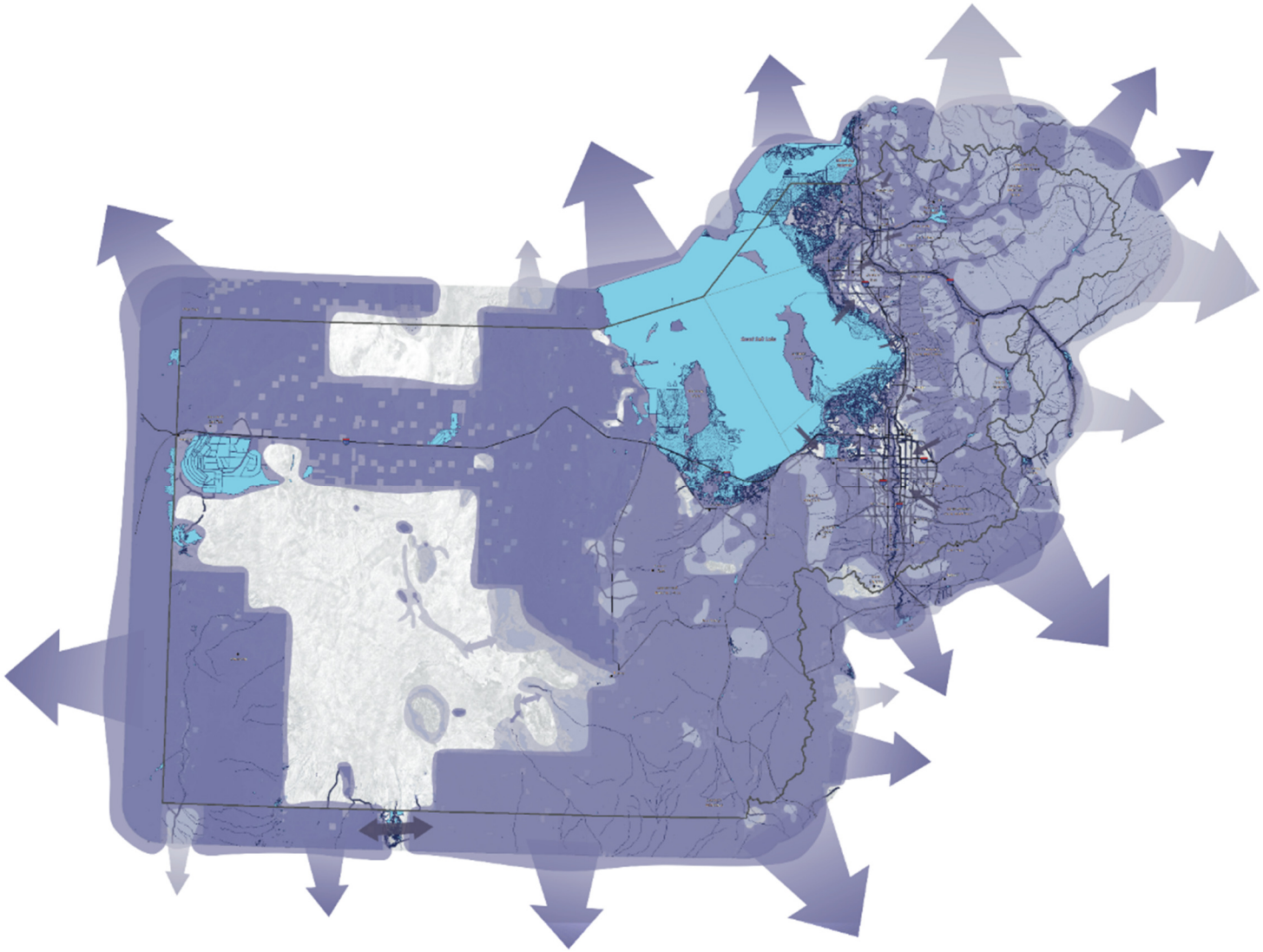
The Green Infrastructure Network Vision Maps realize the Wasatch Front's goal of planning, designing and managing an interconnected network of regionally significant landscapes by illustrating the following:

Maintaining and enhancing the existing green infrastructure networks lands

- Filling in significant 'gaps' in the green infrastructure networks (cores and hubs)
- Improving linkages (corridors) between significant network areas to support overall functionality
- Strengthening the relationship between communities and the green infrastructure networks
- Presenting the larger context of the Wasatch Front's green infrastructure network and the need for proactive land use and collaborative management to the Intermountain West and surrounding



**Map 30 Natural Green Infrastructure Vision Map**



**Map 31 Social Green Infrastructure Vision Map**

## A COLLECTIVE STRATEGY FOR THE WASATCH FRONT

The Wasatch front is at a critical juncture – if steps are not taken to proactively sustain the integrity of the region's remaining matrix of green infrastructure lands, we may lose valuable resources to development pressures, pollution or overuse.

The many distinct resource networks that intermix and connect our communities are the foundation for *(Re)Connect: The Wasatch Front Green Infrastructure Plan*. These networks perform a wide range of functions and deliver many services. Broadening green infrastructure in the Wasatch Front, a process which requires planning, design, management and implementation, provides an opportunity to accomplish many of *(Re)Connect's* environmental, social and economic goals. Green infrastructure's multifunctional character, with benefits enhanced through connectivity, provides a regional planning approach to the use of the region's limited resources.

Much like grey infrastructure, the Wasatch Front's future will require green infrastructure. Both are essential to the foundations of our communities, and both need to be planned and supported in an integrated way. The idea behind a green infrastructure strategy is to develop a systematic process for making decisions about land conservation in a community or region. These decisions are grounded in an understanding about the essential role that green infrastructure plays in our quality of life, economic vitality, and health and welfare.

Because the important elements of green infrastructure are defined by ecological-based, not political, patterns, there are limitations to the effectiveness of planning that is done from the perspective of individual jurisdictions. In order to account for important interplay between these systems, planning needs to simultaneously occur at both the regional and local levels.

*(Re)Connect* is a systematic, evidence-based, replicable way to approach collaborative decision-making. *(Re)Connect's* data and methodology is available to all stakeholders and decision makers, and the Plan's scientific and technical tools for adopting a green infrastructure planning approach are provided.

*(Re)Connect* enables Wasatch Front stakeholders to make informed, strategic, and collective decisions for the region's green infrastructure networks. Through stewardship of the region's resources and systems, *(Re)Connect's* goals can be achieved. The Wasatch Front green infrastructure networks can continue to provide valuable ecosystem services, clean and plentiful water, healthy wildlife habitat, productive working landscapes, exceptional recreational opportunities, and livable communities for generations to come.

# 10. CITY AND COUNTY IMPLEMENTATION EFFORTS

*(Re)Connect* has identified the Wasatch Front's green infrastructure networks, yet the implementation of measures to maintain, improve, and connect these networks are needed to accomplish the Plan's goals and objectives. The following section is dedicated as a practical toolbox that municipal decision makers and planners can customize for the planning, design and management of their respective green infrastructure assets.

The following strategies are not comprehensive and there are many other options or modifications which have been utilized successfully elsewhere. The Wasatch Front Regional Council is a source of ideas and materials on various implementation strategies for meeting planning objectives.

## GREEN INFRASTRUCTURE IMPLEMENTATION STRATEGIES

Though there are many tools and mechanisms available to promote the planning, design, management and implementation of *(Re)Connect's* green infrastructure goals and objectives, it is important that the correct tool be used in the proper place. Many of these tools operate within a spectrum of government participation, and some can be voluntary or temporary arrangements while others can be permanent. Each tool must fit the desired outcome of the landowner or stakeholder and the public. Private property rights are a contentious issue in the Wasatch Front, and green infrastructure strategies should adequately address this. *(Re)Connect's* implementation strategies will be more successful if implemented at the local level with local support.

In addition to implementation gaps or disconnects between policy and 'on-the-ground' construction, there is often a gap in the delivery of the green infrastructure approach to strategic land use planning. This delivery gap largely occurs at the level of local authorities and decision makers who do not have appropriately skilled and resourced teams to deliver 'on-the-ground' implementation. City councils and municipalities will need to first establish a strong leadership, second, to provide sufficient professional coordination and skills, and third, to engage local people in the design and delivery of green infrastructure.

*(Re)Connect's* green infrastructure policy recommendations include not only municipal regulations but also voluntary instruments, expenditures and partnerships, and incentives. The green infrastructure planning tools, implementation strategies and resources provided in *(Re)Connect* may be most helpful when implemented at the appropriate time and used with other planning tools and strategies. The Wasatch Front municipalities should consider how multiple tools might work together and which ones will work best together given each unique situation.

*(Re)Connect* has consistently viewed the Wasatch Front's resources from an asset-based perspective. The five asset categories are again used to give structure to local and municipal implementation strategies.

The five asset networks must be understood as self-supporting, yet interconnected systems. The regional asset network planning objectives will not only positively affect the integrity of each asset network, they will also increase the overall health, function and resilience of the natural and social green infrastructure networks.

## ECOLOGICAL GREEN INFRASTRUCTURE IMPLEMENTATION STRATEGIES

Ecological green infrastructure implementation should focus on integrated and connected green infrastructure lands which create or facilitate multi-functional spaces, especially in the urban corridor where land is in demand. Municipal planners must maximize the uses and benefits of every parcel in many locations.

1) ***Utilize the Green Infrastructure Network Maps and the Ecological Asset Network Map to identify priority areas for land planning actions such as the restoration, management, and conservation of local resources and assets.***
   a) The Network Maps and Ecological Asset Network Map can be reviewed to target maintenance and enhancement projects for greenways and wildlife corridors, including acquisition priorities.
   b) Implement stand density reduction and fuel treatments in the forested areas where fire suppression has led to dense, uniformly-aged stands with a high fuel load. Early investments facilitating these actions will increase forest health and resilience and reduce risk of wildfire in wildland-urban interface areas.
   c) Limit expansive development in large areas of un-fragmented plant and wildlife habitat.
   d) Coordinate investments to create a connected county-wide or city-wide ecological network.
   e) Include ecological network connectivity into open space grant programs and acquisition funds.

2) ***Engage local stakeholders and work with the private sector and non-profit conservation organizations to focus efforts and Best Management Practices (BMPs) to improve the municipalities' green infrastructure network lands and ecological assets.***
   a) Educate regional stakeholders and private landowners on the value of healthy forests, open space, biodiversity and invasive species management.
   b) Establish incentives to private landowners to encourage them to manage their lands in ecologically beneficial ways.
   c) Advance alternatives to large block or concrete retaining walls such as vegetated surface walls, gabion or mesh walls, and cell walls.

3) ***UDOT and other agencies should use sensitive design techniques to protect green infrastructure assets in transportation corridors identified in Wasatch Choices 2040. These design techniques include:***
   a) Eco-bridges such as wildlife overpasses, viaducts, amphibian and underpass tunnels, and habitat culverts to minimize wildlife / human impacts.
   b) Raised pylons and elevated transportation corridors on green infrastructure network lands.
   c) Designing transportation corridors around wetland areas and (when necessary) concentrating mitigation into green infrastructure core network areas.

4) ***Protect and expand the urban forest canopy***
   a) Continue to support the maintenance, restoration and improvement of urban forest ecosystems through programs like the Forest Service's Urban and Community Forestry (UCF) program.
   b) Establish city canopy targets; prioritize improvements.

c) Enhance tree preservation and landscape ordinance requirements and incentives.
d) Encourage re-vegetation in urbanized areas.
e) Maximize the tree canopy on streets ROWs.
f) Consider including developer contributions to street tree planting in zoning requirements though a Street Tree Escrow Fund.
g) Develop context-based tree planting guidelines (spacing, size, diversity).
h) Update tree planting standards to reflect continuous trench structures. Do not promote raised bed or container tree planting techniques.

## HYDROLOGICAL GREEN INFRASTRUCTURE IMPLEMENTATION STRATEGIES

Hydrological green infrastructure implementation strategies seek to maintain, improve and enhance the quality and quantity of water in the Wasatch Front. Important principles reflected in the strategies include managing water both at the source and at the surface. This is achieved through affecting the rate and quality of water immediately, before the burden is felt further 'downstream' in the subsequent pipe, basin or treatment facility. Design techniques which reduce or eradicate the need for piping will reduce municipal fees (clogging, freeze damage, etc.). Overland conveyance of water resources is easier to maintain, easier to install, and provides the opportunity for evaporation, absorption and infiltration.

This natural approach to hydrological assets can also slow runoff and reduce erosion, thereby saving tax payer dollars for services and maintenance. This approach, often exemplified in 'green streets', brings beauty to the neighborhood and urban areas. Green streets also create safer pedestrian crossings and tax revenue through real estate value.

1) ***Utilize the Green Infrastructure Network Maps and the Hydrological Asset Network map to guide development away from sensitive water resources and recharge areas, and focus on land planning actions such as the management, restoration, and conservation of hydrological assets.***
   a) The Network Maps and the Hydrological Asset Map, when used as overlays, identify areas (surface and groundwater resources) where sensitive design and water resource management practices such as LIDs, BMPs and others should be utilized.
   b) Pursue river and stream restoration and day-lighting projects.
   c) Localized sub-watershed planning and management should be encouraged.
   d) Urban and community forest programs initiated by counties and municipalities should encourage sustainable water resource management practices.
   e) Protect areas where natural stream and river channels persist. Employ restoration efforts to return stream segments to natural, unconstrained conditions.
   f) Preserve or restore riparian buffers where possible to reduce nutrient and chemical loads, provide wildlife habitat, and maintain stream integrity.
   g) Integrate water improvement actions and restoration projects with the green infrastructure framework.
   h) Increase the width of required riparian buffers.
   i) Initiate "Adopt-a-Stream" programs.
   j) Consider establishing a stormwater utility fee to help fund improvements and retrofits.

*LID – Low Impact Development techniques include, for example, reducing impervious surfaces, incorporating native landscaping, and capturing and cleaning runoff onsite.*

***2) Engage local stakeholders and work with the private sector and non-profit conservation organizations to focus efforts and Best Management Practices (BMPs) to improve the municipality's network lands and hydrological assets.***

a) Provide model ordinances relating to water resource management activities.
b) Identify and prioritize opportunities for joint stormwater management facilities.
c) Incentivize BMPs and LIDs, especially natural infiltration, in all private developments.
d) Reduce impervious surfaces in all development and infill projects through techniques such as rain gardens, vegetated swales, green roofs, and bio-filtration.
e) Minimize potable water use for irrigation through rainwater collection/re-use.
f) Educate and encourage landowners to implement water-wise landscaping and proper irrigation techniques.
g) Educate developers and others on appropriate storm water management techniques.
h) Increase public education and awareness of invasive species (floral and faunal). This can increase the likelihood of early detection, rapid response, and the subsequent prevention of invasive spread and colony establishment.
i) Require on-site detention basins and infiltration swales to minimize impacts of stormwater and costs on conventional storm sewer systems.
j) Incentivize porous paving surfaces in all development and redevelopment.
k) Include detention/retention basins in street and traffic-calming techniques such as roundabouts, medians and shoulders.

*A stormwater utility establishes user fees based on the volume of stormwater runoff a property generates. Fees are usually based on the property's percentage of impervious area, and credits can be provided for measures taken to reduce runoff volume and improve water quality. Fee revenues are used to implement stormwater management improvements.*

***3) Develop and finance a water retrofit program to update stormwater infrastructure retrofits, utilizing watershed plans as an identification tool for locations requiring restoration and enhancement.***

a) County leaders should assist in the implementation of retrofit programs and provide technical assistance including model codes and ordinances as well as audits, providing updates to regulations.
a) Financing for these programs can be facilitated through local governments' stormwater utility fees.
b) BMPs and LIDs should be incentivized for private landowners.
c) Update landscape irrigation and maintenance ordinances and standards to reflect 'water-wise' techniques.

## RECREATIONAL GREEN INFRASTRUCTURE IMPLEMENTATION STRATEGIES

1) ***Utilize the Green Infrastructure Network Maps and the Recreational Asset Network Map to identify and focus land planning actions such as the enhancement, management and conservation of recreational assets.***
   a) Adopt a regional management approach to recreation in the Wasatch Front to limit recreational conflicts, overuse, and degradation.
   b) Coordinate park acquisition, design and programming within green infrastructure frameworks.
   c) Foster awareness, use and stewardship of public parks and open spaces.
   d) Adopt a policy requiring deed restrictions guaranteeing the preservation of parks, open spaces, and trail connections in considering the sale or transfer of any existing city-owned property.

2) ***Provide increased and improved access to recreational assets such as parks and 'open space', especially in developed or urban areas.***
   a) Foster cooperation between parks districts and school districts to share use of recreational assets.
   b) Finance recreational assets through redevelopment and code or policy modifications.
   c) Conservation easements should directly access or connect recreational cores.
   d) Focus on greenways to connect both ecological and recreational assets networks.
   e) Incorporate greenways and trails into housing developments. Promote loop-trails where possible.
   f) Require conservation subdivision style designs in private real estate development.
   g) Transportation development and construction should have equal support for trail development and construction.
   h) Evaluate the feasibility of obtaining public access easements and creating trail connections.
   i) Design trails and greenways to protect green infrastructure resources, improve stormwater management and water quality, provide habitat corridors, and provide bicycle and pedestrian connections.

## WORKING LANDS GREEN INFRASTRUCTURE IMPLEMENTATION STRATEGIES

Wasatch Front stakeholders and management agencies are encouraged to look at agricultural and working lands preservation as a means to promote green infrastructure network conservation, and as a way for providing continuing services to the region. While farmland preservation has its own merits in many ways – especially as smaller-scale, near-market farms, and local food production – agricultural and working lands can be interim links (corridors) or hubs in the Wasatch Front's natural green infrastructure network. For instance, actively farming agricultural land will tend to limit the spread of noxious weeds relative to leaving it in an unmanaged fallow state.

Ranchers and farmers in the Wasatch Front must be aware of how their practices affect the region's comprehensive resources, including water quality, public health, and wildlife habitat. The planning and management of the Wasatch Front's working lands are critical to the integrity of the overall green infrastructure network. A woodlot owned by a rancher may be part of a core area. A core wetland may border a farmer's field. Maintaining working land productivity and green infrastructure health requires a multi-faceted approach.

Local working lands produce food and livestock which support local and regional economies as well as provide a rural lifestyle and heritage. Yet working lands are often the main source of new developable lands (American Farmland Trust). Farmland is desirable to residential and commercial developers because it is inexpensive to acquire and develop. Green infrastructure planning efforts in the Wasatch Front must protect and conserve these working lands.

1) ***Utilize the Green Infrastructure Network Maps and the Working Lands Asset Network Map to identify and focus land planning actions such as the conservation, enhancement, restoration and management of working land assets.***
   a) Farm resource agencies and local conservation districts should review the Working Lands Asset Network and Green Infrastructure Network Maps to identify working lands that have the largest impact on natural network health. They should work with farmers and ranchers to manage these lands appropriately.
   b) Update and monitor the UDAF's Grazing Improvement Program to reflect green infrastructure strategies and goals.
   c) Concentrate development away from existing farm and ranch lands to minimize conflict and preserve working landscapes.

2) ***Local conservation districts and governments should consider incentive programs, which promote working land preservation, BMPs, environmental restoration activities, and wildlife benefits of working landscapes.***
   a) Where applicable, promote the upgrade of agricultural drainage ditches to two-stage drains with vegetated buffers.
   b) Focus on greenways to connect both ecological and working lands asset networks.
   c) Promote regional farmland preservation through federal and state easement programs.
   d) Encourage regenerative agriculture efforts.

3) ***Raise the understanding and awareness of agricultural production in the region and increase access to local food.***
   a) City and county councils should support local food production, traditional agricultural manufacturing and urban agriculture.
   b) Policy updates include expanding farmland protection programs, revising federal and state policies to support local food production and provide agricultural financing.
   c) Support urban agriculture and community gardens as a local source of food through policy changes and ordinance revisions.
   d) Encourage revisions to federal policy (U.S.DA) to accommodate small and local farms and re-align federal incentives.
   e) Allow transfer of city-owned vacant lots to community gardening non-profits.
   f) Consider subsidizing water connections and use fees for community gardens.
   g) Modify nuisance ordinances (plant height, composting, and rain barrels) to remove barriers to community gardening.
   h) Allow roof-top gardening. Facilitate the piloting of smaller, temporary farmer's markets.

## COMMUNITY INFRASTRUCTURE IMPLEMENTATION STRATEGIES

One of the goals of *(Re)Connect* is to make the region a better place to live. By definition, livable communities aim to maintain and improve quality of life for residents. Livability is primarily generated at the local or municipal level, though planning and development decisions are made by county and city councils and other civic districts. While *(Re)Connect* helps federal and state governments address the green infrastructure network so they may make beneficial decisions at a regional scale, important development decisions, which affect the quality of life in the Wasatch Front's communities, will continue to be made locally and at a county and city level.

1) ***Utilize the network maps and the Community Asset Network Map to identify and focus land planning actions such as the enhancement, conservation and management of community assets.***
   a) Improve community livability through more frequent local and municipal ordinance updates.
   b) Promote sustainable development through BMPs and LIDs.
   c) Employ smart growth strategies such as transit-oriented development and mixed-use development to reduce pressures on air and water quality, preserve green infrastructure network resources, and improve community livability.
   d) Encourage compact, clustered development patterns to preserve green infrastructure landscapes.
   e) Adopt development standards and policy which protect green infrastructure resources.
   f) Design, maintain and operate streets to enable safe and beneficial access for all users which maximize allocated funding.
   g) Utilize inactive/abandoned transportation ROW's as well as utility corridors to link all city neighborhoods to the regional trail systems.
   h) Capitalize on the Wasatch Front's green infrastructure network lands (cores) as assets for economic development and quality of life by encouraging a change in land use along these core areas to more appropriate zoning such as open space and/or mixed use.
   i) Enact location-variable impact fees to offset infrastructure development costs for outlying properties. Consider updating adequate public facility ordinances (APFO's) to limit infrastructure costs initiated by cities.
   j) Modify design guidelines to reflect pavement reduction goals and porous pavement alternatives. Include planted islands, bio-swales, detention/retention basins, and grass or unit pavers to roundabout areas, turnarounds and parking areas
   k) Set impervious surface limits to development, including paved and roof areas, existing and new. Provide incentive programs for retrofits.
   l) Legislate street width limits to enable narrower streets and provide incentive programs for retrofits.

## MUNICIPAL IMPLEMENTATION STRATEGIES IN DETAIL

This section provides additional context and information on the recommended strategies that can help implement *(Re)Connect. (Re)Connect* does not provide specific targeted recommendations for "who should do what" but it does describe supporting actions.

*(Re)Connect* provides a variety of planning tools that can be used to facilitate discussions of green infrastructure potential. These toolkits and implementation strategies can be used by local officials, planners, developers, and residents to help identify important characteristics of green infrastructure in communities and choose the most appropriate planning strategies.

### ADOPT A MUNICIPAL-LEVEL GREEN INFRASTRUCTURE MAP

*(Re)Connect* has identified the green infrastructure network lands on a regional and county scale. As a next step, each municipality should undertake a more detailed inventory and analysis of green infrastructure features within their community. This is one of the best ways to identify what is valuable to a community and to begin to maintain, improve and connect those valuable green infrastructure resources. Each municipality should develop its own green infrastructure network map or maps, utilizing the framework and process outlined in *(Re)Connect* while accounting for specific criteria unique to that municipality.

At the moment, adopting a green infrastructure approach may be difficult and hard to fully comprehend or use because it isn't mapped. There is no record of urban and suburban green infrastructure in The Wasatch Front - specifically where they are, who owns them or what condition they are in. CABE, with support from fifteen organizations across the sector, wants central government to coordinate a single, shared national information resource or 'atlas' so that green infrastructure can be planned and managed strategically.

A municipal-level green infrastructure map identifies the types and locations of green infrastructure resources or assets that are valued by a community and its residents and warrant special consideration in the planning, designing and management of its lands. Much like a zoning map guides development, a green infrastructure network map guides the conservation, restoration, preservation, acquisition, maintenance and enhancement of beneficial lands and the establishment of a community's permanent green infrastructure network.

When a municipality adopts a green infrastructure network map, all parties involved in land use decisions can have a clear understanding of land use expectations, and a community can avoid inconsistencies as it grants approvals and makes other types of land use decisions. As a community builds out, developers understand where development is most appropriate, as the community has already identified its green infrastructure resource priorities. As development occurs, the municipality's green infrastructure system is realized.

The regional and county green infrastructure network maps developed in *(Re)Connect* provide a solid framework for maintaining, improving and connecting the region's green infrastructure resources. Some cities could choose to adopt these green infrastructure network maps, though most will want to add some detail, as *(Re)Connect* focuses more heavily on regional green infrastructure resources and criteria than on local ones. Each community's municipal staff should host an inexpensive event modeled on a visioning workshop to glean additional layers of detail for its network map or maps.

***How to Map a Green Infrastructure Network in your Municipality***

Creating a green Infrastructure network map is based on an easily understood approach. This approach, presented in *(Re)Connect*, helps a community understand, locate and evaluate its green infrastructure resources. *(Re)Connect* has already identified the regional resource categories commonly found and valued in Wasatch Front communities: ecological, hydrological, agricultural and recreational, and community. There may be other layers or asset categories which each municipality may wish to utilize, or further refine the criteria outlined in the Plan. Refer to Graphic 18, next page.

In 2003, the WFRC along with many partners including CGID completed The Regional Open Space Planning Study which identified lands and priorities within the five counties of the Wasatch Front related to open space. Open space is an integral component of green infrastructure, and the findings from the 2003 study should be recognized by Wasatch Front municipalities in the development and refinement of a municipal-level network map.

The report concludes that there is a strong preference toward offering high quality lifestyles through diverse open lands. The region's inhabitants are primarily concerned with protecting communities from hazards and have a strong desire to protect as many different resources as possible.

The three most "important" or valued landscapes to the region's communities include:

1. Mountains and foothills (preserving views and access)
2. Rivers and streams (recreation and continued clean water availability)
3. Great Salt Lake and its shoreline (recreation, wetlands, and agricultural lands)

*(Re)Connect*'s green infrastructure mapping approach allows a community to understand, locate and evaluate its unique green infrastructure resources in terms of ecological, hydrological, agricultural, recreational and community or cultural characteristics. Using an inclusive method to land assessment, *(Re)Connect*'s approach truly addresses all types of landscape resources, because every landscape falls within one or more of these green infrastructure asset typologies. When a community determines which of its green infrastructure resources are important for ecological, hydrological, agricultural, recreational and community or cultural reasons, a community gains valuable insight into the legacy it wants to preserve for future generations.

Dozens of specific types of green infrastructure fall within these five categories. For example, ecological green infrastructure includes slopes, drainages, geological features, wildlife habitat, vegetation, and ecological corridors. A particular community may exhibit all or some of these green infrastructure asset types, and some communities may want to add or further define green infrastructure asset types.

***Tips for Mapping Green Infrastructure in your Municipality***

*Be realistic* – growth is coming, it will have to go somewhere. Know how much you can handle and why.

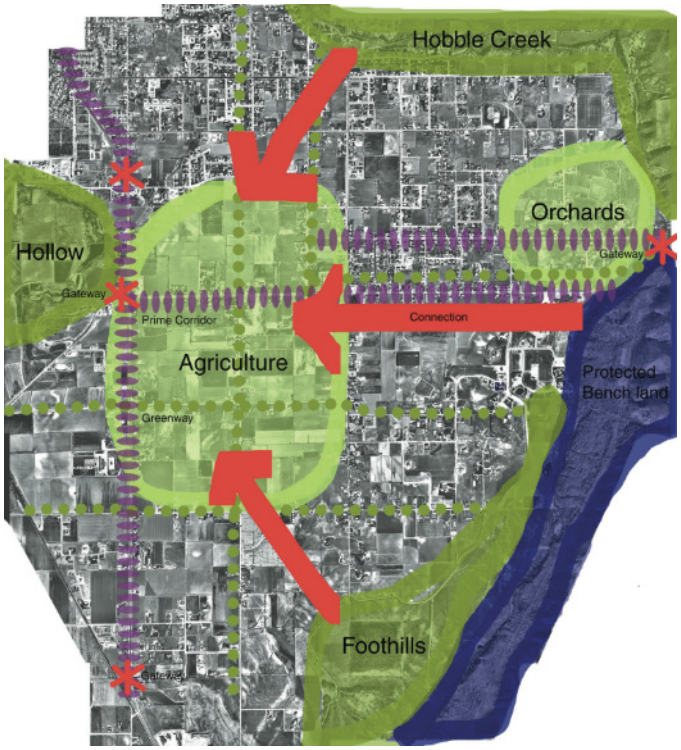
*Be idealistic* – don't settle for second best. Both green infrastructure and development must be considered completely, comprehensively, and with the highest standards.

*Get everyone behind a common vision* - for both how the landscape can change and how it should remain. This means consensus of ideals.

*Find champions* – Get people to carry the cause.

*Put your money where your mouth is* – Conserving land and planning for growth SAVES so much money, the savings should be reinvested back into the programs that protect it. Leverage your dollars, too. Find other sources to match your money for open space.

Go beyond green infrastructure – Work toward the overall goals of the community with this basic catalyst.




Graphic 18 Mapping Green Infrastructure

***GREEN INFRASTRUCTURE SHOULD:***

*Identify resource values* – Cover the five (5) green infrastructure resource categories to get all stakeholders involved. Participants should start to see the common ground.

*Reveal the importance of strategic land-use planning* – Economic, ecological, quality of life issues will all emerge. Emphasize the multiple benefits a single solution offers.

*Capitalize on a community's character* – Many times benefits are qualitative, not quantitative. Numbers can't sell a project, passion can. Community character often comes full circle to a measurable benefit, but how pleased citizens are with their community is a true asset.

*Agreement on what to conserve, how, and why* – Not everything can be protected or is worth protecting. Choose parcels and strategies that optimize the different values inherent in that landscape.

*Understand tradeoffs* – Green infrastructure can only be planned, designed and managed by a willingness to put the development somewhere else, often at a higher density. Sometimes it will cost money, too, if it is important enough. Understand the savings and benefits as well as the costs (maintenance, lower taxes).

*Commitment to realizing the network map* – Implementation should be foremost while crafting the process. Time must be committed to keeping the plan alive. Finding champions for the cause takes this burden off the consultant or staff. Patience is also a virtue. Change takes time and the map will change with refinements, but the spirit should remain intact.

***The Importance of Green Infrastructure Corridors***

The five green infrastructure resource categories (ecological, hydrological, agricultural, recreational and community) in a municipality can be thought of as jewels in a necklace — jewels which must not only be identified, planned, designed and managed, but must also be linked. Connecting corridors, sometimes called "greenways," complete the necklace. They are critical to a true green infrastructure network, which is an interlinked system of landscapes and connecting

corridors in and around a community that has been legally and permanently preserved. Without the element of connectivity, green infrastructure lands are merely a series of unrelated lands rather than an integrated, interconnected system. Once the connections are made and permanently preserved, a community has actualized a green infrastructure system.

Corridors typically make excellent walking, hiking, biking and running paths, as well as wildlife thruways. They allow people to move from one green infrastructure asset to another without leaving the network and should provide community members with convenient access to the many surrounding diverse landscapes.

***The Benefits of Shared Green Infrastructure Maps***

*(Re)Connect's* network maps have fulfilled the goal for a regional and county level green infrastructure network assessment and mapping process. But there is much green infrastructure asset information missing as they are virtually invisible in the Plan's regional data collection process and, in many cases, are non-existent. This absence of basic, critical information about green infrastructure makes it impossible to plan and manage this resource to its full potential. Without this municipal level green infrastructure asset and network information it is extremely difficult to maintain a strategic land-use planning view, coordinate and document the full suite of benefits provided, anticipate future needs and make decisions which benefit the quality of life for now and future generations.

The Wasatch Front will need a shared, comprehensive provision for green infrastructure so that regional and local government can support the better planning, design, management and maintenance of their assets and resources. This in turn will improve quality of life and many of the goals in *(Re)Connect*. A shared green infrastructure 'atlas' or map will inform decisions about investment, quantify the impact of spending by green infrastructure type, and allow better assessment of provision and benefits overall. This cooperative resource will provide the information required to adapt better to changing environmental and social needs. And it will provide the necessary data to track improvements over time and facilitate coordinated responses.

## DESIGN STRATEGIES FOR INCREASING COMMUNITY SUSTAINABILITY

Historically, the community development process in the Wasatch Front has been linear, starting with land acquisition, market analysis, engineering, and political constraints, and followed by conceptual planning, and detailed drawings and construction. At each step of this process, plans are compared with market and financial parameters and appropriate adjustments are made.

The difficulty with this approach is that there is no analysis, documentation or exploitation of the interrelationships among systems, neither built, natural nor social. Nature is not linear – it is cyclical and interconnected. Any impact on land form, soils, sunlight, hydrology, flora or fauna undulates through the others, often with unforeseen consequences (Kellenberg, Stephen). Progressive community designs today are incorporating high-performance standards, low impact development (LID) practices, green streets, reduced water and efficient irrigation systems, and energy conservation and generation, achieving savings and environmental benefits from each system. These strategies improve environmental health, economic stability and quality of life, all of which contribute to overall community sustainability.

Wasatch Front communities can project green infrastructure framework and inherent sustainable values into the future through their planning documents. A city's general plans and comprehensive plans embody their values. These public policy documents make statements about themselves and their desired future. Wasatch Front municipalities should strive for Place-Based Policy Improvements. Place based policies are unique to each community and can directly meet their specific goals and community needs.

In August 2009 a White House memorandum offered policy guidelines for interagency collaboration in support of place based policies:

> ***Effective place-based policies can influence how rural and metropolitan areas develop, how well they function as places to live, work, operate a business, preserve heritage and more.***

*(Re)Connect's* green infrastructure framework will trickle-down from regional and federal agencies to local municipalities and governments. Incremental changes over time, enabled by renewed conversations about sustainability and conservation and a commitment to asset-based land use planning, will facilitate the implementation strategies herein.

***Green Infrastructure Subdivisions***

A green infrastructure subdivision is very similar to conservation subdivisions and an alternative to conventional subdivision development patterns, which typically produce only house lots and streets. A green infrastructure subdivision is informed by valued green infrastructure resources present on the site, and the size and location of these valued green infrastructure network lands become the central organizing element when designing the subdivision.

While the overall "yield", or number of lots developed, remains the same, the lots are configured in a manner that conserve lands valued by a community as green infrastructure assets. Green infrastructure subdivisions can be seen as the building blocks of a community's green infrastructure network, as each subdivision can be informed by the overall municipal green infrastructure network map or maps. When green infrastructure subdivisions serve as building blocks of a community's green infrastructure network, the purpose for establishing a system of interconnected, benefit-providing lands within a development becomes clear, and a community can realize its system without being dependent on expensive acquisition programs.

> ***Green infrastructure subdivisions are attractive to developers as they offer lower development-related expenses with a high-quality, marketable product as the end result.***

***How can Wasatch Front municipalities implement green infrastructure subdivisions?***

*Adopt the Regional Natural and Social Green Infrastructure Network Maps -* The regional green infrastructure maps developed as a part of *(Re)Connect* provide illustrations for green infrastructure planning, design and management goals. To forward the goal of establishing a regional plan and to acquire the support of all local municipalities, each municipality in the Wasatch Front should adopt the regional natural and social green infrastructure maps.

*Adopt a Municipal-Level Green Infrastructure Map -* Each municipality should develop their own green infrastructure network map or maps – utilizing the framework and process outlined in *(Re)Connect* while accounting for specific criteria unique to that municipality.

*Adopt Clear Standards to Guide the Conservation Subdivision Process -* The green infrastructure subdivision style of development could be used to guide some or all future residential, commercial and retail development in a municipality, but a process to guide the design process should be adopted. There is more detail in the supplemental materials provided with this document and in general reviews of planning documents distributed at an earlier date, but to summarize, the usual planning process should be reversed.

*Developers should:*

a. Identify green infrastructure network lands.

b. Respecting these valuable green infrastructure network lands, identify potential areas for development and locate house sites.

c. Align streets and trails.

d. Draw in the lot lines, without concern for uniform lot size.

This sequence will enable developers to build the same number of house lots that zoning permits, and it establishes a means for open space conservation to occur utilizing simple design guidelines.

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***Communities should make sure that their green infrastructure values are reflected in both their general plans and subdivision regulations. While general plans usually do account for these beneficial lands, a means identifying them and designing around them are not usually present in subdivision regulations. The four-step design process highlighted above brings consistency to a community's planning documents.***

***What developers need is not a list of things they need to do but methods, costs, realistic life-cycle estimates, and detailed research and explanations that they can use to obtain financing and utilize as workable marketing tools. And importantly, they need professional design consultants and builders who are willing to do things differently. – Tony Wernke, Development Today***

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***The Economic Benefits of Green Infrastructure and Conservation Subdivisions***

Conservation subdivisions are a type of green infrastructure subdivision focusing on the conservation of green infrastructure features within a development. Conservation subdivisions preserve 50-70% of the buildable land, while still allowing the same maximum number of home sites as conventional subdivision development. Home sites are strategically placed for maximum views of green infrastructure lands.

Homeowners can enjoy the walking trails among the wildlife and natural lands. Conservation subdivisions provide an alternative to the destruction of the land from conventional grid style subdivision developments.

According to an article on conservation subdivisions in Big Builder magazine (May 1, 2006), "Leaving land in its natural state or building trails through it is cheaper than building infrastructure or golf courses. The results show that lots in conservation subdivisions carry a premium, are less expensive to build, and sell more quickly than lots in conventional subdivisions. Together, the results show that conservation subdivisions are more profitable to developers than conventional subdivisions. That lots in conservation subdivisions sold in about half the time as lots in conventional subdivisions must be advantageous to the cash flow of developers. These numbers translate into premiums for lots in conservation subdivisions ranging from $13,000 to $18,000 per acre over lots in conventional subdivisions."

Green infrastructure based, high-density developments are more cost effective to develop. [55] In terms of investment, a 1974 estimate found high-density investment fell 44% below that needed for low-density, sprawl development (Real Estate Research Corp., 1974).[56] More recently, an analysis completed by Robert Burchell and others at Rutgers University for the State of New Jersey compared typical development with a "planned development" alternative that would include a range of densities and housing types similar to green infrastructure approach development patterns (Gersh, 1996). [57] Projecting from 1990 to 2010, the analysis concluded that planned development could save taxpayers $9.3 billion in avoided capital, operation, and maintenance costs for roads, schools, and utilities. Meanwhile, 175,000 acres of land would also be saved.

Many studies have compared the costs associated with various development patterns. The South Carolina Coastal Conservation League (SCCCL), assisted by the Westvaco Development Corporation, compared the costs of developing a 96-acre parcel in a conventional pattern to the cost of developing the parcel using a high-density development pattern. The conventional development consisted of 242 single family homes on quarter-acre lots, a density of four units per acre, the highest density allowed in most residential zones (SCCL, 1993). [58]The high-density plan consisted of 333 homes with a mix of single family, duplex, quadriplex, and single-family homes built on third-acre lots, creating an average density of 6.5 units per acre. In the high-density development, 240 residences were placed within walking distance of a bus line, thoughtful planning considering that bus service is considered workable when density reaches 6 or 7 units per acre.

[55] The Benefits of Green Development. "Green Development Literature Search: Summary and Benefits Associated with Alternative Development Approaches." Located at the Smart Growth Network webpage, www.smartgrowth.org.

[56] Real Estate Research Corporation. 1974. The Costs of sprawl. Executive summary of the report The Costs of Sprawl: Detailed Cost Analysis, for the Council on Environmental Quality; the Office of Policy Development and Research, Department of Housing and Urban Development; the Office of Planning and Management, Environmental Protection Agency. April.

[57] Gersh, Jeff. 1996. Subdivide and Conquer: Concrete, Condos, and the Second Conquest of the American West. The Amicus Journal. (Fall):14-20.

[58] South Carolina Coastal Conservation League. 1993. Living the American dream: Density and home ownership. SCCL Land Development Bulletin. No. 3, March.

The study found that the costs of developing the conventional plan would be $26,000 per lot, compared to $16,000 per lot for the high-density plan. The cost savings in the high- density development are primarily attributed to savings in per-lot land costs and site preparation costs such as excavating, landscaping, grading, and paving. These cost- savings would be passed on to buyers. A homebuyer looking to purchase a 1,500 square- foot home in the conventional development would pay $95,000, while a home of the same size and quality would cost $82,000 in the high-density plan, a savings of 14%.

In general, there are three main components of residential development infrastructure: 1) road building; 2) storm drainage; and 3) water and sewer service (Schueler, 1995). [59] This infrastructure constitutes approximately half the cost of residential subdivision construction. High density development typically reduces infrastructure demands. For example, road length can be cut by 50% to 75%. In addition, narrower road widths reduce road surface area by 25% to 35%. [60]

Considering that each linear foot of road constructed costs an average of $100, high-density development patterns can produce significant cost savings. Table 3 provides examples of the unit cost for development infrastructure (Schueler, 1995).

| **Table 3 Unit Costs of Subdivision Development** | |
|---|---|
| **Subdivision Improvement** | **Unit Cost** |
| Roads, Grading | $22.00 per linear foot |
| Roads, Paving (26-foot width) | $71.50 per linear foot |
| Roads, Curb, and Gutter | $12.50 per linear foot |
| Sidewalks (4 feet wide) | $10.00 per linear foot |
| Storm Sewer (24-inch) | $23.50 per linear foot |
| Driveway Aprons | $500 per apron |
| Parking Spaces | $1,100 per parking space ($2.75/sf) |
| Clearing (forest) | $4,000 per acre |
| Sediment Control | $800 per acre |
| Stormwater Management | $300 per lot (variable) |
| Water/Sewer | $5,000 per lot (variable) |
| Well/Septic | $5,000 per lot (variable) |
| Street Lights | $2.00 per linear foot |
| Street Trees | $2.50 per linear foot |

Adapted from Site Planning for Urban Stream Protection, December 1995, prepared by Tom Schueler of the Center for Watershed Protection for the Metropolitan Washington Council of Governments.

***Conservation Subdivision Case Studies in the Intermountain West***

- Sundance Springs Bozeman, Montana
- Summit View Big Sky, Montana
- Nava Ade Santa Fe, New Mexico
- Rancho Viejo Santa Fe, New Mexico
- Mesa del Sol Albuquerque, New Mexico
- High Desert Albuquerque, New Mexico, River Valley Ranch Carbondale, Colorado

[59] Schueler, T.R. 1995. Environmental Land Planning Series: Site Planning for Urban Stream Protection. Department of Environmental Programs, Metropolitan Washington Council of Governments, 777 N. Capitol Street, Suite 300, Washington, D.C. 20002.

[60] See Reference 56

- Catamount Ranch Steamboat Springs, Colorado
- Lambert Ranch Douglas County, Colorado
- Highlands Ranch Highlands Ranch, Colorado
- Hidden Springs Boise, Idaho
- Civano Tucson, Arizona
- McDowell Mt. Ranch Scottsdale, Arizona
- Canyon Ridge Cave Creek, Arizona, Santa Fe Springs Prescott, Arizona
- Commercial Corner Flagstaff, Arizona
- Colonia Solana Tucson, Arizona
- Caughlin Ranch Reno, Nevada
- Blackhawk Station Park City, Utah
- Kayenta Ivins, Utah

***Transit-Oriented Development***

Wasatch Choice for 2040 and the Wasatch Front's long range transportation plan strongly advocate for the development and redevelopment of transit facilities and transit-oriented developments (TODs). TODs assemble commercial and residential hubs around transit facilities, decreasing resident reliance upon personal automobiles. TODs are usually accompanied by a decrease in pollution and other negative effects associated with sprawl and an increase in physical health associated with walking, biking and other activities (Fenton 2005).

Much of the Wasatch Front's growth in the past several decades has occurred on former agricultural land. Often, residential development occurs first, and then the demand for more roads, schools and other services follows. Low density development in the WF's rural and suburban communities reduces the economic viability of public transportation and residents predominantly rely on single-occupancy vehicles for transportation. Increased vehicle use reduces air quality. Wasatch front municipalities must look for ways to increase density and decrease distance of communities from existing infrastructure.

***Mixed-Use Development***

Mixed-use development allows for multiple uses within a neighborhood and its buildings. Many mixed-use developments include a combination of residential, retail and office spaces. Current zoning in many Wasatch Front communities prohibit a mix of uses, favoring instead separate residential and commercial zones. This Euclidean zoning leads to a decrease in community walkability, an increased reliance on personal vehicles, and a tendency toward sprawling, inefficient development. A mix of uses in a single developed area results in compact development that makes more efficient use of infrastructure and transit opportunities, increasing walkability and improving sense of community.

***Urban Infill***

Urban infill is the process of developing vacant and underutilized land in areas that are already covered by municipal services and grey infrastructure. Vacant properties have great development potential. When left undeveloped, they are a threat to any community, straining the local economy by their mere existence. As noted by the National Vacant Properties Campaign in Vacant Properties: The True Cost to Communities (2005):

*"Vacant properties strain the resources of local police, fire, building, and health departments, depreciate property values, reduce property tax revenue, attract crime, and degrade the quality of life of remaining residents."*

Urban infill is a widely popular planning strategy because it addresses these problems while helping to protect agricultural land and green infrastructure by redirecting growth into more centralized cores. Infill development will serve to protect the Wasatch Front's outlying farms and forests and reduce the impacts of sprawl on lakes, streams, climate and air. Infill development can range from a single parcel to a large-scale development project; it can include recreational resources, employment centers, and residential development. Reinvesting in existing communities and utilizing existing resources benefits the entire region.

There are many land use planning terms often associated with infill development which also meet the goals of reconnect and a green infrastructure framework. These include:

Brownfield–Formerly industrial or commercial properties that are contaminated, or perceived to be contaminated, in some way and would require special clean-up before development can occur.

*Greenfield*–Undeveloped open space or agricultural land.

Grey*field*–Commercial or retail properties that have become old, obsolete or abandoned (i.e. abandoned 'big box' stores and strip malls).

*Improvement/Land Value Ratio (I/L Ratio)* – The value of a parcel's improvements (buildings or other structures) divided by the value of the land. This ratio helps determine the economic utility of the parcel.

*Land Suitable for Infill*– All vacant, partially-used, and underutilized land within populated places that is zoned commercial, industrial, or residential that is not for public use and is not restricted by other factors (such as environmental concerns).

*Partially-used Land*– Parcels of land that are occupied by a use consistent with zoning, but which contain enough land to subdivide into more parcels.

*Recyclable Land*– Developed and improved parcels that are economically underutilized.

*Underutilized Land*– Parcels of land that are zoned for more intensive use than that which currently occupies the property, as determined by the Improvement to Land Value Ratio (I/L Ratio).

*Vacant Parcels*– Parcels of land that may be publicly-or privately-owned, have no structures, or have structures of very little value, and are not designated open space or agricultural land. The structures may be abandoned, boarded up, or partially destroyed.

***The Economic Benefits of Urban Infill***

Without considering the public and social costs, sprawl makes more economic sense than infill redevelopment. One estimate conducted for the Bay Area in California suggests that the costs of sprawl to the developer are on the order of $100-132 per square foot, while infill redevelopment costs come in at around $163-191 per square foot -- about 50% more (Bragado, et al., 1995). The savings are associated with lower land, construction, and parking costs and lower permitting and design fees for developments in outlying areas (see Table 4). However, experience over the last 30 years, has shown that the social costs of sprawl are significant -- primarily from loss of ecosystem-service providing lands and agricultural lands, greater reliance on vehicles, blighting of urban centers, higher resource consumption (i.e. energy and water), greater infrastructure costs, and higher costs of services.

| Table 4 Development Costs | | |
|---|---|---|
| **Sprawl versus Infill Development – 1993 Estimates for Bay Area, California (Dollar $ / Square Foot)** | | |
| | **Infill Development** | **Sprawl Development** |
| Land | $15-$20 | $8-12 |
| Site Preparation | $5-10 | $5-10 |
| Construction | $60-65 | $45-55 |
| Parking | $15-18 | $0 |
| Soft Costs (permits, fees, etc.) | $32-37 | $20-26 |
| Contingency 5% | $6-7 | $4-5 |
| Subtotal | $133-157 | $82-108 |
| Profit 15% | $20-23 | $12-16 |
| Marketing | $10-11 | $6-8 |
| Total Cost | $163-191 | $100-132 |
| Source: Bragado, et al., 1995. | | |

***Loss of Open Space and Agricultural Lands***

With decentralization and sprawl development, the West's farmland is rapidly disappearing. A study by the American Farmland Trust has estimated that the U.S. is losing about 50 acres an hour to sprawling developments. If this trend continues, the Trust estimates that 13% of prime U.S. farmland could be redeveloped by 2050 (Longman, 1998). The consequences of this trend have been hotly debated. With increases in productivity, the U.S. has been able to grow more crops with less land and labor (Gordon, 1998). Part of the problem, however, is what land is being lost. Between 1982 and 1987, the Central Valley—California's leading agricultural region—lost almost a half-million acres of productive farmland (Bank of America, 1996). Some of this land can be replaced by bringing new land into agricultural production, but often at high economic and environmental cost. In addition, loss of agricultural land in close proximity to urban centers represents a loss in efficiency and a loss in ability for small farmers to easily sell their fruits and vegetables in local markets. Out of a total of about 250 million acres of cultivated farmland in the U.S. only 48 million areas are within 50 miles of the 100 largest urbanized areas (Nelson, 1992b).

***Greater Reliance on Vehicles***

Sprawl leads to an increase in vehicle dependence, which has both social and private costs. Since 1970, population density has been steadily declining in the U.S. with this decline in density, has come a greater reliance on the automobile. From 1970 to 1996, the mileage people drive has grown four times as fast as the population, and twice as fast as licensed drivers. The number of cars has also outgrown the population. During the same time period, the number of cars grew by more than 97 million, while the population increased only 61 million (USA Today, January 16, 1998).

| Table 5 Increase in Population, Vehicles, Drivers, and Miles Driven From 1970-1996 | | |
|---|---|---|
| | **1996 Total** | **% Increase from 1970** |
| Miles Driven | 2.5 trillion | +123% |
| Vehicles | 205.4 million | +90% |
| Drivers | 179.5 million | +61% |
| Population | 265.3 million | +30% |
| Source: USA Today (1/16/98) | | |

The U.S. is currently one of the most car dependent nations in the world, with private ownership rates about twice those of Western Europe. The cost of owning a car can be a financial burden on families. Owning and operating a car costs about $3600 a year (Durning, 1996), which translates to about 16-20% of total household expenditures (Young, 1995). Put another way, a median income family would spend 27 hours a month working to pay for the 32 hours a month they spend on average in a car (Durning, 1996).

Living in the suburbs does not necessarily translate into more driving. With many industries and companies locating themselves in suburbs, most commuting now takes place suburb-to-suburb (Gordon, 1998). Nonetheless, studies show as much as a doubling of vehicles miles traveled (VMT) per capita for people living in sprawl-like development compared to older transit-oriented development (Calthorp, 1993). In addition, uses of other modes of transportation (i.e. biking, walking, using the bus or other forms of public transit), are significantly less in sprawl development. Some would argue this simply reflects that cars are a superior choice of transportation – neglecting the fact that more than 32% of the US population can't drive (10% excluding children under 16) (Littman, 1998). Sprawl development can be designed to be more pedestrian, bike and public transit friendly, recognizing, however, that the viability of these alternate modes of transportation (beyond recreational uses) is highly affected by density, or the lack thereof.

Driving also has costs associated with loss of habitat, congestion, resource consumption, and a decline in air quality. The social costs of the increased reliance on the automobile in the U.S. have been estimated to be as much as $184 billion a year (Cobb, 1998), which does not even include productivity losses from congestion or tax revenue losses from land used for roads. Cobb's estimate of damages includes $36 billion in uncompensated damages from accidents, $40 billion in road maintenance costs not covered by tolls and user fees, $19 billion for defending oil supplies, and $89 billion in environmental damages (see Table 6). Of the total environmental damages, $62 billion are estimated to be from health effects, visibility loss, and crop damage resulting from air pollution. Traffic congestion is also costly in terms of fuel loss and time loss. The average worker now spends about 9 hours per week, or more than a full working day, traveling in a car due to increased commuting times and congestion.

| **Table 6 U.S. Subsidies for Driving (in $ Billions)** | |
|---|---|
| **Direct Subsidies** | **Indirect Subsidies** |
| Highway construction, maintenance and services (less user fees and tolls) - $31 | Accidents (uncompensated deaths, injuries, and medical expenses) - $36 |
| Local streets and services - $9 | Air pollution - $62 |
| Strategic Petroleum Reserve - $1 | Water pollution - $6 |
| Military protection of oil supplies - $18 | Noise pollution - $8 |
| *Total Direct Costs $59* | Global warming - $13 |
| | *Total Indirect Costs - $125* |
| TOTAL COSTS - $184 | |
| *Source: Cobb, 1998* | |

***Blighting of Urban Centers***

The movement away from urban cores also has costs. Downs (1988) makes a strong argument for how government policies and peripheral growth have directly exacerbated problems of intensive concentrations of poor households in central portions of our metropolitan areas. Unlimited sprawl removes new jobs from accessibility by unemployed inner-core residents; fragmented controls over land use permit exclusionary zoning policies; and cities designed for cars deprive poor people and non-drivers of mobility (Downs, 1998).

Urban disinvestment translates into lost sales and property tax revenues. Empty urban lots are also targets for arson, graffiti, and other types of crime. Surrounding businesses and properties often lose value due to the crime and stigma associated with vacant lots. Today, it's not just an issue of movement away from the urban core, many metropolitan areas are now seeing problems of blight and abandonment in areas of what policy experts call the inner-ring suburbs – suburbs developed 20-30 years ago now surrounded by new development. Lacking the newness of suburban development on the outside, and without the quality of housing stock and cultural amenities that help fuel downtown revitalization, experts fear some of these areas could become islands of urban decay (Anton, 1998).

***Higher Resource Consumption***

Energy consumption is affected by the size of homes and business spaces, as well as what is called the "shared-wall" phenomenon where townhomes and apartments can enjoy much lower heating bills than freestanding homes. Per capita water consumption, particularly in arid climates, goes up dramatically for homes with larger lots and lawns that need watering.

A recent study by the City of San Jose, California tried to estimate the savings associated with implementing growth restrictions to limit sprawl. If the city had not implemented an urban growth boundary, an estimated 3,000 homes would have been built in outlying areas. These homes would have resulted in 200,000 additional vehicle miles by commuters, 3 million additional gallons of water and 40% greater energy use for heating and cooling each day (Allen et al., 1996).

***Higher Infrastructure Costs and Costs of Services***

The cost of providing infrastructure and municipal services is higher with sprawl or non-compact development. Studies in California and Florida have shown these extra costs to be on the order of $20,000 per residential unit (Nicholas, et al., 1991 as cited, p. 1). Similarly, study by Rutgers University comparing a sprawl development in New Jersey with a more compact infill development found a differential of about $25,000 per residence (Bragado, et al., 1995). Another study, looking specifically at sewer hookups cost found that in Tallahassee, Florida, sewer hookups cost $11,433 in suburban areas compared to $4,447 for the mostly black, center-city neighborhoods nearest the sewage treatment plant. Despite this nearly $7,000 difference in real cost, all households pay the same price of about $6,000 for sewer connection. The urban residents paid $2,000 extra in hookup costs, while suburban homes received a subsidy of $5,000 (Longman, 1998).

Costs of services to different areas of a municipality are also influenced by location. Simply put, the further away developments are from the service centers that serve them, the more costly it usually is to provide those services. Another critical issue facing communities is whether new development occurs in areas where existing facilities, namely schools, libraries, parks and police stations can absorb capacity. Cities witnessing both rapid suburban growth and urban disinvestment at the same time can have situations where taxpayers are paying for new facilities while other facilities are being underutilized. Between 1970 and 1995, the number of public-school students in Maine declined by 27,000, yet the state spent more than $338 million building new schools in fast-growing suburban towns (Longman, 1998).

Finally, street connectivity and route distance can be more influential than physical proximity. The maze-like effect of cul-de-sac development, for example, makes it more time consuming and expensive for police to watch neighborhoods on the beat. Rarely, however, do communities try to quantify these differences and make different areas pay appropriately. Paying the Costs of Sprawl: Using Fair-Share Costing to Control Sprawl by Ken Snyder and Lori Bird, December 1998.

***Urban Forestry***

The benefits of trees are becoming better known. Trees provide clean air and water, provide shade which cools roads, parking lots and buildings, mitigate storm water runoff effects, provide biodiversity and wildlife benefits, and increase real estate values.

Urban and suburban tree canopy coverage rates vary between each of the cities of the Wasatch Front and even between neighborhoods within a city. The American Forests national forest advocacy group recommends that suburban residential areas have at least 50% canopy coverage rates, while urban residential areas have 25% coverage and urban downtowns have 15% coverage. This issue of urban forest canopy coverage is an important component of the ability of urban corridors to provide connections between a municipality's and the region's green infrastructure network core and hub areas.

***Greenways***

Greenways, and blueways or 'esplanade reserves', are an effective method to provide multifunctional use and multiple benefits to the Wasatch Front's communities. A greenway, in the context of *(Re)Connect*, is defined as "linear open spaces or parks along rivers, streams, ridgelines, or historic infrastructure corridors such as canals or railroads that shape urban form and connect people with places" (Urban Greenways. Lindsay, Wilson, Yang and Alexa).

## PLANNING TOOLS FOR FACILITATING GREEN INFRASTRUCTURE IN YOUR COMMUNITY

There are many types of planning and policy mechanisms which can be utilized by municipalities to plan, design and manage their networks of green infrastructure resources.

***Conservation Easements***

A conservation easement is a permanent restriction placed on a piece of property to protect the resources or functions – natural or manmade – associated with the parcel. In the case of green infrastructure, the easement precludes future real estate development and identifies permitted and prohibited uses.

A conservation easement is a legally binding, voluntary agreement on the part of a landowner that prevents development and limits certain uses while preserving the property's green infrastructure values in perpetuity. Conservation easements often provide landowners with tax benefits while allowing them to retain many private property rights and to live on or use their land. Easements can be individually tailored to meet a landowner's needs, providing benefits to all parties involved as well as the environment.

***The Benefits of Conservation Easements***

- A legacy building tool
  - Over time, 50% of remaining lands would be conserved
- Great assurance for homebuyers that open land will remain open
  - We know that the "swing" areas will be at least half green
- Great for landowners desirous of conserving their lifestyle
  - Working landscapes get the acreage they need
  - Charitable tax treatment provides advantages

***Conservancy Lots***

A conservancy lot is a large, privately owned lot that encompasses part of an area identified as a green infrastructure asset. The purpose of the conservancy lot is to provide surrounding residents with visual access to green infrastructure lands while keeping the land under private ownership and maintenance. Only a small, delineated portion of such lots may be developed; the remainder must be protected through conservation easements and used in conformance with the municipality's standards for green infrastructure resources.

***Transfer of Development Rights (TDRs)***

Transfer of development rights (TDR) programs are attracting increasing attention throughout the United States, particularly in the West. Many Western communities are growing rapidly and are looking for ways to balance resource and open space protection with concern over property rights.

When designed correctly, TDR programs, which seek to shift permissible development densities from unsuitable development areas to more appropriate sites, can be an effective growth management tool. By creating off-site "receiving area" markets for the sale of unused development rights, TDR programs encourage the maintenance of low density land uses (like farming), valued green infrastructure, and sensitive features of designated "sending areas."

When a landowner in a sending area sells development rights to another landowner in a receiving area, the purchaser thereby augments his development rights in excess of his otherwise permissible limits. In this manner, local governments can protect a variety of sensitive features while providing a mechanism to help offset any perceived diminution in land development potential.

***A transfer of development rights is the process of transferring the right to develop one parcel of land to a different parcel of land in order to protect natural or agricultural attributes of the first parcel. The parcel where the rights originate is known as the "sending" parcel, and the parcel to which the rights are transferred is called the "receiving" parcel.***

***After the TDR is completed, all or part of the sending parcel becomes protected by a conservation easement, and the owner of the receiving parcel is often allowed to develop at a higher density than typically allowed by the base zoning.***

***Benefits of a TDR Program***

A TDR program provides a mechanism to conserve valued green infrastructure lands while making sure that landowners maintain the right to benefit financially from the development rights that they have per current zoning. Landowners would simply "send" their development rights from their property to an appropriate receiving zone, gaining an opportunity to "cash in" where development is needed and wanted. They would continue to own their land, but a conservation easement would be placed on it in exchange for the right to develop at a slightly greater density in a designated receiving area. Appropriate receiving zones seem to be the cities and more populated "nodes" within the unincorporated county.

Since there is not a lot of density associated with the lands people want to conserve, the impact on the cities and nodes would be minimal but could serve to benefit the revitalization and development goals of some locales. Conversely, the resulting conservation of agricultural uses and green infrastructure in the county would be substantial, as removing even small amounts of density would ensure the viability of agricultural and other green infrastructure systems.

- TDR programs permit a landowner to separate and sell the right to develop to a third party (i.e. transfer this right to another).
- Realize economic value of land (often viewed as a landowner's 401K)
- Allow land to be assessed at a lower tax rate, decreasing property and inheritance taxes on the land
- Maintain current use of land

***Implementing a TDR Program***

A TDR program could be implemented in a number of ways. One possible scenario follows:

The county enters into inter-local agreements with interested municipalities.

The county downzones county lands identified on the regional green infrastructure maps adjacent to participating municipalities, creating incentive to move development off of these lands. These lands become the sending areas.

Determine the number of TDRs available. Landowners in the sending areas maintain their development rights in the form of TDRs. The number of TDRs each landowner could equal the number of development units held prior to the downzone.

Note that minor subdivisions for family estates should still be accommodated. Families should have the right to plan whatever lots they anticipate needing for family homes in a single plan. Once this plan is completed, the rest of the land should be placed in an agricultural conservation easement or other easement designation. This enables families to provide for anticipated housing needs but does not allow for multiple subdivisions of property, as this erodes agricultural, for instance, use over time.

Participating cities or population nodes become the receiving area for all TDRs associated with their adjacent lands. Cities will know where development should occur within their city limits based on their green space design. Areas identified as green infrastructure network areas and areas designated for conventional style development can become receiving areas.

Participating cities must restrict zoning changes until TDRs are exhausted, so that there is incentive for developers within the city to purchase TDRs. A system of TDR exchange ought to be set up among participating municipalities and the county, so that areas desiring/needing more growth can acquire TDRs from areas that do not.

TDR ordinances for residential development have proven to be extremely difficult to implement in most localities for several reasons. When the size of local governmental units administering land use regulations is relatively small, the ability of those local governments to designate sufficient low density “sending districts” and high-density "receiving districts" in locations appropriate in terms of physical infrastructure, environmental limitations, and political acceptability is severely constrained. The result is a very small market in which to buy and sell the development rights.

A second reason for the general difficulty of implementing TDR systems is that, when most urban-fringe lands are already zoned at relatively low densities, the number of potential new dwellings that would need to be accommodated within TDR "receiving districts" becomes extremely high, unless only a small part of the rural area were to be protected in this manner. The experience of TDR systems typically is that the "sending districts" (to be preserved) should be relatively modest in scale so that they will not overwhelm the "receiving districts" with more dwelling units than they can reasonably handle. For this reason, TDRs are inherently limited to playing only a partial role in preserving a community's undeveloped lands, and they should therefore be viewed as a tool for only occasional use. Experience suggests that TDRs work best at a countywide or equivalent level, or where rural zoning densities are typically much lower (e.g., 20 or more acres per dwelling) than those in nearby built-up areas.

The logic of transferring development rights from an area in need of protection to one more desiring development remains strong. Yet real-world problems have hindered municipalities to even adopt these policies in the Wasatch Front. Though this strategy is best suited for large land-holding developers, and the market demand must be present, TDR’s offer a viable opportunity for municipalities to maintain, improve, and connect their economically productive and quality of life benefitting network landscapes.

***Purchase of Development Rights (PDRs)***

Local government purchase of development rights is inherently limited as an area-wide open space preservation tool by municipal budgets already straining to provide basic services. However, PDRs provide an excellent way for a municipality to conserve an entire high-priority parcel or vital connecting link in the community’s green infrastructure on an occasional basis, and for this reason they can play a critical supporting role in protecting individual properties of great local significance. Some communities have found widespread public support for proactive open space preservation and have established special property tax levies or sales tax surcharges earmarked for acquisition.

***Performance Zoning***

Performance zoning is based on the concept of providing a level of performance that developers must show evidence that they can meet prior to approval of their project. Tied directly to green infrastructure implementation strategies such as permeable pavers, green streets and retention basins, a developer is awarded ‘points’ for green infrastructure network planning and design efforts which can lead to density bonuses or other bonuses.

Performance zoning is not cluster-zoning - performance zoning establishes qualitative performance standards (e.g. on-site retention targets, impervious surface square footage) and developers are given flexibility in how they address and meet these standards.

***Exclusive Use Zoning***

Typically utilized in agricultural zoning regulations, exclusive use zoning places restrictions on the land. Much of the Wasatch Front's urban corridor overlays prime agricultural soils. Though down zoning from residential to agricultural use is politically challenging, voluntary decisions by landowners, encouraged through incentives (tax) and partnerships (non-profit land managers), will promote important diversity in municipalities.

***Limited Development***

In this strategy, a developer's unit density is limited to protect important green infrastructure resources. This strategy will require the use of updated planning and zoning tools. Limited development will work best in the Wasatch Front if there are subsidies from municipalities or non-profit organizations to truly ensure a 'limited' outcome.

***Community Preservation***

As a legislative act, a Community Preservation Act would allow communities to establish a local real-estate surcharge to set aside money for green infrastructure land-use planning actions. This must be enacted by the State and will provide matching funds to communities through recording fees at a county level.

***Heritage Based Rural Development***

Helps build sustainable communities and strengthen regional economies though the conservation, use, and promotion of historic and cultural assets. These assets may include buildings, structures, artifacts, districts, Main Streets, farmsteads and landscapes, as well as regional arts, crafts, music, food, and events. (Forum Journal, Winter 2010)

The Wasatch Front will need to draw on regional assets, including natural, heritage and cultural assets, to uncover innovative and unique sources of competitive advantage. Rural development has been aided in other regions by strong leaders and a sense of entrepreneurship. Successful strategies include historic building renovations, agricultural-tourism, heritage place-mapping, historical tourism, and a strong heritage-based marketing and incentive programs.

***De-Annexation***

This strategy includes readjusting municipal boundaries to shrink infrastructure service areas and reduce costs.

***Decommission***

A beneficial strategy as it will remove surplus public infrastructure and limit municipal services. This reduces costs for maintaining infrastructure and providing services to developments that have been abandoned.

***Service Transfer***

Transfer service responsibility to private entities such as homeowner associations. This puts the burden of municipal services to the private sector to reduce municipal costs.

***Mitigation***

*(Re)Connect*'s framework and green infrastructure network maps can help cities and agencies achieve tangible benefits from ecosystem services. The Plan has identified the highest quality green infrastructure lands these are areas where environmental, social and economic impacts could be offset.

Should mitigation be a land-use planning option, *(Re)Connect* offers a mitigation selection process which will comply with regulatory requirements, but will also yield the greatest benefit for the overall green infrastructure networks while remaining economically prudent given the proposed impacts from potential developments.

Mitigation can be project-specific or multiple project-based and can include 'land banking' strategies. *(Re)Connect* does not recommend in-lieu fee or off-site mitigation, especially for existing wetlands or aquifer recharge/discharge areas.

***Hillside Zoning***

If residential development should occur on hillsides, the density should be 5 acre minimum parcel size. This retains visible viewsheds and reduces erosion impacts from tree removal.

***Permeable Pavement***

Permeable pavement comes in four forms: permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers. Permeable concrete and asphalt are similar to their impervious counterparts but are open graded or have reduced fines and typically have a special binder added. Methods for pouring, setting, and curing these permeable pavements also differ from the impervious versions. The concrete and grid pavers are modular systems. Concrete pavers are installed with gaps between them that allow water to pass through to the base. Grid pavers are typically a durable plastic matrix that can be filled with gravel or vegetation. All of the permeable pavement systems have an aggregate base in common which provides structural support, runoff storage, and pollutant removal through filtering and adsorption. Aside from a rougher unfinished surface, permeable concrete and asphalt look very similar to their impervious versions. Permeable concrete and asphalt and certain permeable concrete pavers are ADA compliant.

Of all the green streets practices, municipal DOTs have been arguably most cautious about implementing permeable pavements, though it should be noted that some DOTs have, for decades, specified open-graded asphalt for low use roadways because of lower cost; to minimize vehicle hydroplaning; and to reduce road noise. The reticence to implement on a large- scale, however, is understandable given the lack of predictability and experience behind impervious pavements. However, improved technology, new and ongoing research, and a growing number of pilot projects are dispelling common myths about permeable pavements.

***Permeable pavement roadways often raise concerns of safety, maintenance, and durability. Municipalities can replace impervious surfaces in other non-critical areas such as sidewalks, alleys, and municipal parking lots. These types of applications help municipalities build experience and a market for the technology.***

The greatest concern among DOT staff seems to be a perceived lack of long-term performance and maintenance data. Universities and DOTs began experimenting with permeable pavements in parking lots, maintenance yards, and pedestrian areas as early as twenty years ago in the U.S., even earlier in Europe. There is now a wealth of data on permeable pavements successfully used for these purposes in nearly every climate region of the country. In recent years, the cities of Portland, OR, Seattle, WA, and Waterford, CT and several private developments have constructed permeable pavement pilots within the roadway with positive results. SOURCE EPA Managing Wet Weather with Green Infrastructure Municipal Handbook, EPA GREEN STREETS.

Freeze/thaw and snow plows are the major concerns for permeable pavements in cold climate communities. However, these concerns have proven to be generally unwarranted when appropriate design and maintenance practices are employed. A well designed permeable pavement structure will always drain and never freeze solid. The air voids in the pavement allow plenty of space for moisture to freeze and ice crystals to expand. Also, rapid drainage through the pavement eliminates the occurrence of freezing puddles and black ice. Cold climate municipalities will need to make adjustments to snow plowing and deicing programs for permeable pavement areas. Snow plow blades must be raised enough to prevent scraping the surface of permeable pavements, particularly paver systems. Also, sand should not be applied.

Costs vary depending on material use, soil type, and size of the paved area. The sometimes higher cost of construction is offset by the avoided costs of maintenance and sewer improvements that would have been needed if the alleys were redesigned and resurfaced with impermeable pavement. In addition, the cost of alternative paving materials is decreasing as they become more common. The 2008 cost of permeable concrete in Chicago is about $100 less per cubic yard than it was when the program began in 2006. Center for American Progress, its Easy Being Green: Chicago's Alleys Get a Makeover, April 23, 2008, available at http://www.americanprogress.org/issues/2008/04/green_alleys.html

As residents experience environmental improvements in their neighborhood, awareness increases. In addition, exposure to stormwater management increases the likelihood that residents will consider the use of other complementary practices such as rain barrels and rain gardens on their properties.

### *Enable a Permeable Pavement Retrofit Policy and Incentive Program*

With so many paved surfaces in the urban environment, there are plenty of opportunities to retrofit sidewalks, driveways, parking lots, plazas, roads, and alleys with permeable materials. Paved surfaces fall into two categories from a retrofit policy perspective: paved surfaces on private property and publicly owned paved surfaces.

Publicly owned paved surfaces account for a large portion of the impermeable cover in urban areas. The City of Chicago, for example, has over 1,900 miles of alleys. Because many of these alleys were not built with connections to the combined or storm sewer system, stormwater pools on paved surfaces, often flooding nearby garages and basements. Conscious Choice: Chicago's Green Alley Program, March 2008, available at

http://www.consciouschoice.com/2008/03/commish0803.html.

Retrofit policies can gain greater community support when they directly address local needs or concerns. For example, if water supply is a local concern, the infiltration capacity of green infrastructure practices to recharge groundwater and/or the benefits of rainwater harvesting in conserving potable water sources should be emphasized. If energy costs are a local concern, energy savings associated with green roofs should be clearly communicated.

To date, green infrastructure retrofit policies have largely been driven by municipalities' immediate regulatory concerns with CSOs and stormwater runoff. However, future programs to encourage retrofits should capitalize more fully on the multiple benefits provided by green infrastructure. Each jurisdiction has its own set of unique challenges and opportunities, and successful green infrastructure retrofit policies capitalize on those opportunities to develop creative and sustainable solutions.

***Culvert Replacement***

Many old culverts under roads don't allow migrating fish to pass through, and can cause flooding and erosion during heavy rains. Replacing them with culverts designed to allow fish to pass through makes more habitat accessible to native fish. It also restores a more natural stream flow that helps the ecosystem and protects property.

***Re-Vegetation***

Restoring native plants and trees in natural areas and open spaces provides healthy habitat and better water filtration. Re-vegetation makes urban forests more fire-resistant and better able to adapt to climate changes. Regular natural area maintenance costs less than restoring degraded land, and creates healthy natural areas for future generations.

## MUNICIPAL IMPLEMENTATION SUMMARY

Green infrastructure and sustainable community design involves connecting upfront with the larger social, environmental and economic context of a project. If a municipality is not prepared to nurture and augment a new addition to its community, *(Re)Connect* recommendations, including LID's and other innovative strategies, will go unheralded, and green infrastructure services and benefits may deteriorate. Future development in the Wasatch Front should seriously consider site selection and location. A development next to a transit corridor will generate less pollution. Locating housing close to jobs will reduce vehicle miles traveled. A green infrastructure approach to land-use planning understands and optimizes the relationship of a development to its surroundings.

A green infrastructure approach is enabled by many of the implementation strategies in this chapter, which include ecological enhancements (source- making the case for ecological enhancements – a white paper, Jan 2004, ITRC). These enhancements increase the natural and social green infrastructure network resources while protecting human health. It is important to remember that these implementation strategies are not 'one size fits all', and site-specific considerations as well as comprehensive evaluations must be objectively studied.

Green infrastructure and sustainable communities will require collaboration between multiple disciplines and stakeholders, especially during the initial stages of planning. Designers and developers will be challenged within *(Re)Connect*'s strategic framework to consider new strategies, systems, and products that better support sustainable outcomes and lead to a productive and beneficial relationship between communities and their natural and social green infrastructure systems.

***The Wasatch Front must recognize the economic value of its green infrastructure networks by strengthening existing communities and encouraging new development and redevelopment that supports the integration of social, environmental and economic concerns.***

Green infrastructure planning will require a shift in the mindset of municipalities. *(Re)Connect*'s many benefits can only be realized if both regional and local decision makers are open to a slightly different view of the Wasatch Front's resources, one where interconnectivity and cause/effect are part of every decision. If this adjustment does not occur, the developer and their design team will abandon performance practices and new, efficient technologies in the face of schedule constraints, budgetary restrictions (Kellenberg, Stephen–ULI, Developing Sustainable Planned Communities).

As discussed, this mindset must occur at the top with our regional public land agency stakeholders; otherwise municipalities will not be empowered to make tough and unfamiliar, yet beneficial, decisions. Together, partners can work to implement *(Re)Connect's* green infrastructure approach to projects, development and conservation. In doing so, substantive contribution to water quality, livability and ecosystem health and recovery can be made that are sometimes missed when regulations are administered on a project-by-project basis. Although *(Re)Connect's* green infrastructure approach can have significant and tangible benefits to the environment and the public, and has the potential to promote improved interagency coordination, it cannot completely eliminate conflict. Instead, *(Re)Connect*'s green infrastructure approach should viewed as a tool to assist partners in developing acceptable solutions that complement their goals.

***"Planning alone is not the final answer. But without wise and far-sighted planning, there can be no answers. How wisely, or wastefully, we use the heritage of our land, is not solely the responsibility of the planner, the developer, the builder, the community official. It is the responsibility of all of us, who are the American community" - Urban Land Institute***

Municipalities are important to the success of *(Re)Connect* because of their role in land use decisions, which ultimately influence the livability of communities and quality of life for their residents. Proactive planning will be essential to *(Re)Connect's* municipal implementation success. Localized planning strategies in the Wasatch Front's communities must cease to be reactionary. A willingness to embrace change involves taking risks, but there are ways to mitigate those risks; the best is to get involved in the process.

Many state and local green infrastructure projects throughout the United States, although relatively new, have already enjoyed wide success engaging public and private partners as well as the general public. (www.serconline.org/grInfrastructure/fact.html) From 1998 to 2001, voters across the U.S. passed nearly 400 measures funding conservation programs - some 85% of all local and statewide conservation measures placed on ballots. Green infrastructure's conservation measures, which provide direct economic benefits to individuals, constitute successful conservation initiatives.

Growth over the next 30 years in the Wasatch Front must proceed in a different direction from that of the last 30 years. This new direction will be made possible by the recognition that the green infrastructure systems of the Wasatch Front are held together by more than just a series of infrastructure projects – that these systems truly form the connective tissue that sustains life and health for the region and its communities. *(Re)Connect: The Wasatch Front Green Infrastructure Plan* is not just about today; it is about instilling the framework and vision for a healthy landscape, both built and natural, that we can move toward progressively and sustainably. We must remember our history and reconnect with the strategies and the land ethic that worked well for our ancestors. We must embrace new technology, while retaining an understanding of natural systems and processes and cultivating the stewardship of our valuable landscapes.

Green infrastructure design, planning and management principles must not be an afterthought. *(Re)Connect's* success will require proactive individuals, policy, incentives, and funding which address the land-use decision making process in relation to the broader ecological, infrastructural and social processes and systems that constitute our landscape.

The ability of *(Re)Connect's* implementation strategies to deliver multiple environmental, social, and economic benefits makes *(Re)Connect* a valuable planning tool for promoting community health, quality of life, and sustainability.

# APPENDIX A. STAKEHOLDERS

## EXECUTIVE COMMITTEE

| *Last Name* | *First Name* | *Agency* |
|---|---|---|
| Bennett | John | Governor's Office of Planning and Budget |
| Davenport | LaNiece | Wasatch Front Regional Council, Project Manager |
| Ewing | Margie | U.S. Forest Service |
| Halford | Val John | Wasatch Front Regional Council |
| Hattery | Doug | Wasatch Front Regional Council |
| LeBrasseur | Rick | Center for Green Infrastructure Design, Consultant Project Lead |
| McNaughton | Geoff | UT Division of Forestry, Fire & State Lands |
| Nelson | Sarah | Center for Green Infrastructure Design |
| Perkins | Meridith | UT Division of Forestry, Fire & State Lands |
| Pudlock | Kelsey | Center for Green Infrastructure Design |
| Swaner | Sumner | Center for Green Infrastructure Design |

## STEERING COMMITTEE

| *Last Name* | *First Name* | *Agency* |
|---|---|---|
| Adams | Stacee | UT Department of Environmental Quality |
| Adams | Todd | UT Department of Natural Resources, Division of Water Resources |
| Barnett | Kimberly | Salt Lake County, Environmental Policy Coordinator |
| Bird | Bryce | UT Department of Environmental Quality, Division of Air Quality |
| Cline | Nicole | Tooele County, Planning |
| Crowell | Grant | Morgan County, Planning |
| Defreese | Amy | U.S. Fish and Wildlife Service, Utah Field Office |
| DeLoretto | Mary | Utah Transit Authority |
| Hess | Scott | Davis County, Planning |
| Jaber | Ahmad | UT Department of Transportation, Planning and Programming |
| Jencks | Hollis | U.S. Army Corps of Engineers |

| *Last Name* | *First Name* | *Agency* |
|---|---|---|
| Johnson | Kate | UT Department of Environmental Quality, Division of Drinking Water |
| Kahlow | Cathy | U.S. Forest Service, Salt Lake District Ranger |
| Mickelson | Thayne | U.S. Department of Agriculture and Food |
| Page | Kent | Tooele County, Planning |
| Reynolds | Rory | UT Division of Wildlife Resources, Watershed Restoration |
| Scott | Rob | Weber County, Planning |
| Wilkerson | Aaron | U.S. Bureau of Land Management, Forestry Program |
| Williams | Jeff | U.S. Department of Agriculture, Resource Conservation and Development |
| Yoshinaga | Rolen | Salt Lake County, Planning |
| Zarekarizi | Susan | UT Department of Natural Resources, Division of State Parks |

## TECHNICAL COMMITTEE

| *Last Name* | *First Name* | *Agency* |
|---|---|---|
| Admundsen | Ole | The Conservation Fund |
| Arens | Hilary | UT Department of Environmental Quality, Division of Water Quality |
| Beck | Ryan | Envision Utah |
| Brown | David | U.S. Department of Agriculture, Natural Resources Conservation Service |
| Buchi | Douglas | School and Institutional Trust Lands |
| Crowell | Grant | Morgan County |
| Damery | Bill | UT Department of Environmental Quality |
| DeMillion | Marcy | U.S. Department of the Interior, National Park Service |
| Ewert | Charles | Morgan County |
| Farnsworth | Jamie | University of Utah, City and Metropolitan Planning Student |
| Ferebee | Brian | U.S. Forest Service, Wasatch-Cache National Forest |
| Gaines | Michelle | University of Utah, City and Metropolitan Planning Student |
| Gillen | Sylvia | U.S. Department of Agriculture, Natural Resources Conservation Service |
| Goodrich | Kerry | U.S. Department of Agriculture, Natural Resources Conservation Service |
| Gragg | Jimi | UT Department of Natural Resources, Division of Wildlife Resources |
| Granberg | Bert | Utah Automated Geographic Reference Center |
| Hansen | Ross | UT Department of Natural Resources, Division of Water Rights |
| Harja | John | UT Public Lands Policy Coordination |

| *Last Name* | *First Name* | *Agency* |
|---|---|---|
| Herbert | Robert | UT Department of Environmental Quality, Division of Water Quality |
| Hess | Scott | Davis County |
| Johnson | Kate | UT Department of Environmental Quality, Division of Drinking Water |
| Knight | Robert | U.S. Army, Dugway Proving Ground |
| Lawrence | Russell | U.S. Air Force, Camp Williams |
| Lehman | Todd | University of Utah, City and Metropolitan Planning Student |
| Licon | Carlos | UT State University, Swaner Green Space Institute |
| Maynard | Paul | Utah Trust for Public Lands |
| Mermejo | Lauren | U.S. Bureau of Land Management |
| Montague | Chris | The Nature Conservancy |
| Norman | John | Colorado State University |
| Oostema | Christie | Envision Utah |
| Page | Kent | Tooele County |
| Perry | Barbara | UT Department of Natural Resources, Division of Water Resources |
| Roberts | Mike | The Nature Conservancy |
| Scott | Rob | Weber County |
| Romberg | Ryan | UT Association of Conservation Districts |
| Weston | Brandon | UT Department of Transportation |
| Stromness | Rebecca | UT Department of Transportation |
| Ward-Thompson | Catharine | University of Edinburg |
| Wilhelmsen | Teresa | UT Department of Natural Resources, Division of Water Rights |
| Yoshinaga | Rolen | Salt Lake County |

## STAKEHOLDER COMMITTEE

| *Last Name* | *First Name* | *Agency* |
|---|---|---|
| Bedel | Mark | Weber Pathways |
| Beulter | Kerry | Tooele County |
| Bradley | Jim | Salt Lake County Urban Farming |
| Chan | Leslie | Salt Lake City |
| Chappell | Chuck | Wasatch Front Regional Council |
| Chestnut | Chris | UT Transit Authority |

| *Last Name* | *First Name* | *Agency* |
|---|---|---|
| Cook | Bill | Ogden City |
| Christensen | Curtis | UT Stormwater Advisory Committee |
| DeFreitas | Lynn | Friends of the Great Salt Lake |
| Delligatti | Cameron | U.S. Department of Agriculture and Food, Natural Resources Conservation |
| Epperson | Gabe | Envision Utah |
| Erler | Elise | School and Institutional Trust Lands |
| Fisher | Wendy | Utah Open Lands |
| Gellner | David | Salt Lake County Planning |
| Goldsmith | Stephen | University of Utah |
| Hubbard | Marian | Salt Lake County Public Works |
| Huskinson | Wayne | UT Chapter of the Sierra Club |
| Joyce | Everett | Salt Lake City Planning |
| Klemm | Sam | Wasatch Front Regional Council |
| Kocher | Janice | U.S. Department of Agriculture and Food, Rural Development |
| Krusemark | Meg | Weber Pathways |
| LaBonty | G.J. | UT Transit Authority |
| Maloutas | Emy | Salt Lake City Public Services Department |
| Maynard | Paul | UT Trust for Public Lands |
| McCandless | Christopher | CW Management Corp. |
| Morey | Keith | Ogden City Council |
| Nelson | Patrick | Salt Lake City |
| Peck-Dabling | Julie | Salt Lake County, Open Space Trust Fund Urban Farming |
| Roberts | Mike | The Nature Conservancy |
| Romberg | Ryan | UT Association of Conservation Districts |
| Roxanne | Tea | U.S. Bureau of Land Management |
| Springsteen | Laura | URS Corporation |
| Symes | Glenn | Ogden City Council |
| Toth | Richard | Utah State University |
| Uno | Claire | Wasatch Community Gardens |
| Vernon | Jason | Great Basin Research Center |
| Weber | Ted | The Conservation Fund |
| Weston | Brandon | UT Department of Transportation |

| *Last Name* | *First Name* | *Agency* |
|---|---|---|
| American Planning Association | | |
| Jordan Valley Water Conservancy District | | |
| Rails to Trails | | |
| Tree Utah | | |
| Trout Unlimited | | |
| University of Utah, Environmental Planning Center | | |
| University of Utah, Department of City and Metropolitan Planning | | |
| Utah League of Cities and Towns | | |
| Wasatch Audubon Society | | |

# APPENDIX B. STUDIES AND REPORTS

## REGIONAL STUDIES AND REPORTS


Bonneville Shoreline Trail Coalition. (2005). Bonneville Shoreline Trail: Alignment plan for Salt Lake County. http://www.bonnevilleshorelinetrail.org/resources/BSTAlignPlan.pdf

Busch, G., Lilieholm, R.J., Toth, R.E., & Edwards, T.C., Jr. (2005). Alternative future growth scenarios for Utah's Wasatch Front: Assessing the impacts of development on the loss of prime agricultural lands. *Transactions of Ecology and the Environment, 81.*

Davis County. (2008). Davis Conservation District Long Range Plan – 2008-2013. http://davisconservation.org/wp-content/uploads/2010/12/Davis-Long-range-plan.pdf

Davis County Council of Governments. (2001). Davis County Shorelands: Comprehensive Land Use Master Plan. http://www.mitigationcommission.gov/wetlands/pdf/davis_shorelands_masterplan.pdf

Defreis, L., Stratford, K., Degeorgio, J., Hancock, B., & Taylor, J. (2008). Weber Soil Conservation District Long Range Plan. http://weberconservation.org/wp-content/uploads/2010/12/Weber-5-yr-plan-final.pdf

Envision Utah. Envision Morgan: Your valley your vision. http://www.envisionutah.org/Envision%20Morgan%20Final%20Report.pdf

Envision Utah. (2007). Blueprint Jordan River – Public Presentation.

Envision Utah. (2008). Blueprint Jordan River. http://www.blueprintjordanriver.slco.org/pdf/BlueprintJordanRiver.pdf

Envision Utah. (2004). Wasatch Choices 2040: A four county land-use and transportation vision. http://www.wfrc.org/cms/publications/wasatchchoices2040report.pdf

Envision Utah. (2010). Wasatch Choice for 2040. http://www.wasatchchoice2040.com/the-vision/

Impact Sciences, Inc. (2009). One Valley One Vision Draft Program EIR: County of Los Angeles Area Plan.

Institute for Outdoor Recreation and Tourism. (2000). Utah's Great Outdoors Open Space Project Conclusions and Recommendations. http://extension.usu.edu/iort/files/uploads/pdfs/Conclusions_and_Recommendations.pdf

Institute for Outdoor Recreation and Tourism. (2002). Summary Report – The Bonneville Shoreline Trail Study. http://extension.usu.edu/iort/files/uploads/pdfs/Bonneville_ST.pdf

Institute for Outdoor Recreation and Tourism. (2008). Utah's Public Lands Socioeconomic Baseline Study: Summary Report. http://extension.usu.edu/iort/files/uploads/pdfs/Final%20Summary%20Report_Gov_public_lands.pdf

Morgan County. (2007). Morgan Conservation District Long Range Plan – 2008-2013. http://morganconservation.org/PDFs%20of%20Minutes%20etc/Morgan%20Long-Range%20Plan.pdf

Salt Lake City Planning Commission. (2009). *Northwest Quadrant: Creating a sustainable community.* http://www.slcgov.com/ced/planning/documents/MasterPlans/NWQMasterPlan_files/NWQ_MasterPlan_PC%20Recommendation.pdf

Salt Lake County. (2009). Salt Lake Countywide Watershed – Water Quality Stewardship Plan. http://www.waterresources.slco.org/html/wtrQualSteward/WaQSP_Final.html

Utah Partners for Conservation and Development, U.S. Geographic Society, Bureau of Land Management. (2009). Healthy Lands Initiative. http://www.blm.gov/ut/st/en/prog/more/Healthy_Lands_Initiative.html

Wasatch Front Regional Council. (2003). *Regional open space planning study.* Salt Lake City: Swaner Design, LLC. http://www.wfrc.org/cms/index.php?option=com_content&view=article&id=88&catid=68&Itemid=38

Weber Soil Conservation District. (2006). Weber Soil Conservation District Long Range Plan. http://weberconservation.org/wp-content/uploads/2010/12/Weber-5-yr-plan-final.pdf

## AGENCY REPORTS

***Water***

City of Salt Lake Public Utilities Corporation. (1999). Salt Lake City Watershed Management Plan. http://www.townofalta.com/pdf/SLC_Watershed_Management_Plan.pdf

Institute for Outdoor Recreation and Tourism. (2007). Recreational Water Use and Regional Planning on Utah's Lakes and Reservoirs. http://extension.usu.edu/iort/files/uploads/pdfs/Boating%20Report%20Final.pdf

Jordan Valley Water Conservancy District. (2010). 2010 Water Quality Report. http://www.jvwcd.org/news/default.aspx

U.S. Environmental Protection Agency. (2005). National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution. http://www.epa.gov/owow/NPS/wetmeasures/pdf/guidance.pdf

Utah Department of Agriculture and Food. (2010). Nonpoint Source Pollution Management Program. http://www.waterquality.utah.gov/NPS/2009_FINAL_NPS_Annual_Report_combined_chapters.pdf

Utah Department of Environmental Quality. (2000). Nonpoint Source Pollution Management Plan. http://www.waterquality.utah.gov/documents/NPS_Mgmt_Plan_2001.pdf

Utah Department of Environmental Quality. (2008). Nonpoint Source Management Plan for Hydrological Modifications. http://www.waterquality.utah.gov/documents/hydromod.pdf

Utah Department of Environmental Quality – Division of Water Quality. (2001). Watershed Protection Approach. http://www.waterquality.utah.gov/watersheds/ws_brocure.pdf

Utah Department of Environmental Quality – Division of Water Quality. (2004). Utah's 2004 303(d) List of Impaired Waters. http://www.waterquality.utah.gov/documents/2004303dlistFINALall-11-04-04.pdf

Utah Department of Environmental Quality, Division of Water Quality. (2006). Monitoring Manual. http://www.waterquality.utah.gov/Monitoring/06_DWQ_monitoring_manual.pdf

Utah Department of Environmental Quality – Division of Water Quality. (2008). Utah 2008 Integrated Report: Part 1 – Water Quality Assessment. http://www.waterquality.utah.gov/documents/2008_IR_Part1_71409_fin.pdf

Utah Department of Natural Resources – Division of Water Resources. (2003). Utah's M&I Water Conservation Plan. http://www.water.utah.gov/M&I/plan7-14-03.pdf

Utah Department of Natural Resources – Division of Water Resources. (2005). Conjunctive Management of Surface and Groundwater in Utah. http://www.water.utah.gov/cmreport/cmreport1bcc.pdf

Utah Department of Natural Resources – Division of Water Resources. (2009). Weber River Basin – Planning for the Future. http://www.water.utah.gov/planning/SWP/Weber_riv/WeberDraft0704.pdf

U.S. Geological Survey. (2002). Water Quality Assessment for the Great Salt Lake Basins, Utah, Idaho, and Wyoming – Environmental Setting and Study Design. http://pubs.usgs.gov/wri/wri024115/pdf/wri024115.pdf

***Forests***

U.S. Forest Service. (1993). Comprehensive Inventory of Utah's Forest Resources, 1993. http://www.fs.fed.us/rm/pubs/rmrs_rb001.pdf

U.S. Forest Service. (1998). A Landowner's Guide to Building Forest Access Roads. http://www.na.fs.fed.us/spfo/pubs/stewardship/accessroads/accessroads.htm

Utah Department of Natural Resources – Division of Forestry, Fire and State Lands. (2003). Forest Health in Utah. http://www.ffsl.utah.gov/foresthealth/fhgov4a.pdf

Utah Department of Natural Resources – Division of Forestry, Fire and State Lands. (2008). Communities at Fire Risk. http://www.ffsl.utah.gov/firemgt/wui/comatrisk/2010CARsFinal-web.pdf

Utah Department of Natural Resources – Division of Forestry, Fire and State Lands. (2010). Utah Statewide Forest Resource Assessment & Strategy Guide. http://www.ffsl.utah.gov/stateassessment/UtahStateAssessmentStrategy-FinalLowRes.pdf

Utah State University Extension. (2008). Managing Forests for Water Quality: Streamside Management Zones. http://extension.usu.edu/forestry/Reading/Assets/PDFDocs/NR_FF/NRFF008.pdf

Utah State University Extension. (2008). Utah Forest Types: An Introduction to Utah's Forests. http://extension.usu.edu/forestry/Reading/Assets/PDFDocs/NR_FF/NRFF011.pdf

***Air Quality***

Utah Department of Environmental Quality – Division of Air Quality. (2009). Annual Report. http://www.airquality.utah.gov/Public-Interest/annual-report/2009AnnualReportFinal.pdf

Utah Department of Natural Resources. (2006). Utah Smoke Management Plan. http://www.utahsmp.net/

Utah Department of Natural Resources. (2008). Regional Haze Report.

***Wildlife***

Gardner, P.A., Stevens, R., & Howe, F.P. (1999). A Handbook of Riparian Restoration and Revegetation for the Conservation of Land Birds in Utah with Emphasis on Habitat Types in Middle and Lower Elevations. http://wildlife.utah.gov/pdf/riparian.pdf

U.S. Forest Service. (1993). The Northern Goshawk in Utah: Habitat Assessment and Management Recommendations. http://www.fs.fed.us/rm/pubs/rmrs_gtr022.pdf

Utah Department of Natural Resources. (2010). Big Game Guidebook. http://wildlife.utah.gov/guidebooks/2010_biggame/2010_biggame.pdf

Utah Department of Natural Resources – Division of Wildlife Resources. (2005). Utah Comprehensive Wildlife Conservation Strategy. http://wildlife.utah.gov/cwcs/

Utah Department of Natural Resources – Division of Wildlife Resources. (2011). Utah Sensitive Species List. http://dwrcdc.nr.utah.gov/ucdc/ViewReports/SSLAppendices20110329.pdf

Utah Department of Natural Resources – Division of Wildlife Resources. (2011). Utah's Threatened and Endangered Species List. http://dwrcdc.nr.utah.gov/ucdc/viewreports/te_list.pdf

***Invasive Species***

Utah Department of Natural Resources – Division of Wildlife Resources. (2009). Utah Aquatic Invasive Species Management Plan. http://wildlife.utah.gov/pdf/AIS_plans_2010/AIS_mgt_plan_full.pdf

Utah Weed Control Association. (2004). Utah Strategic Plan for Managing Noxious and Invasive Weeds. http://www.utahweed.org/PDF/strategic_plan.pdf

## ANNUAL REPORTS


Bureau of Land Management. (2007). Performance Report. http://www.blm.gov/pgdata/etc/medialib/blm/wo/Business_and_Fiscal_Resources.Par.19394.File.dat/PerformReport07.pdf

California Coordinated Resource Management and Planning (CRMP) Handbook. http://twiki.sacriver.org/pub/Main/CoordinatedResourceManagementHandbook1996/CRMPHandbook_CARCD.pdf

Governor's Office of Planning and Budget. (2008). Baseline Info. http://www.envisionutah.org/2008%20GOPB%20Baseline_Intro_ExecSumm.pdf

School and Institutional Trust Lands Administration. (2010). SITLA Fiscal Year 2010 – 16th Annual Report. http://www.utahtrustlands.com/news/documents/TL2010AnnualReportWeb.pdf

Utah Department of Natural Resources. (2009). Department of Natural Resources Annual Report. http://naturalresources.utah.gov/pdf/dnr_ar_09-10.pd


## EXISTING GREEN INFRASTRUCTURE PROJECTS AND CASE STUDIES


Allen III, W.L. & Phillips, Jr., B.T. (2006). *Kent County, Delaware: Rapid assessment of green infrastructure.* The Conservation Fund.

Behan Planning Associates, LLC. (2006). *Green Infrastructure Plan for Saratoga County.*

Benedict, M., Allen, W., & McMahon, E. (2004). *Advancing strategic conservation in the Commonwealth of Virginia: Using a green infrastructure approach to conserving and managing the Commonwealth's natural areas, working landscapes, open space, and other critical resources.* Arlington, VA: The Conservation Fund.

Eugster, J.G. (2003). Washington: City in the woods. Prepared for the Joint Ventures Conference: Partners in Stewardship, Los Angeles, CA.

Liverpool City Council Planning Service. Liverpool Green Infrastructure Strategy: Technical Document Version 1.0.

Mid-America Regional Council. (2009). *Final report: Integrating regional indicators into the planning and implementation of the Kansas City Regional MetroGreen Project.* Kansas City: Mid-America Regional Council.

Nashville: Naturally. (2011). *Nashville Open Space Plan: Creating, enhancing and preserving the places that matter.*

Open Space Seattle 2100. (2006). *Envisioning Seattle's Green Future.*

Richmond Regional PDC, Green Infrastructure Center, Capital Region Land Conservancy. (2009). *The Richmond Region green infrastructure project: Building a regional green infrastructure network for our communities.*

TEP. Green Infrastructure for the Liverpool and Manchester City-region. Indigo Lithoprint.

The Conservation Fund. (2004). *Maryland's green infrastructure assessment and GreenPrint Program.* Green infrastructure – linking lands for nature and people: Case study. Arlington, VA: The Conservation Fund.

The Conservation Fund. (2006). *Travis County, TX Greenprint for Growth.* Arlington, VA: The Conservation Fund. http://www.ci.austin.tx.us/acpp/downloads/greenprint.pdf

The Conservation Fund. (2007). *Cecil County, Maryland green infrastructure plan*. Arlington, VA: The Conservation Fund.

The Conservation Fund. (2008). *Angelina County, Texas: Green infrastructure plan*. Arlington, VA: The Conservation Fund.

The Conservation Fund & Central Indiana Land Trust. (2010). *Greening the crossroads: A green infrastructure vision for Central Indiana*. Arlington, VA: The Conservation Fund.

Wasatch Front Regional Council. (2003). *Regional open space planning study.* Salt Lake City: Swaner Design, LLC.

Weber, T. (2003). *Maryland's green infrastructure assessment: A comprehensive strategy for land conservation and restoration.* Annapolis, MD: Maryland Department of Natural Resources.

Weber, T., Wolf, J., Blank, P., Aviram, R. & Lister, J. (2004). *Restoration targeting in Maryland's green infrastructure.* Annapolis, MD: Maryland Department of Natural Resources.

## GIS DATA

| DATA LAYER NAME | SOURCE | DESCRIPTION | NOTES |
|---|---|---|---|
| AERIAL | AGRC | 2009 NAIP ORTHOPHOTOGRAPHY | BLACK AND WHITE, CLIPPED TO COUNTY BOUNDARIES, RASTER FILES |
| AGRICULTURAL CONS. EASEMENTS | AGRC | AGRICULTURAL CONSERVATION EASEMENTS ONLY | FILTERED FROM CONSERVATION EASEMENTS DATASET |
| AGRICULTURAL PROTECTION AREAS – OGDEN VALLEY | WEBER COUNTY | DESIGNATED BASED ON UTAH'S AGRICULTURAL PROTECTION ACT | |
| AGRICULTURAL PROTECTION AREAS – WESTERN WEBER | WEBER COUNTY | DESIGNATED BASED ON UTAH'S AGRICULTURAL PROTECTION ACT | |
| AGRICULTURAL PROTECTION AREAS – TOOELE COUNTY | TOOELE COUNTY | DESIGNATED BASED ON UTAH'S AGRICULTURAL PROTECTION ACT | |
| AQUIFER RECHARGE/DISCHARGE AREA | AGRC | AQUIFER RECHARGE AREA | |
| BLM AREAS OF CRITICAL ENVIRONMENTAL CONCERN | BLM | DESIGNATED AERAS OF CRITICAL ENVIRONMENTAL CONCERN ON PUBLIC LANDS MANAGED BY THE BLM | |

| DATA LAYER NAME | SOURCE | DESCRIPTION | NOTES |
|---|---|---|---|
| CANALS | AGRC | ARTIFICIAL CANALS FOR WATER MANAGEMENT DISTRIBUTION (IRRIGATION, FLOOD CONTROL, ETC.) | |
| CEMETERIES | AGRC | ALL CEMETERIES (POINT) | |
| COMMUNITY AREAS | AGRC | IMPORTANT COMMUNITY LOCATIONS (POLYGON) | INCLUDES RED BUTTE ARBORETUM, HOGLE ZOO and OGDEN NATURE CENTER |
| COMMUTER RAIL (ROUTES) | AGRC | FRONTRUNNER TRANSIT LINE | COMBINES WITH LIGHTRAIL and RAILROADS AND LABELED AS "TRANSIT LINES" |
| COMMUTER RAIL (STOPS) | AGRC | FRONTRUNNER STOPS (POINT) | COMBINES WITH LIGHTRAIL AND LABELED AS "TRANSIT STOPS" |
| CONSERVATION EASEMENTS (ALL) | AGRC and UDWR | VARIOUS TYPES OF LAND PROTECTED FROM DEVELOPMENT | BROKEN DOWN INTO ASSETS; MERGED WITH UDWR EASEMENTS |
| COOPERATIVE WILDLIFE MANAGEMENT UNITS (CWMUS) | UDWR | CWMUS AS REFERRED TO IN THE 2010 UTAH BIG GAME GUIDEBOOK | |
| COUNTY BOUNDARIES | AGRC | COUNTY BOUNDARIES | MERGED INTO ONE LAYER |
| CULTIVATED LAND (ALL) | AGRC | ALL CULTIVATED LAND | MERGED GAP AGRICULTURAL LAND WITH NLCD CULTIVATED LAND and CULTIVATED LAND FROM AGRC DOMINANT VEGETATION LAYER |
| DAMS | AGRC | | |
| DEVELOPED LAND | AGRC | INCLUDES HIGH, MEDIUM and LOW INTENSITY DEVELOPMENT and DEVELOPED OPEN SPACE | FILTERED FROM LAND COVER DATASET – USED AS EXCLUSION FACTOR IN ECOLOGICAL MAP |
| DRINKING WATER SOURCE PROTECTION ZONES | UDWQ | VARIOUS ZONES (DETERMINED BY AMOUNT OF TIME IT TAKES WATER and POLLUTANTS TO REACH AQUIFERS) FOR PROTECTION PRIORITIES | USING ZONES 1-3 (UP TO 3 YEAR TIME OF TRAVEL) |
| ELDERLY CARE FACILITIES | AGRC | ALL ELDERLY CARE FACILITIES (POINT) | |
| FAITH-BASED ACTIVITY AREAS | AGRC | ALL CHURCHES, TEMPLES, SYNAGOGUES, ETC. (POINT) | |
| FAULT LINES | AGRC | GEO HAZARD FAULT LINES | |

| DATA LAYER NAME | SOURCE | DESCRIPTION | NOTES |
|---|---|---|---|
| FIRE HAZARD | WFRC | AREAS OF A CERTAIN FIRE HAZARD RISK | ONLY HIGH AND EXTREMELY HIGH RISK AREAS DISPLAYED |
| FLOODPLAIN - DAVIS COUNTY | AGRC | FEMA FLOODPLAIN | |
| FLOODPLAIN - GREAT SALT LAKE | AGRC | 100 YEAR FLOODPLAIN | |
| FLOODPLAIN - WEBER COUNTY | FEMA | FEMA FLOODPLAIN | |
| FOREST PRIORITY AREAS | UDFFSL | PRIORITY WATERSHEDS FOR FOREST HEALTH OBJECTIVES | ONLY “TIER 1” AREAS DISPLAYED |
| GAME SPECIES HABITAT | AGRC | | |
| GAP DATA | AGRC | VEGETATION COMMUNITIES | |
| GOLF COURSES | AGRC | GOLF COURSES (POLYGON) | |
| GRAZING ALLOTMENTS – BLM | BLM | BLM DESIGNATED GRAZING ALLOTMENTS and PASTURES | |
| GRAZING ALLOTMENTS – NEVADA | BLM – NEVADA STATE OFFICE | NEVADA GRAZING ALLOTMENT BOUNDARIES | |
| GRAZING LEASES – SITLA | SITLA | SITLA DESIGNATED GRAZING LEASES | |
| GREAT SALT LAKE | AGRC | | |
| GREATER SAGEGROUSE BROODING HABITAT | UDWR | SAGEGROUSE BROODING USE AREAS | ONLY “CRUCIAL” HABITAT AREAS DISPLAYED |
| GREATER SAGEGROUSE WINTER HABITAT | UDWR | SAGEGROUSE WINTER USE AREAS | ONLY “CRUCIAL” HABITAT AREAS DISPLAYED |
| GREATER SAGEGROUSE MASKED LOCATIONS | UDWR | POINT LOCALITIES MASKED TO WITHIN ONE SQUARE MILE | |
| HILL AIR FORCE BASE | AGRC | SELECTED FROM LAND OWNERSHIP DATASET | |
| HISTORIC CONSERVATION EASEMENTS | AGRC, UDWR | HISTORIC CONSERVATION EASEMENTS ONLY | FILTERED FROM CONSERVATION EASEMENTS DATASET |
| HISTORIC DISTRICTS | AGRC | VARIOUS DISTRICTS OF HISTORICAL VALUE | |
| HISTORIC TRAILS | AGRC | VARIOUS HISTORIC TRAILS, INCL. PONY EXPRESS, MORMON PIONEER, DONNER/CLYMEN/MORMON TRAILS, LINCOLN HIGHWAY | MERGED FROM MULTIPLE (PONY EXPRESS, DONNER, ETC.) |
| HOSPITALS | AGRC | ALL HOSPITALS (POINT) | |

| DATA LAYER NAME | SOURCE | DESCRIPTION | NOTES |
|---|---|---|---|
| HYDRIC SOILS | USING SOILS WITH GREATER THAN 70% HYDRIC COMPONENTS | | |
| IMPAIRED WATERS | AGRC | | |
| IMPERVIOUS SURFACES | | | |
| IMPORTANT BIRD AREAS | AUDUBON SOCIETY | SITES THAT PROVIDE ESSENTIAL HABITAT FOR ONE OR MORE SPECIES OF BIRD | |
| INTEREST POINTS | CGID | POINTS OF INTEREST FOR CONTEXTUAL REASONS | DEFINED POINTS OF INTEREST (E.G. AIRPORT, PEAKS, ETC.) |
| IRRIGATED LAND USE | AGRC | TYPES OF LAND USE THAT ARE IRRIGATED OR SUBIRRIGATED (FARMING LANDS) | FROM WATER RELATED LAND USE DATASET |
| LAKES | AGRC | FROM NATIONAL HYDROLOGICAL DATASET | |
| LAND COVER | NRCS | ACTUAL LAND COVER 9 BUILT, FOREST, ETC.) | CONVERTED FROM RASTER FILE |
| LAND OWNERSHIP | AGRC | DEFINED OWNER LAND AREA THROUGH PUBLIC AGENCY OF PRIVATE | |
| LANDSLIDE AREAS | AGRC | GEOLOGIC HAZARD AREAS | |
| LIBRARIES | AGRC | ALL LIBRARIES (POINT) | |
| HIGH LIQUIFACTION POTENTIAL | AGRC | GEOLOGIC HAZARD AREAS, AREAS WHICH (IN THE EVENT OF AN EARTHQUAKE) HAVE THE MOST POTENTIAL FOR SHIFTING | ONLY AREAS OF “HIGH” POTENTIAL DISPLAYED |
| MAJOR CITIES | AGRC | MAJOR CITIES (SELF-DEFINED) | |
| MARINAS | AGRC | ALL MARINAS (POINT) | |
| MINING AREAS | AGRC | | |
| MULE DEER HABITAT | UDWR | MULE DEER HABITAT DEFINED BY UDWR AS CRUCIAL AND SUBSTANTIAL | |
| NOXIOUS WEEDS | AGRC | NOXIOUS WEED LOCATIONS | |
| OGDEN VALLEY IMPORTANT WILDLIFE HABITAT AREAS | WEBER COUNTY | AREAS IDENTIFIED BY WEBER COUNTY AS IMPORTANT WILDLIFE HABITAT – SOME DEVELOPMENT LIMITATIONS APPLY | |
| PARKS - LOCAL | AGRC | LOCATIONS OF LOCAL PARKS, EXCLUDING STATE and FEDERALLY OWNED PARKS | |
| PARKS - STATE | AGRC | LOCATIONS OF ALL STATE PARKS | |

| DATA LAYER NAME | SOURCE | DESCRIPTION | NOTES |
|---|---|---|---|
| PASTURE AND HAY LANDS | AGRC | FILTERED FROM NATIONAL LAND COVER DATASET | |
| PRIME FARMLAND SOIL | NRCS | AREAS WITH SOIL THAT HAS HIGH VALUE FOR FARMING USE (SOME MAY REQUIRE IRRIGATION) | FILTERED FROM SOILS DATASET – BOTH POTENTIAL AND ACTUAL PRIME FARMLAND ARE CONSIDERED PRIME |
| PROBLEM SOILS (EXPANSIVE SOILS) | WFRC | AREAS WHERE SOIL EXPANDS WHEN MIXED WITH WATER (GEOLOGIC HAZARD AREAS) | |
| PROJECT BOUNDARY | MANUAL | PROJECT BOUNDARY | |
| PUBLIC LANDS | AGRC | AREAS (FROM LAND OWNERSHIP) THAT ARE STRICTLY PUBLIC – EXCLUDES PRIVATE, TRIBAL and DOD | DERIVED FROM LAND OWNERSHIP DATASET, CONTAINS PARK DATASET |
| RAILROADS | AGRC | | |
| REGIONAL TRAILS | AGRC, WFRC, USFS, MANUAL | PARKWAYS AND HIKING TRAILS | ALL TRAILS, INCLUDING MANUALLY GENERATED PARKWAYS |
| REGIONAL TRAILHEADS | WFRC | ALL TRAILHEADS | 2002 OPEN SPACE REPORT |
| RESERVOIRS | AGRC | MANMADE LAKES FOR DRINKING WATER AND IRRIGATION USES (DIFFERENT FROM LAKES) | |
| RESTORATION SALT LAKE COUNTY – COMPLETED | SL COUNTY FLOOD CONTROL and WATER QUALITY DIVISION | ECOSYSTEM RESTORATION SITES ON THE JORDAN RIVER IN SALT LAKE COUNTY | |
| RIVERS | AGRC | MAJOR RIVERS | OGDEN, JORDAN, WEBER LABELED |
| ROADS – MAJOR | AGRC | INTERSTATE HIGHWAYS | FILTERED BY CODE = 1 |
| ROADS – MAJOR and SECONDARY | AGRC | INTERSTATE AND STATE HIGHWAYS | FILTERED BY CODE = 1 OR 2 |
| SALINE SOILS | NRCS | SOILS THAT ARE SALINE | SALINE SOIL TYPES SELECTED FROM NRCS SOILS DATASET |
| SALT LAKE COUNTY FLOODPLAIN | AGRC | FEMA FLOODPLAIN | |
| SCHOOLS | AGRC | ALL SCHOOLS (POINT) | |
| SHALLOW GROUNDWATER | AGRC | 0 FOOT DEPTH TO GROUNDWATER | |
| SKI LIFTS | AGRC | | |
| SOILS OF STATEWIDE IMPORTANCE | NRCS | FARMLAND OF STATEWIDE IMPORTANCE | DERIVED FROM THE NRCS SOILS DATASET |

| DATA LAYER NAME | SOURCE | DESCRIPTION | NOTES |
|---|---|---|---|
| STREAMS (MAJOR) | AGRC | MAJOR STREAMS ONLY | |
| STREAMS (MAJOR and MINOR) | AGRC | ALL STREAMS MAJOR and MINOR | FROM STREAM DATASET |
| SUB-WATERSHED (LEVEL 5) | AGRC | SUB-WATERSHED AREAS | LEVEL FIVE ZONES DISPLAYED ONLY |
| TRIBAL LANDS | AGRC | DERIVED FROM LAND OWNERSHIP DATASET | |
| UNIVERSITIES | AGRC | ALL UNIVERSITIES (POINT) | |
| WATER RELATED CONS. EASEMENTS | AGRC, UDWR | CONSERVATION EASEMENTS (WATER RELATED ONLY) | FILTERED FROM CONSERVATION EASEMENTS DATASET |
| WATERSHED (BASINS – LEVEL 4) | AGRC | WATERSHED AREAS | BASIN ZONES DISPLAYED ONLY |
| WATERSHED RESTORATION INITIATIVE AREAS | AGRC | PRIORITY AREAS THAT ARE PROTECTED TO ASSIST IN UTAH'S WATERSHED RESTORATION INITIATIVE | FOUR DATASETS MERGED INTO ONE |
| WETLANDS | USFWS | WETLANDS AS DEFINED BY THE USFWS NATIONAL WETLANDS INVENTORY | |
| WILDERNESS AREAS | AGRC, BLM, USFS | AREAS UNDER THE WILDERNESS DESIGNATION – TYPICALLY DO NOT ALLOW RESOURCE EXTRACTION OR DEVELOPMENT | |
| WILDLAND URBAN INTERFACE AREAS | UDFFSL | HAZARD AREAS BASED ON FUEL TYPE AND PROXIMITY | |
| WILDLIFE ACTION PLAN CONSERVATION ACTION AREAS | AGRC, UDWR, TNC | ACTION AREAS MEANT TO INFORM THE DECISION-MAKING PROCESS ASSOCIATED WITH THE WILDLIFE ACTION PLAN | |
| WILDLIFE RESERVES and MANAGEMENT AREAS | AGRC | AREAS THAT PROHIBIT DEVELOPMENT and RESOURCE EXTRACTION TO PROTECT NATIVE WILDLIFE AND AREAS UNDER HIGHER MANAGEMENT PRACTICES | DERIVED FROM LAND OWNERSHIP DATASET |

## OUTREACH EFFORTS

**FEDERAL AGENCIES**

- U.S. Department of Agriculture
- U.S. Forest Service
- Natural Resource Conservation Service
- U.S. Department of the Interior
- National Park Service
- Bureau of Land Management
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. Department of Defense
- U.S. Army Corps of Engineers
- U.S. Air Force – Camp Williams
- U.S. Army – Dugway Proving Ground

**STATE AGENCIES**

- Utah Quality Growth Commission
- Utah Department of Environmental Quality
- Division of Air Quality
- Division of Water Quality
- Utah Department of Natural Resources
- Division of Wildlife Resources
- Division of Drinking Water
- Division of Water Rights
- Division of Forestry, Fire and State Lands
- Division of State Parks and Recreation
- Division of Water Resources
- Division of Oil, Gas and Mining
- Division of Geological Survey

- Utah Department of Transportation
- Utah Transit Authority
- Utah Department of Agriculture and Food
- School and Institutional Trust Lands
- Governor's Office of Planning and Budget
- Governor's Public Lands Policy Coordination Office
- Utah Association of Conservation Districts

**REGIONAL/MUNICIPAL**

- Wasatch Front Regional Council
- Salt Lake County Planning Department
- Davis County Planning Department
- Weber County Planning Department
- Tooele County Planning Department
- Morgan County Planning Department
- City of Salt Lake
- City of Ogden

**ORGANIZATIONS/INSTITUTIONS**

- The Nature Conservancy
- The Conservation Fund
- Utah State University
- University of Utah
- Envision Utah
- Utah Open Lands
- Utah Trust for Public Lands
- Sierra Club
- Salt Lake County Open Lands
- Salt Lake City Open Space
- Urban League of Cities and Towns
- Rails to Trails Conservancy
- Jordan River Watershed Council

- Jordan River Commission
- Utah Rivers Council
- Trout Unlimited
- Tree Utah
- Green Ogden
- Blueprint Jordan River
- Kuer Farm – Salt Lake County Urban Farming
- Great Salt Lake Water Quality Steering Committee
- Utah Stormwater Advisory Committee
- Friends of Salt Lake
- Great Basin Research Center
- Entrix, Co.
- Wasatch Audubon Society
- Weber Pathways – Ogden
- Bonneville Shoreline Trails Coalition
- American Planners Association – Utah Chapter
- Jordan Valley Water Conservation District

## PUBLIC OUTREACH

1. In Spring of 2012, the WFRC circulated an on-line survey specifically directed to public community to receive feedback on the Project and gauge public concerns. The survey received nearly 100 responses.

2. The WFRC held a series of open houses to inform the public on the project and green infrastructure, encourage participation in the project, and accept input and feedback. These open houses were held throughout the Wasatch Front on July 13th, 14th, and 15th 2010.

***Tuesday July 13, 2010***

Salt Lake County: Salt Lake City Library- Level 4

210 East 400 South, Salt Lake City, UT 84111

6:00 – 9:00 p.m.

Tooele County: Tooele County Courthouse- Basement Auditorium

47 South Main Street, Tooele City, UT 84074

4:00 – 8:00 p.m.

***Wednesday July 14, 2010***

Morgan County: Morgan City Hall

48 West Young Street, Morgan City, UT 84050

4:00 – 8:00 p.m.

Weber County: Pleasant Valley Public Library - Alan Nye Board Room

5568 S Adams Avenue Parkway, Ogden (Washington Terrace), UT 84405

4:00 – 8:00 p.m.

***Thursday July 15***

Salt Lake County: Sandy City Hall - 2nd Floor

10000 Centennial Parkway, Sandy, UT 84070

4:00 – 8:00 p.m.

Davis County: The Utah House (Utah Botanical Center)

920 South 50 West, Kaysville, UT 84037

4:00 – 8:00 p.m.

# APPENDIX C. MAPPING CRITERIA AND METHODOLOGY

## ECOLOGICAL ASSET NETWORK MAP CRITERIA

The ecological asset network map includes high quality forest lands, wetlands, riparian, scrub/shrub, and desert lands. It also includes protected lands (including public lands and conservation easements), important bird habitat areas, wildlife reserves, and wilderness areas.

| ECOLOGICAL ASSET NETWORK MAP CRITERIA | | |
|---|---|---|
| **CORES** | **SIGNIFICANCE / EXPLANATION** | **FURTHER RESEARCH** |
| 1. Protected lands or public lands with ecological assets within them | Protected lands have a higher likelihood of providing permanent services. Inclusion of protect lands is well-documented[1]. | Need to determine if a minimum size or buffer area is needed for these protected or public lands. |
| 2. High quality wetlands - min. size of 50 m in diameter and not "too" isolated | Based off the American White Pelican and Black-Necked Stilt habitats. Based on literature and conversations with UDWR staff. Working with UDWR staff to identify a freshwater wetlands species. | 1. Need to determine if a minimum size or buffer area is needed for wetlands.<br>2. For wetlands and the remaining land cover types, future research should incorporate plant species as indicators as well. |
| 3. High quality uplands - lands indicated by UDWR as crucial for the Mule Deer and potential habitat for the Northern Goshawk | These species are listed as indicator species by UDWR (Mule Deer) and USFW (Northern Goshawk in the Uinta-Cache National Forest). See end of document for specific criteria. | Future research should incorporate plant species as indicators as well. A suggestion was made to also include Rocky Mountain Elk, as these habitats are often different and elk is an important species to the Wasatch Front. |
| 4. High quality riparian areas – all streams with documented occurrences of the Bonneville Cutthroat Trout (with a 50 foot buffer), and potential beaver habitat (open water, permanent streams adjacent to woody vegetation). | Recommended by UDWR and used by the Uinta-Cache National Forest as an indicator species. Based on discussions with UDWR and USFS. | Future research should incorporate plant species as indicators as well. |

| | | |
|---|---|---|
| 5. High quality scrub/shrub areas - lands indicated as critical or substantial for the Greater Sage Grouse | Based off the greater sage grouse habitat layer provided by UDWR. | Future research should incorporate plant species as indicators as well. |
| 6. Areas of Critical Environmental Concern | A BLM designation – includes the Bonneville Salt Flats and Horseshoe Springs within this study area. | |
| **Exclusion Factors:** | | |
| 1. For priority saline wetlands – remove areas of high human disturbance | Includes marinas, recreational trails, fishing areas, etc. Conversation with John Neill, UDWR - 9/13/2010 | Fishing areas should be evaluated on a case-by-case basis- recommend including this in future research. |
| 2. Remove areas affected by development | Buffer recommendations – 180 m (Odell and Knight 2001), Bock 1999 - 200 m (see Lenth 2006 paper for reference). | |
| 3. Remove areas affected by invasive species | Based on data downloaded from AGRC, including invasive species and dominant vegetation shapefiles. | |
| 4. Remove riparian areas with diversions, dams, culverts and de-watered reaches; For beavers remove recreational areas and mineral developments. | These areas serve as barriers to BCT migration (pers. comm. with UDWR 2010). As per the USFS Suitability analysis, beavers will not establish colonies where significant human disturbance is located. | Culverts should be evaluated on a case-by-case basis – recommend including this on a more site-specific study. |
| 5. Exclude major roads. | Species will be negatively affected by roads, through mortality or avoidance. | |
| **HUBS** | **SIGNIFICANCE / EXPLANATION** | **FURTHER RESEARCH** |
| 1. Reservoirs | American White Pelican utilizes these areas. | |
| 2. High priority forest lands | DFFSL completed a planning process in 2010 that identified priority forest lands. | |

| | |
|---|---|
| 3. For upland habitats – lands indicated as substantial habitat for mule deer and areas with aspen as dominant vegetation cover for Goshawks. | Substantial Mule Deer habitat based on data from UDWR. Based on breeding and foraging requirements (from USFS), Aspen is important for the Northern Goshawk (USFS). |
| 4. Wildlife Action Areas within the study area and important wildlife areas | As per the Wildlife Action Plan developed by UDWR and Ogden Valley important wildlife areas. |
| 5. For scrub/shrub habitat for Sage Grouse - all areas of sagebrush within 1 mile of masked species locations | Habitat data provided by UDWR was masked up to 1 mile, as per confidentiality reasons, these hub areas would encompass all possible habitats. As this species is a sagebrush-obligate species, hubs should include areas with sagebrush as the dominant vegetation species. |
| 6. Riparian areas - all permanent streams that have surrounding forest land cover. | Beaver criteria reviewed by USFS. |
| 7. Important Bird Areas | Areas identified as important for a suite of bird species throughout the region (UDWR, pers. comm. 2010). |
| **Exclusion Factors:** | |
| 1. Exclude roads that create barriers for species travel, e.g. major highways | Species will be negatively affected by roads, through deaths in crossing or avoidance. |
| 2. Remove areas affected by development | Buffer recommendations – 180 m (Odell and Knight 2001), Bock 1999 - 200 m (Lenth, 2006). |

| *CORRIDORS* | *SIGNIFICANCE/EXPLANATION* | *FURTHER RESEARCH* |
|---|---|---|
| 1. For riparian areas -Least-cost path analysis between the core areas, using acceptable habitat types, e.g. the streams in the cores/hubs listed above, with preferred connections between higher quality streams and streams with woody riparian vegetation. | Based off the Bonneville Cutthroat Trout and beaver, based on discussions with UDWR and USFS. | |
| 2. For shrub/scrub and Mule Deer habitats, prioritize connections between summer and winter ranges (e.g., for Mule Deer and Greater Sage Grouse) and connections via preferred habitat. | Based on conversations with UDWR staff, species need connections between winter and summer ranges first, then other connections. | Species movement modeling was beyond the scope of this project and so was not included in the ecological corridor modeling. It should be considered in future planning efforts. |
| 3. Least-cost path analyses between the core and hub areas, using acceptable habitat types. | See least cost path analysis process below. | |
| 4. For wetlands, utilize discharge areas, hydric soils and shallow aquifer areas for connections. | Emphasize hydrological connections to support wetland connectivity. | |

[1]See Utah DFFSL 2010 Statewide Assessment document available at http://www.ffsl.utah.gov/stateassessment.php.

***References:***


Lenth, B. A., R. L. Knight, and W. C. Gilgert. 2006. Conservation value of clustered housing developments. Conservation Biology 20:1445-1456.

Odell, E. A., and R. L. Knight. 2001. Songbird and medium-sized mammal communities associated with exurban development in Pitkin County, Colorado. Conservation Biology 15:1143-1150.

U.S. Forest Service. (1993). The Northern Goshawk in Utah: Habitat Assessment and Management Recommendations. http://www.fs.fed.us/rm/pubs/rmrs_gtr022.pdf


***Experts Consulted:***

Utah Division of Wildlife Resources – avian biologists, big-game biologists, upland game biologists, Utah Natural Heritage Program

Utah State University – wildlife biologists, foresters

Utah Division of Forestry, Fire, and State Lands – GIS staff, urban foresters

National Park Service Rivers, Trails, and Conservation Assistance Program

U.S. Forest Service – wildlife biologists

# ECOLOGICAL ASSET NETWORK MAP - DESIGN PROCESS

*Ecological Cores*

*Species criteria for the design of the core areas:*

Upland and Riparian Species:

Beaver – areas with known/documented beaver populations (data from U.S. Forest Service), those permanent streams with woody riparian vegetation with a minimum of 0.5 miles of stream length, perennial ponds, lakes, and reservoirs with dimmable outlet (not Currant Creek, Tibble Fork, Silver Lake Flat, or Strawberry Reservoirs). Appropriate vegetation within 300' of the water body and stream gradient less than 15%. For hubs, include streams with less than 0.5 miles of length when connected to another body of water within 600 feet. Reaches of intermittent streams connected to perennial streams and ponds are considered capable. Remove recreational areas, mineral developments, administrative and development sites, and roads.

Mule Deer – areas classified by UDWR as crucial or substantial habitat for this species; and

Northern Goshawk – includes areas listed as nesting or post fledgling habitat areas as classified by the USFS, foraging areas will be incorporated as hubs.

Nesting habitat – appropriate forest cover types, e.g., aspen, aspen/conifer, dense conifer, etc.; minimum canopy cover of >70%, minimum patch size of 30 acres.

Post Fledgling Habitat – minimum patch of 450 acres (at least 30 acres of nesting habitat), same covers as for nesting with a canopy cover >50%, must be within .25 miles of another polygon of post fledgling habitat or nesting habitat.

Foraging habitat (hubs) – include aspen, aspen/conifer, other deciduous forest types with large trees, conifer, and oak tree types; minimum patch size of 5400 acres (excluding nest and PF habitat), all foraging habitat within 1.72 miles of nesting habitat, all canopy cover types and must include 30 acres of nesting habitat.

*Note: for this study, percent canopy cover data was not available – Goshawk habitat areas were based exclusively on appropriate land cover types.*

*Ecological Core Design Process*

Create a new toolbox in ArcCatalog for Recreational modeling - ~EcologicalAssets

#1 Core Criteria – protected and public lands with ecological assets

Select all lands with protection designation – BLM Wilderness, US Forest Service Wilderness, National Conservation Association parcels, Division of Natural Resources wildlife reserves, and ecological easements. Merge into one layer→ecolands_protected2

Convert to raster→prot_ecoland1

Reclassify to 0 and 1 for analysis→***rc_ecoprot1***

#2 Core Criteria – high priority wetlands

Select those wetlands (from USFWS National Wetland Inventory) greater or equal to .6 acres (as per species habitat information and conversations with UDWR staff)→ NWI_wetlands_over6ac

Remove tailings ponds south of the Great Salt Lake (as per conversations with water quality experts)

Convert to raster→all_wetlands1

Reclassify to 0 and 1 for analysis→***rc_wetlands4***

#3 Core Criteria – high quality uplands

Select crucial mule deer habitat from data received from UDWR → MuleDeerHabitat_Crucial, convert to raster → mdeer_crucial, reclassify → rc_mdeer_cruc

Extract vegetation used by the northern goshawk from the SWreGAP data → Goshawk_GAP_veg2, convert to raster→ goshawk1, reclassify → rc_goshawk1

Use single output map algebra to add the above two layers → uplandhab2

Reclassify to 0 and 1 for analysis→***rc_uplandhab1***

#4 Core Criteria – high quality riparian

Buffer by 50 feet streams where Bonneville Cutthroat Trout occur and streams with permanent woody riparian vegetation and merge together → riparianforcore_50ftbuff , convert to raster →riparian50ft, reclassify to 0 and 1 for analysis → rc_ripar50ft

Extract from SWreGAP data all riparian vegetation types, open water and wet meadow → beaver_water; merge with streams_perm2_pgon → beaver_water2; extract from SWreGAP data all vegetation types useable by the beaver → beaver_usable_veg; select by location all features within beaver_water2 that are within 600 feet of beaver_usable_veg (per USFS beaver habitat criteria) →beaver_habitat; merge this layer with beaver_water2 → beaver_habitat2; convert to raster → beaver_hab1; reclassify to 0 and 1 for analysis → rc_beaverhab1

Buffer rivers by 50 ft → rivers_50ft_buff, convert to raster → rivers_50ft, reclassify → rc_rivers50ft

Use single output map algebra to add the above three layers → ripcore, reclassify to 0 and 1 → ***rc_ripcore3***

#5Core Criteria – high quality scrub/ shrub areas

Merge together sagegrouse brooding and winter habitat from AGRC →sagegrouse_habitat

Convert to raster → sagegrse_hab

Reclassify to 0 and 1 for analysis→***rc_sagehab***

#6 Core Criteria – areas of environmental concern

Select BLM Areas of Critical Environmental Concern →BLM_areasenvtalconcernt

Convert to raster→BLM_AEC

Reclassify to 0 and 1 for analysis→***rc_blm_aec2***

Merge together the core criteria 1 – 6

Use single output map algebra to add the above final, reclassified rasters together → eco_cores5

Use the reclassify tool to change any value above 1 to a 1, and then all nodata values to 0 → ***rc_ecocores5***

Create exclusion layers

Create exclusion factor #1 – areas of high human disturbance – marinas (note: marinas to be included with recreational areas, see exclusion factor #4), trails

Buffer trails and regional trails by 50 meters and merge → all_trails_50ftbuff, convert to raster → trails_50m, reclassify for analysis → ***rc_trails50m***

Create exclusion factor #2 – areas affected by development

Select developed lands from AGRC land cover →developed_land_all

Buffer by 200 m →dev_land_all_200mbuff

Convert to raster → urbanareas2

Reclassify to 0 and 1 for analysis→***rc_urban6***

Create exclusion factor #3 – areas affected by invasive spp.

Clip noxious weeds layer from AGRC to project boundary →noxiousweeds_AGRC

Select noxious weeds from dominant vegetation shapefile (from AGRC, include cheatgrass, which is not on the noxious weed list but has significant ecological and productivity ramifications)→noxiousweeds_cheatgrass

Merge the noxious weeds layer →noxiousweeds_all

Convert the noxiousweeds_all layer to raster (noxiousweeds) and reclassify for analysis→***rcnoxweeds1***

Create exclusion factor #4 – riparian barriers and human disturbance

Buffer dams by 50 feet →dams_50ftbuffer, merge buffered dam layer with mining lands → dams_mines, and convert to raster → dams_mines

Reclassify to 0 and 1 for analysis → ***rc_mine_dam1***

Use reclassified recreation area file from Recreational Core Criteria #5 (includes ski areas, marinas and golf courses) →***Rc_recareas1***

Conduct single output map algebra to add these two areas → ***Rc_recmindam1***

Create exclusion factor #5 – road creating barriers for species travel

Select major roads from AGRC Roads shapefile → Roads_Major

Buffer by 40 m (Forman 1995) → MajorRoads_40mbuff

Convert to raster → roads_40mbuff

Reclassify to 0 and 1 for analysis → ***rc_roads40m1***

Use single output map algebra to multiply the 5 exclusion layers together → ***ecocoreexfac2***

Remove exclusion layers

Use single output map algebra to multiply the final cores layer with the exclusion layer → ***eco_cores6*** – vector file is ecocores7

*Ecological Hub Design Process*

Develop hub criteria

#1 Hub Criteria – reservoirs

i. Select the reservoirs layer → reservoirs_clip
ii. Convert to raster → reservoirs
iii. Reclassify to 0 and 1 for analysis → ***rc_reservoir***

#2 Hub Criteria – high priority forest lands

i. Select all Tier 1 lands from DFFSL priority areas layer→priority_areas
ii. Convert to raster→fs_priority
iii. Reclassify to 0 and 1 for analysis→***rc_fs_prior1***

#3 Hub Criteria – substantial mule deer habitat and areas dominated by aspen

i. Select areas dominated by aspen→aspen_dominant, convert to raster→aspen, reclassify to 0 and 1 for analysis→***rc_aspen***
ii. Extract substantial mule deer habitat from data received from UDWR → MuleDeerHabitat_Substantial, convert to raster → mdeer_subst, reclassify → rc_mdeer_subs
iii. Use single output map algebra to add the above two layers → upland_hub, reclassify → ***rc_uplandhub***

#4 Hub Criteria – Wildlife Action Areas and Important Wildlife Areas

Merge the Wildlife Action Areas as designated by the Wildlife Action Plan with Ogden Valley's Important Wildlife Habitat→wildact_impwild

Convert to raster→wildact_imp1

Reclassify to 0 and 1 for analysis→***rc_wild_imp3***

#5 Hub Criteria – shrub habitat

i. Select all shrub lands (from GAP data) within 1 mile of masked species locations→sagebrush_adjtomaskedlocations
ii. Convert to raster →shrub_hub1
iii. Reclassify to 0 and 1 for analysis→***rc_shrb_hub2***

#6 Hub Criteria – riparian areas

iv. Select all permanent streams adjacent to forest lands → perm_streams_adjacenttoforests
v. Convert to raster →stream_forest
vi. Reclassify to 0 and 1 for analysis → ***rc_stm_fores2***

#7 Hub Criteria – Important Bird Areas

i. Convert the ImportantBirdAreas shapefile to raster → IBAs1
ii. Reclassify to 0 and 1 for analysis → ***rc_IBAs2***

Merge together the hub criteria 1 – 7

Use single output map algebra to add the above final, reclassified rasters together → eco_hubs3

Use the reclassify tool to change any value above 1 to a 1, and then all nodata values to 0 → ***rc_eco_hubs2***

Create exclusion layers

Use single output map algebra to multiply the hub exclusion factors together (rc_urban4 and rc_roads40m1) → ***ecohubexfact1***

Remove exclusion layers from hubs

Use single output map algebra to multiply the final hubs with the hub exclusion layer → ***ecohubs_excl4***

*Ecological Corridor – Least Cost Path Analysis Design Process*

1. Create the cost surface raster
    a. Convert the ecocores_exc4 raster to vector → ecocores5
        i. Dissolve by value field → eco_cores_dissolve
        ii. Add field – label; start editing session – add “Cores” to the one attribute field under “label”
    b. Convert the ecocores_exc4 raster to vector → ecohubs1
        i. Erase the cores from the hubs (erase tool only available with ArcInfo license) → ecohubs_erase
        ii. Dissolve by value field → eco_hubs_erase_dissolve
        iii. Add field – label; start editing session – add “Hubs” to attribute field under label
    c. Merge together hydric soils (hydric70pct), shallow groundwater areas (grndh20_0ft) and aquifer recharge zones (aquifer_10km_boundary) → hydric_shallow_recharge
        i. Dissolve by value field → hydshallowrecharge_dissolve
        ii. Add label field; start editing session – add “Hydric soils, shallow groundh2o, aquifer recharge” to attribute field
    d. Buffer all streams by 15 m → streams_15mbuff
        i. Dissolve by buffer distance → streams_15mbuff_dissolve
        ii. Add label field; start editing session – add “All Streams” to attribute field
    e. Select all developed land from land cover layer → developed_land_all
        i. Dissolve by buffer value field → developed_land_dissolve

ii. Add label field; start editing session – add “Developed Land” to attribute field

f. Select appropriate habitat land cover types from NLCD layer – all forest, shrub, grassland and wetland types → forest_shrub_grass_wetland
   i. Dissolve by value field →all_habitat_dissolve
   ii. Add field – label; start editing session – add “Habitat Landcover” to the one attribute field under “label”
g. Select permanent streams adjacent to woody vegetation (from Hydrological criteria) → permstreams_adjtoforest_50ftbuff
   i. Dissolve by value field → streams_forestadj_dissolve
   ii. Add field – label; start editing session – add “Permanent Streams adjacent to Forests” to attribute field
h. Select parks from Community Criteria → all_parks
   i. Dissolve by value field → all_parks_dissolve
   ii. Add field – label; start editing session – add “Parks” to attribute field
i. Select major roads → major roads
   i. Dissolve by value field → major_roads_dissolve
   ii. Add field – label; start editing session – add “Roads” to attribute field
j. Select impaired water bodies
   i. Dissolve by value field → impaired_waters_dissolve
   ii. Add label field; start editing session – add “Impaired Waters” to attribute field
k. Merge eco_cores_dissolve, eco_hubs_erase_dissolve, hydshallowrecharge_dissolve, streams_15mbuff_dissolve, developed_land_dissolve, all_habitat_dissolve, streams_forestadj_dissolve, all_parks_dissolve, major_roads_dissolve, and impaired_waters_dissolve together → eco_corridor_perm (note, this should be the cost surface file – to be renamed in raster classification)
   i. Under value field, insert the following values (values assigned to dictate which layers will override other layers):

| **Value** | **Label** |
|---|---|
| 1 | Habitat Landcover |
| 2 | Hydric soils, shallow groundh20, aquifer recharge |
| 3 | Cores |
| 4 | Hubs |
| 5 | Developed Land |
| 6 | Parks |
| 7 | Roads |
| 8 | Streams |

| | |
|---|---|
| 9 | Permanent Streams adjacent to Forests |
| 10 | Impaired Waters |

ii. Convert file to raster→***eco_costsurf***

iii. Add PermValue field with the following values:

| OBJECTID | Value | Label | PERMVALUE |
|---|---|---|---|
| 0 | 1 | Habitat landcover | 0.6 |
| 1 | 2 | Hydric soils, shallow groundwater, aquifer recharge | 0.7 |
| 2 | 3 | Cores | 1.0 |
| 3 | 4 | Hubs | 0.9 |
| 4 | 5 | Developed land | 0.1 |
| 5 | 6 | Parks | 0.5 |
| 6 | 7 | Roads | 0.1 |
| 7 | 8 | Streams | 0.7 |
| 8 | 9 | Permanent streams adjacent to forests | 0.8 |
| 9 | 10 | Impaired waters | 0.0005 |

*Ecological Corridor Design Process*

1. Create study map with cores, hubs, least cost paths and linear ecological features that could serve as corridors
   a. Add cores → ecocores5 and hubs → ecohubs_erase
      b. Add least cost paths to map → movement_prob
         i. In Symbology, select "Classified"; compute histogram; exclude data between 0 – 0.5686 (retains highest value paths)
   c. Add waterways → streams_rivers
2. Create new shapefile → Eco_Corridors_Existing
      a. Trace waterways that serve as connecting corridors between core and hub areas
3. Create new shapefile → Eco_Corridors_Proposed
         a. Assess areas where connectivity is lacking and draw in corridors using the following criteria
            i. Trace existing waterways first, even if they do not completely connect two core patches – such partial corridors are included in the existing corridor shapefile – draw in proposed corridors to complete these connections
            ii. Secondly, use least cost paths to draw in corridors where connectivity is still lacking

| | |
|---|---|
| Merged Cores | Ecological_Cores |
| Merged Hubs | Ecological_Hubs |
| Existing Corridors | Ecological_Corridors_Existing |
| Proposed Corridors | Ecological_Corridors_Proposed |

*Note – merged files have been dissolved by layer – data is extremely simplified.*

| | |
|---|---|
| Core #1 – Protected lands with ecological assets | Protected_Ecological_Lands |
| Core #2 – High quality wetlands | Wetlands_Over_6Ac |
| Core #3 – High quality uplands | Upland_Core |
| Core #4 – High quality riparian areas | Riparian_Core |
| Core #5 – High quality scrub/shrub areas | ShrubSteppe_Core |
| Core #6 – Areas of Critical Environmental Concern | BLM_AreasofEnvironmentalConcern |
| Core Exclusion #1 – Disturbed saline wetland areas *(Marinas included in core exclusion #5)* | Trails_50ftbuffer |
| Core Exclusion #2 – Areas affected by development | Developed_Land_200mbuffer |
| Core Exclusion #3 – Invasive species | Noxious_Weeds |
| Core Exclusion #4 – Disturbed riparian areas | Disturbed_Areas |
| Core Exclusion #5 – Major roads | MajorRoads_40mbuffer |
| Hub #1 – Reservoirs | Reservoirs |
| Hub #2 – DFFSL high priority forest lands | DFFSL_Priority_Forest_Lands |
| Hub #3 – Substantial mule deer habitat and Aspen-dominated areas | Upland_Hub |
| Hub #4 – Wildlife Action Plan areas and Ogden Valley important wildlife areas | WAP_Important_Wildlife_Areas |
| Hub #5 – Sagebrush areas with 1mile of masked Sage Grouse locations | ShrubSteppe_Hub |
| Hub #6 – Permanent streams with surrounding forest landcover | Riparian_Hub |
| Hub #7 – Important Bird Areas (IBAs) | Important_Bird_Areas |
| Hub Exclusion #1 – Major roads | MajorRoads_40mbuffer |
| Hub Exclusion #2 – Areas affected by development | Developed_Land_200mbuffer |

## HYDROLOGICAL ASSET NETWORK MAP CRITERIA

The hydrological asset network map Includes reservoirs, lakes, streams, rivers, wetlands, aquifer recharge/discharge areas, drinking water source protection zones, water-related conservation easements, canals, land cover data, and Watershed Restoration Areas.

| HYDROLOGICAL NETWORK CRITERIA | | |
|---|---|---|
| **CORES** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Protected lands with hydrological assets within them | Permanently protected lands have a higher likelihood of providing permanent green infrastructure services. Inclusion of protect lands is well-documented[1]. | Need to determine if a minimum size or buffer area is needed for these protected lands. |
| 2. High quality water bodies -includes reservoirs, streams, lakes, rivers | See exclusion factors below, e.g., impaired waters (303d) are removed from core areas; Buffers are incorporated as hubs (see below). All GIS data from AGRC. | |
| 3. Important wetlands within the Wasatch Front | As wetlands within Utah only consist of 0.2% of the entire state, all of the wetlands are critical to water quality and quantity (USFS National Wetland Inventory data). | Research into minimum size of wetlands to support a suite of wetland species within the Wasatch Front. |
| 4. Floodplains, where available | Incorporated in multiple green infrastructure planning efforts, including, but not limited to, the Maryland GI Plan (2003), the Travis County Greenprint for Growth Plan (2006), Cecil County, MD Green Infrastructure Plan (2007). Floodplain data for Salt Lake and Weber Counties and the Great Salt Lake are from AGRC and FEMA. | Identify floodplain data for all counties (currently only have Weber, Salt Lake, the Great Salt Lake and minimal data for Morgan). |
| 5. Restored landscapes within the Wasatch Front | Areas where counties and municipalities have actively restored hydrological assets (data from Salt Lake Co Flood Control and Water Quality Division); polylines were buffered by 50ft as per discussion with Salt Lake County staff. | Data for these core areas only exist within Salt Lake County at this time. |

| **Exclusion Factors:** | | |
|---|---|---|
| A. Remove 303(d) listed waters | 303(d) listed waters are considered impaired by federal standards, and thus, would not provide a high level of services to the region's green infrastructure network. Data from AGRC. | |
| B. Impervious areas greater than 10% (would include roads, highways, and heavily urbanized areas) | Arnold and Gibbons 1996; Schueler 1994; Schueler, Fraley-McNeal and Cappiella 2009 all list impervious areas greater than 10% as being impacted. Data derived from the National Land Cover Dataset (AGRC). | Future research should amend percentages based on proximity to stream and positions within the watershed (Brabec 2009); the Wasatch Front, similar to the Front Range, may be affected by "multiple interacting stressors" (Sprague et al. 2006, 4) that may require a less simplistic number for finer scale analyses. |
| **HUBS** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Watershed Restoration Areas | These areas could be considered core areas when restoration is complete. Data from AGRC. | |
| 2. Groundwater discharge areas, aquifers, and drinking water source protection zones | Incorporated in multiple green infrastructure planning efforts, including, but not limited to, the Maryland green infrastructure Plan (2003), the Travis County Greenprint for Growth Plan (2006). Aquifer discharge and recharge area data from AGRC; drinking water source protection zone data from UDWQ. | |
| 3. Buffers around streams<br>A. in urban areas - min. buffer of 50' on either side; expand width to include adjacent wetlands, land covers, etc.<br>b. In nonurban areas - recommendation of 100-300' for species biodiversity;<br>c. Cutthroat trout streams 30.5 m buffers<br>d. Major Rivers – 150’ | a. Brown (2000) suggests this minimum width, see also Hearty (1993);<br>b. ELI (2003);<br>c. Hickman and Raleigh (1982), see Castelle et al. (1994)<br>d. Morgan County standards for Weber River | Cities’ and counties’ individual ordinances should be examined to tailor buffers to community requirements |

| | | |
|---|---|---|
| 4. Buffers around wetlands:<br>a. In urban areas - min. buffer of 50’ for water quality;<br>b. In nonurban areas - min. of 100-300' for species diversity | a. Standards within Morgan and Salt Lake County (for planned developments) require 50’ buffers around wetlands. According to the ELI (2008), a min. of 30’ is needed for water quality (phosphorous and sediments). For nitrogen, a min. of 100’ is needed.<br>b. ELI (2008) | Consider a more detailed matrix and slope adjustments as per ELI 2008 |
| 5. Hydric soils or areas with shallow groundwater (0’) | Hydric soils (a component of wetlands) and shallow groundwater areas support groundwater/surface water interactions and could support the region's hydro assets. Data from AGRC. | |
| 6. Appropriate land covers that can serve as riparian vegetation for the high priority riparian areas | Appropriate land covers would include non-urbanized land covers (e.g., forests, grasslands, shrub/scrub, etc.) within 300 m of the surrounding core areas to reduce edge effects (ELI 2003). Data derived from the National Land Cover Dataset. | |
| **Exclusion Factors:** | | |
| B. Impervious areas greater than 25% | Schueler, Fraley-McNeal and Cappiella (2009) list impervious areas greater than 25% as being non-supporting of urban drainage. Data derived from the National Land Cover Dataset. | Original figures suggested 30% impervious percentages (Schueler 1994; Arnold and Gibbons 1996). Research within the Wasatch Front would be useful to further refine these numbers. |
| **CORRIDORS** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. High quality streams and rivers - from core analysis above | The hydrological system identified in the core and hub areas will be used as corridors, given the linear nature of the systems. | |
| 2. Canals | Serve as conduits for hydrological systems within the Wasatch Front. | Irrigation canals may or may not add to region’s water quality. |
| **Suitability Factors** | **Significance/Explanation** | **Further Research** |
| 1. Impaired water bodies would be rated less than higher quality water bodies | 303(d) listed waters are considered impaired by federal standards, and thus, would not provide a high level of services to the region's green infrastructure network. | |

[1]See Utah DFFSL 2010 Statewide Assessment document available at http://www.ffsl.utah.gov/stateassessment.php.

**References:**


Arnold, Chester L., and C. James Gibbons. 1996. Impervious Surface Coverage: The Emergence of a Key Environmental Indicator. Journal of the American Planning Association 62 (2):243 - 258.

Brabec, Elizabeth A. 2009. Imperviousness and Land-Use Policy: Toward an Effective Approach to Watershed Planning. Journal of Hydrologic Engineering 14 (4):425-433.

Brown, Kenneth. 2000. Urban Stream Restoration Practices: An Initial Assessment. Center for Watershed Protection.

Castelle, A.J., Johnson, A.W., and Conolly, C. 1994. Wetland and Stream Buffer Size Requirements – A Review. Journal of Environmental Quality 23: 878-882.

Center for Watershed Protection. 2000. The Architecture of Urban Stream Buffers. In The Practice of Watershed Protection, edited by T.R. Schueler and H.K. Holland. Ellicott City, MD: Center for Watershed Protection.

Environmental Law Institute. 2003. Conservation Thresholds for Land Use Planners. Washington, D.C.

Environmental Law Institute. 2008. Planner's Guide to Wetland Buffers for Local Governments. Washington, D.C.

Heraty, M. (1993). Riparian Buffer Programs: A Guide to Developing and Implementing a Riparian Buffer Program as an Urban Stormwater Best Management Practice. Metropolitan Washington Council of Governments. Produced for U.S. EPA Office of Wetlands, Oceans, and Watershed. Washington, DC.

Hickman, T. and Raleigh, R.F. 1982. Habitat suitability index models: Cutthroat trout. FWS/OBS-82/10.5. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Schueler, Thomas R. 1994. The importance of imperviousness. Watershed Protection Techniques 1:100-111.

Schueler, Thomas R., Lisa Fraley-McNeal, and Karen Cappiella. 2009. Is Impervious Cover Still Important? Review of Recent Research. Journal of Hydrologic Engineering 14 (4):309-315.

## HYDROLOGICAL ASSET NETWORK MAP – DESIGN PROCESS

*Hydrological Cores*

Create a new toolbox in ArcCatalog for Hydrology modeling - HydroAssets

Create Cores

#1 Core Criteria – protected lands with hydrological assets within them

Merge vector files H20ConvEasementst, Easements_hydrology and SaltLakeprotectedarea together → hydro_protected_lands

Convert to raster → hyd_protland

Reclassify to 0 and 1 for analysis → ***rc_hydprotect***

#2 Core Criteria – high quality water bodies, including reservoirs, lakes, streams and rivers

Add lakes from National Hydrological Dataset (includes reservoirs), manually remove tailings ponds sound of the Great Salt Lake (lakes), convert to raster → lakes2, reclassify → rc_lakes1

Add major rivers (majorrivers), convert to raster → majorriver3, reclassify → reclass_majorriv2

Add permanent and intermittent streams, convert to raster → streams_perm1, streams_int1, reclassify → reclass_stre1, reclass_stre_int

Using single output map algebra, add the above 4 reclassified rasters together →all_hydro5

Reclassify all values greater than 1 as 1 → ***rc_allhydro1***

#3 Core Criteria – important wetlands

Add wetlands as defined by the USFWS in the National Wetlands Inventory, clip to 10km project boundary → NWI_wetlands_clip

Convert to raster → NWI_wetlands

Reclassify → ***rc_NWIwetland***

#4 Core Criteria – floodplains

Merge together floodplains for counties with accessible data (Floodplains_SaltLakeCty, Floodplains_Weber, Davis_Floodplains, Floodplains_GSLclip) → Floodplains_All1

Convert to raster → floodplains1

Reclassify → ***rcfloodplain1***

#5 Core Criteria – restored hydrological landscapes

Add Restoration_Salt LakeCty_completed to map

Convert to raster and reclassify to 0 and 1 for analysis → ***rcslrestor***

Merge cores together

Using single output map algebra, add together the above 6 reclassified rasters → hydro_cores35

Reclassify all values above 1 as 1 and NoData as 0 → rchydrocores4

Merge core exclusion factors

Merge exclusion layers – impervious surfaces (imp_grt10pct) and 303(d) impaired waters (impair_h20) → ***hydro_excl***

Reclassify ***hydro_excl*** where 1 values are now no data and nodata values are now 1→ ***rc_hydroexcl***

Complete core analysis

Using single output map algebra, multiply the hydro_cores35 layer with the rc_hydroexcl layer → ***hydro_cores36*** – vector file is ***hydrocores5***

*Hydrological Hubs*

Create hubs

A. #1 Hub Criteria – Watershed Restoration Areas

Clip Watershed Restoration Focus Areas (UDWR Watershed Restoration Initiative) to project boundary → watershed_restoration_areas

Convert to raster → h20_restor

Reclassify → ***rc_h20restor***

#2 Hub Criteria – groundwater discharge areas, aquifers and drinking water source protection zones

Clip USGS aquifer file (includes recharge and discharge areas of principle aquifers) to new boundary → aquifer_10km_boundary

Add drinking water source protection zones (DWSPzones), select protection zones 1 through 3 (1=100-foot radius from margin of collection area, 2=area within 250-day ground water time of travel to margin of collection area, 3=area within a 3-year ground water time of travel to margin of collection area) → DWSP_Zones1-3

Merge together the aquifer_10kmboundary layer and the DWSP_Zones1-3 layer → DWSPzones_aquifer, convert to raster → DWSP_aquifer, reclassify to 0 and 1 for analysis →***rc_DWSP_aquif***

B. #3 Hub Criteria – buffered streams

i. Transform the streams (permanent and intermittent) into urban and non-urban areas to perform buffer analyses

ii. Buffer according to criteria → majorrivers_buffer150ft, streams_perm_urban_Buffer50ft, streams_perm_nonurban2_Buffer100ft, streams_intermittent_nonurban_buffer100ft, streams_intermittent_urban_Buffer_50ft, BCT_streams_100ftbuff

iii. Merge the above 6 shapefiles together → all_streams_buffered

iv. Convert to raster → allstreamsbuf

v. Reclassify to 0 and 1 for analysis → ***rc_buffstream***

C. #4 Hub Criteria – buffered wetlands

i. Transform wetlands into urban and non-urban areas to perform buffer analyses (using select by location – those wetlands that intersect with developed_land_all1) → NWI_wetlands_UrbanIntersect; NWI_wetlands_nonurban_ByIntersectSwitch
ii. Buffer according to criteria → NWI_wetlands_urban_50ftbuff; NWI_wetlands_nonurban_100ftbuff
iii. Merge the above 2 shapefiles together → NWI_wetlands_buffered
iv. Convert to raster → wetlandsbuff1
v. Reclassify to 0 and 1 for analysis → ***rc_wetlanbuf1***

D. #5 Hub Criteria – shallow ground water and hydric soils
   i. Hydric soils with percentage greater than 70% hydric components (as per conversation with NRCS State Soil Scientist) → hydric70pct
   ii. Use single output map algebra to merge together the hydric70pct layer with the rchydrodist300 layer to select all hydric soils within 300 m of core areas → hydric70pt300
   iii. Reclassify → rc_hydric300
   iv. Select ground water at a depth of 0 feet → grndh20_0ft
   v. Convert to raster → shal_grndh20
   vi. Reclassify → rc_shalgrh20
   vii. Use single output map algebra to add the rc_hydric300 layer and the rc_shalgrh20 layer → hyd_shallow
   viii. Reclassify all values above 1 as 1 → ***rc_hydshallow***
E. #6 Hub Criteria – supporting riparian land covers
   i. Select appropriate land covers, including forested (mixed, evergreen, and deciduous), grassland, wetland (herbaceous and woody), and shrub/scrub cover → hydro_landcover
   ii. Use the single part to multipart tool to "undissolve" all of the land cover areas in individual parts (polygons)
   iii. Buffer the hydro_cores layer by 30 m →hydro_cores_30mbuffer
   iv. Select by location all of those areas in the hydrolandcover_multipart that intersect the hydro_cores_30mbuffer (captures all polygons in the adjacent cells) →hydro_landcover_adjacenttocores
   v. Buffer the hydro_cores7 layer by 300 m (total of 300 m) →hydro_cores_300mbuffer;
   vi. Intersect the hydro_landcover_adjacenttocores with the hydro_cores_300mbuffer→hydrocoveradj
   vii. Convert each of the above layers to raster (output = hydrocoveradj and rchydrodist300); perform a single map output algebra to merge together those areas that are overlapping →hydrocovadj300
   viii. Reclassify hydrocovadj300 to include "nodata" values in the analysis (change from NoData to 0)→***rccovadj300***

Merge hubs together

A. Using single output map algebra, add the six reclassified raster riles together → hydro_hubs14

B. Reclassify all values greater than 1 as 1 → ***rc_hydrohubs2***

Create hub exclusion factors

A. Select impervious surfaces greater than 25% → ImperviousSurfacegrtthan25pct
B. Convert to raster → imp_grt25pct
C. Reclassify so all 1 values are 0 and NoData is 1 → ***rc_imperv25_1***

Complete hub analysis

A. Using single output map algebra, multiply the rc_hydrohubs2 layer with the rc_imperv25_1 layer → ***hydro_hubs15***

*Hydrological Corridors*

Hydrological corridors (streams and canals) are inherent in the core areas and required no additional mapping or design process.

*Final Shapefiles for Agencies and Organizations*

| | |
|---|---|
| Merged Cores | Hydrological_Cores |
| Merged Hubs | Hydrological_Hubs |

*Note – merged files have been dissolved by layer – data is extremely simplified.*

| | |
|---|---|
| Core #1 – Protected lands with hydrological assets | Protected_Hydro_Lands |
| Core #2 – High quality streams, rivers, lakes and | Streams_Rivers_Lakes_Reservoirs |
| Core #3 – Important wetlands | Wetlands |
| Core #4 – Floodplains | Floodplains |
| Core #5 – Restored landscapes | SaltLakeCounty_Restoration |
| Core Exclusion #1 – 303(d) listed waters | Impaired_Water |
| Core Exclusion #2 – Impervious areas greater than 10% | Impervious_Surfaces_Over10Percent |
| Hub #1 – Watershed restoration areas | Watershed_Restoration_Areas |
| Hub #2 – Aquifers and drinking water source | DWSP_Zones_Aquifer_Recharge protection zones |
| Hub #3 – Stream buffers | Buffered_Streams |
| Hub #4 – Wetland buffers | Buffered_Wetlands |
| Hub #5 (1) – Hydric soils | Hydric_Soils_AdjacentToCores |
| Hub #5 (2) – Shallow groundwater areas (0') | Shallow_Groundwater_0ft |
| Hub #6 – Riparian vegetation buffering core areas | Supporting_Landcover |
| Hub Exclusion #1 – Impervious areas greater than 25% | Impervious_Surfaces_Over25Percent |

## RECREATIONAL ASSET NETWORK MAP CRITERIA

Datasets include golf courses, parks, trails, trailheads, marinas, natural lands, ski areas, water bodies and waterways, threatened and endangered species areas, land cover, hazards, canals, and habitat for popular game species.

| RECRETIONAL ASSET NETWORK CRITERIA | | |
|---|---|---|
| **CORES** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Protected lands or public lands with recreational assets within them (includes the public lands that allow recreation, e.g., hunting, skiing, hiking etc. within them). | Protected lands have a higher likelihood of providing permanent green infrastructure recreational services. Inclusion of protected lands is well-documented[1]. Includes public lands that allow recreational-related access, including U.S. Forest Service, BLM, State-owned lands that allow recreation, etc. | Update this list as necessary. |
| 2. Regional trail Assets and Priorities | Regionally significant trails provide the backbone for the region's recreational green infrastructure network[2] Includes national historic trails, national recreation trails, and the respective trailheads. | |
| 3. Regional Park Assets and Priorities | Regionally significant parks provide the backbone for the region's recreational green infrastructure network[3]; If regionally significant parks were not available, minimum park sizes were incorporated. Community parks classification (over 20 acres) were employed within this study. Also includes all state parks. | Further refinement of community priorities and levels of service should be incorporated into individual city or county planning efforts. Parks can be prioritized by proximity to number of people in the prioritization stage. |
| 4. Regional Natural Lands Assets and Priorities | Regionally significant open spaces provide the backbone for the region's recreational green infrastructure network[4] Also includes the Great Salt Lake, Jordan River, Ogden River, and Antelope Island as per discussions with county planners and others for open space priorities. | |

| | | |
|---|---|---|
| 5. Other regional amenities that provide significant value, e.g., golf courses, marinas, and ski hills. | | |
| 6. Major waterways, permanent streams, and lakes. | Serve as wildlife viewing areas, fishing, boating, etc. opportunities. | |
| 7. Scenically-rich areas of the Wasatch Front, e.g., ridgelines, scenic byways and backways, etc. | The Wasatch Front represents one of the most scenically-rich areas in the country. | Establish criteria for how to determine these scenic areas in future mapping efforts. |
| **Exclusion Factors:** | | |
| 1. Threatened and endangered Species areas | Remove areas with threatened and endangered species within them to protect their habitat. | We do not have access to these data at this time – update this section as data become available. |
| **HUBS** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Suitable land surrounding the core areas that allow recreational uses. | Developed, open space areas and public lands that allow recreation. | Incorporate site specific data as it becomes available. |
| 2. Other trails, parks, and open space, not identified as core areas, that connect into the core areas. | Connectivity into the core system strengthens the overall recreational opportunities for the region. | |
| 3. Intermittent streams, washes, canyons, etc. | Washes and intermittent streams are used for recreational access. | |
| 4. Crucial or substantial habitat areas for popular game species (more than 1 species). | Includes all habitat data for areas within the Wasatch Front that is available, based on UDWR publications. | Many species data do not exist. See note below. |
| 5. Cooperative wildlife management units within the Wasatch Front | UDWR works with private landowners to maintain private lands for wildlife habitat. While these areas are not permanently protected, they do offer significant indirect value to the area's recreational opportunities. | |
| **Exclusion Factors:** | | |
| 1. Threatened and endangered Species areas | Remove areas with threatened and endangered species within them to protect their habitat. | We do not have access to these data at this time – update this section as data become available. |

| CORRIDORS | SIGNIFICANCE/EXPLANATION | FURTHER RESEARCH |
|---|---|---|
| 1. Regional trails | Prioritize regional trail connections first. | |
| 2. Other trails, public lands, open spaces, and parks | Second, connect recreational asses through other trails, public lands, etc. | As data become available, connect through public lands, such as schools, etc. that are not traditionally thought of as open space but allow access. |
| 3. Waterways | Third, connect recreational opportunities via waterways (water-based recreational activities; drainages often used as links for hiking, etc.). | As data become available, add canals with public access. |
| 4. Major Roads | Fourth, connect recreational opportunities via major roadways for driving and biking. | |
| 5. Least cost path analyses between the core areas, using acceptable land cover types. | See least cost path analysis process below. | |
| **Suitability Factors** | | |
| 1. Habitat corridors – rank these less than other potential corridors | Many species are sensitive to recreation and thus, habitat corridors should be designed around when possible. | Species corridor modeling was beyond the scope of this project and so was not included in the recreation corridor modeling. It should be considered in future planning efforts. |

1 See Utah DFFSL 2010. The DFFSL Statewide Assessment document is available at http://www.ffsl.utah.gov/stateassessment.php.

2 Regionally significant trails are as follows: Salt Lake (From Salt Lake County Parks and Recreation Master Plan 2005): Jordan River Trail, Bonneville Shoreline Trail, Great Western Trail, Mormon Pioneer Trail, Pony Express Trail, Donner-Reed Trail, Parley's Creek, Dimple Dell Trail, Utah and Salt Lake Canal Trail, and the Decker Trail; Morgan County: trail corridor along the Weber River (Envision Morgan 2008); Davis County: Bonneville Shoreline Trail, Legacy Trail, Denver and Rio Grande Rail Trail, east-west connections.

3 Regionally significant parks are as follows: Salt Lake (From Salt Lake County Parks and Recreation Master Plan 2005): Equestrian Park, West Jordan Soccer Complex, Big Cottonwood Regional Park, South Cottonwood Regional Park, Welby Regional Park, Valley Regional Park, Redwood Regional Park, and Sugarhouse Park. Weber County: use min. size thresholds; Morgan County: use min. size thresholds; Davis County: using min. size thresholds; Tooele County: using min. size thresholds.

4 Regionally significant open spaces are as follows: Salt Lake County (From Salt Lake County Parks and Recreation Master Plan 2005): Dimple Dell Regional Park, Millcreek Canyon Regional Park, Yellow Fork Canyon Regional Park; Davis County: Antelope Island, open lands in the foothills.

5 For the following game species, GIS data were available for download: band-tailed pigeon, blue grouse, California Quail, Gambel's Quail., Hungarian Partridge, ring-necked pheasant, ruffed grouse, sage grouse, sharp-tailed grouse, white-tailed ptarmigan, wild turkey, black bear, bison, desert bighorn sheep, elk, moose, mountain goat, mule deer, pronghorn, Rocky Mountain Bighorn Sheep, and snowshoe hare. Note that the following species do not have crucial or substantial habitat within the Wasatch Front (as per GIS data downloaded from UDWR): Gambel's Quail, white-tailed ptarmigan, and the desert bighorn sheep. Species GIS data was not available for the following species: bobcat, beaver, marten, mink, badger, gray fox, kit fox, red fox, cougar, ring tail, spotted skunk, striped skunk, weasel, sandhill crane, prairie dog, cottontail rabbit, or the Eurasian collared dove.

## RECREATIONAL ASSET NETWORK MAP – DESIGN CRITERIA

*Recreational Cores*

Create a new toolbox in ArcCatalog for Recreational modeling - ~RecreationalAssets

#1 Core Criteria – protected and public lands with recreational assets

Select all public lands that allow recreation – BLM, U.S. Forest Service, State Parks, etc. Merge into one layer→recreationallandowners_all

Merge the recreationallandowners_all with the easements_recreational layer→recreationallands_protected

Convert to raster→prot_reclands

Reclassify to 0 and 1 for analysis→***rc_protreclan***

#2 Core Criteria – regional trails

Merge together the historic trails, urban trails, cross country ski trails and priority trails (in footnote 2)→ all_trails

Buffer by 50 feet → all_trails_50ftbuff

Convert to raster→ trails_50ft

Reclassify to 0 and 1 for analysis→***rc_trails50ft***

#3 Core Criteria – regional parks

Select those parks that meet the core criteria described above and in footnote 3 →all_parks_over20ac1

Convert to raster→reg_parks2

Reclassify to 0 and 1 for analysis→***rc_regparks3***

#4 Core Criteria – regional open spaces

Merge together those parks listed in core criteria #4 and those listed in footnote 4→regionalopenspace4

Convert to raster→reg_open1

Reclassify to 0 and 1 for analysis→***rc_regopen1***

#5Core Criteria – other regional amenities

Merge together golf courses, marinas, ski lifts and ski hills→important_recareas

Convert to raster→recareas1

Reclassify to 0 and 1 for analysis→***rc_recareas1***

#6 Core Criteria – major waterways, permanent streams, and lakes

Merge together major waterways, permanent streams, and lakes →rec_waterways

Convert to raster→rec_waterway

Reclassify to 0 and 1 for analysis→***rc_recwater***

Merge together the core criteria 1-6

Use single output map algebra to add the above final, reclassified rasters together→rec_cores3

Use the reclassify tool to change any value above 1 to a 1 and 0 values to NoData→***rc_reccores3***

*Recreational Hubs*

Develop hub criteria

#1 and #2 Hub Criteria – public lands and open space areas that allow for recreation and remaining parks and trails

Convert rc_protreclan to vector→rc_protectland

Merge rc_protectland with the trails_6ft, regionalopenspace3, Parks_OpenSpace and NLCD_openspace layers→ prot_rechub1

Convert to raster→ rec_prothub1

Reclassify to 0 and 1 for analysis→***rcprotrechub1***

#3 Hub Criteria – intermittent washes, streams, etc.

Convert intermittent streams, washes, etc. (all_hydrology_hubs) to raster→recwater_int

Reclassify to 0 and 1 for analysis→rc_rech20int

Use single output map algebra to add the rc_rech20int to the rc_recwater layer →allhydro_hubs

Reclassify to 0 and 1 for analysis→***rc_allhydro***

#4 Hub Criteria – wildlife habitat

Game birds – use single map algebra to add each of the game birds species together, includes California Quail, Blue Grouse, Chukar, Hungarian Partridge, Ruffed Grouse, Sage Grouse, Sharp-tailed grouse, ring-necked pheasant and wild turkey→uplandgame1

Reclassify the uplandgame1 to only include areas with 2 or more values as 1 →rc_uplndgme

Big game – use single output map algebra to add each of the big game species together, including bison, black bear, elk, bighorn sheep, pronghorn, moose, mountain goat, mule deer and snowshoe hare→biggame

Reclassify the biggame to only include areas with 2 or more values as 1 →rc_biggame

Merge rc_uplndgme with rc_biggame→wildlifehab2;

Reclassify to only include values of 0 and 1→***rc_wildlife***

#5 Hub Criteria – Cooperative Wildlife Mgmt Units

Convert the CoopWMUs shapefile to raster→CWMUs

Reclassify to 0 and 1 for analysis→***rc_CWMUs***

Merge together hub criteria

Use single output map algebra to add the above final, reclassified rasters together→rec_hubs1

Use the reclassify tool to change any value above 1 to a 1, and then all nodata values to 0→***rc_rechubs1***

*Recreational Corridors – Least Cost Path Analysis*

2. Create the cost surface raster - Merge recreational cores with all the remaining recreational features
    a. Convert the rc_reccores2 layer to vector → reccores2
        i. Dissolve reccores2 by value field → rec_core_dissolve
        ii. Add field – label; start editing session – add "Cores" to the one attribute field under "label"
    b. Convert the rc_rechubs1 layer to vector → rechubs3
        i. Erase the reccores2 layer from the rechubs3 layer, leaving only hub areas that do not overlap with cores (erase function only possible with ArcInfo license) → rechubs_erase2
        ii. Dissolve by value field → rechubs_erase_dissolve
        iii. Add field – label; start editing session – add "Hubs" to attribute field under label
    c. Buffer regionaltrails3 by 15 m (for one pixel cell size)→regionaltrails_15mbuff;
        i. Dissolve the regionaltrails_15mbuff by buffer distance →reg_trails_15mbuff_dissolve
        ii. Add field – label; start editing session – add "Regional Trails" to the one attribute field under "label"
    d. Select local trails → trails
        i. Buffer by 15 meters (for one pixel size) → LocalTrails_15mbuff
        ii. Dissolve by buffer distance → LocalTrails_15mbuff_dissolve
        iii. Add field – label; start editing session – add "Local Trails" to the one attribute field under "label"
    e. Convert rc_allhydro raster (from Hub Criteria # 3) to vector → rec_waterways_forcorridors
        i. Select by attribute all areas where GRIDCODE = 1 → rec_waterways_forcorridors1
        ii. Dissolve by value field→ rec_waterways_dissolve
        iii. Add field – label; start editing session – add "Waterways" to the one attribute field under "label"
    f. Select UDOT roads with codes 1 and 2 (state and interstate highways) → roads_1and2
        i. Dissolve by value field → major_roads_dissolve
        ii. Buffer by 15 meters (for one pixel size) → major_roads_15mbuff_dissolve
        iii. Add field – label; start editing session – add "Roads" to the attribute field under label
    g. Select hazards (fault lines, fire hazard areas, liquefaction areas, problem soils, landslide areas) → rec_hazards3
        i. Dissolve by value field → rec_hazards_dissolve
        ii. Add field – label; start editing session – add "Hazards" to the attribute field under label

h. Merge the rec_core_dissolve, rechubs_erase_dissolve, reg_trails_15mbuff_dissolve, LocalTrails_15mbuff_dissolve, rec_waterways_dissolve, major_roads_dissolve and rec_hazards_dissolve → rec_corridor_permeability4 (note, this should be the cost surface file – to be renamed in raster classification)

i. Under value field, insert the following values:

| | Label |
|---|---|
| 1 | Cores |
| 2 | Hubs |
| 3 | Regional Trails |
| 3 | Roads |
| 4 | Local Trails |
| 5 | Waterways |
| 6 | Hazards |

ii. Convert to raster → ***rec_costsurf1***

iii. Add PermValue field, start editing session and insert the following values:

| OBJECTID | Value | Label | PERMVALUE |
|---|---|---|---|
| 0 | 1 | Cores | 1.0 |
| 1 | 2 | Hubs | 0.9 |
| 2 | 3 | Regional Trails | 0.8 |
| 3 | 3 | Roads | 0.8 |
| 4 | 4 | Local Trails | 0.7 |
| 5 | 5 | Waterways | 0.6 |
| 6 | 6 | Hazards | 0.1 |

*Recreational Corridors – Design Process*

1. Create study map with cores, hubs, least cost paths and linear recreational features that could serve as corridors
   a. Add cores → rec_cores2 and hubs → rechubs_erase2
      b. Add least cost paths to map → movement_prob
         i. In Symbology, select "Classified"; compute histogram; exclude data between 0 – 0.653 (retains highest value paths)
   c. Add trails → all_trails; waterways → streams_rivers; major roads → roads_1and2
2. Create new shapefile → Rec_Corridors_Existing

a. Trace existing linear recreational features that serve as connecting corridors between core areas (hub areas not considered in this connectivity analysis because they represent supporting recreational land types, not destinations – many corridors are present in hub areas)

3. Create new shapefile → Rec_Corridors_Proposed
    a. Assess areas where connectivity is lacking and draw in corridors using the following criteria
        i. Trace existing corridor features first, even if they do not completely connect two core patches – such partial corridors are included in the existing corridor shapefile – draw in proposed corridors to complete these connections
        ii. Secondly, use least cost paths to draw in corridors where connectivity is still lacking

*Final Shapefiles for Agencies* and *Organizations*

| | |
|---|---|
| Merged Cores | Recreational_Cores |
| Merged Hubs | Recreational_Hubs |
| Existing Corridors | Recreational_Corridors_Existing |
| Proposed Corridors | Recreational_Corridors_Proposed |

*Note – merged files have been dissolved by layer – data is extremely simplified.*

| | |
|---|---|
| Core #1 – Protected lands with recreational assets | Protected_Recreational_Lands |
| Core #2 – Recreational trail assets | Trails_50ftbuffer |
| Core #3 – Regional park assets | Parks_Over_20Ac |
| Core #4 – Regional natural lands assets | Regional_Open_Space |
| Core #5 – Golf courses, marinas, ski hills | Golf_Ski_Marina |
| Core #6 – Major waterways, permanent streams, lakes | Recreational_Waterways_Lakes |
| Core #7 – Scenically-rich areas | Not mapped |
| Hub #1 – Land around cores allowing recreation | Not mapped |
| Hub #2 – Other trails, parks and open space not included | Other_Parks_OpenSpace in core designations |
| Hub #3 – Intermittent streams and washes | Intermittent_Streams_Washes |
| Hub #4 – Game species habitat | Wildlife_Habitat |
| Hub #5 – Cooperative wildlife management units | Coop_Wildlife_Mgmt_Units |

## WORKING LANDS ASSET NETWORK MAP CRITERIA

Working lands asset network map includes canals, prime farmland soils, agricultural easements, irrigated agricultural land, state trust grazing leases and other cropland.

| **WORKING LANDS ASSET NETWORK CRITERIA** | | |
|---|---|---|
| **CORES** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Protected lands with working land assets within them | Protected lands have a higher likelihood of providing permanent green infrastructure services. Inclusion of protected lands is well-documented[1]. Includes county-based Agricultural Protection Areas (Tooele, Davis, and Weber County), and agricultural-related conservation easements. | Davis County APA areas are not available at this time. |
| 2. Working lands (agricultural production) on prime farmland soil | Working lands in the U.S. are rapidly disappearing[2]; thus, agricultural lands on prime farmland soil, as determined by NRCS, should be prioritized | Incorporate NRCS participants in programs in future planning efforts (those that have long-term or permanent easements through NRCS programs, e.g. EQIP, WHIP, etc., if volunteered by participants). |
| 3. Ranching and grazing lands | Includes state trust grazing leases, those lands identified as pasture/hay lands under the National Land Cover dataset, and BLM grazing allotments. | Determine grazing leases within federal lands and private lands by parcel. |
| **Exclusion Factors:** | | |
| 1. Future and existing roads that cut through - remove with buffer | Roads affect water quality and cause erosion, affecting the quality of working lands (conversation with NRCS, 10.18.10). Most studies focus on ecological effects, but sedimentation and pollution issues have been documented at 40 m (Forman 1995). | Include roads that have a management plan in place to attenuate erosion. |

| | | |
|---|---|---|
| 2. Unmanaged/unused working lands | Existing agricultural lands left fallow should not be included in core areas (but should be listed as hubs). | Data does not currently exist – include in future efforts. |
| 3. Working lands next to noxious weeds | Noxious weeds have a detrimental effect on high quality farmlands. | Future research efforts should determine an appropriate buffer size. |
| 4. Saline soils | Exclude saline soils due to hindrance on productivity (NRCS 10.18.10). | |
| 5. Threatened and endangered Species areas | Remove areas with Threatened and endangered species within them to protect their habitat. | Incorporate this exclusion when data become available. |
| 6. Remove working lands in proximity to core hydrology areas, esp. streams (for water quality protection). | Remove based on hydrology core areas; similar buffers used in the hydrology criteria. | |
| **HUBS** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. All soils of statewide importance – prime, prime if irrigated, soils of statewide and local importance. | Prime farmland soils should be protected for working lands purposes, even though they may not have working lands on them at present. | |
| 2. Other working lands | Other working lands not identified in the core areas, i.e. working lands not on prime farmland soil, non-irrigated agricultural lands. | Identify under-utilized/unmanaged agricultural lands to include within the study area in future efforts. |
| 3. Related land-covers adjacent to working lands, e.g. grasslands, forests, and other land covers that support ecological services provided by the working lands systems, i.e. pollination, biodiversity, etc. | Grasslands and other land covers support ecosystem services, e.g. water quality, pollination, biodiversity that assist working lands in functioning. Forests provide soil stability and agro-forestry related services (see DFFSL 2010). | |
| **Exclusion Factors:** | | |
| 1. Aquifer discharge areas | Working lands adjacent to an aquifer discharge area can have a negative impact on water quality (NRCS 10.18.10). | |

| | | |
|---|---|---|
| 2. Those forest lands within the Wildland Urban Interface | Higher fire frequency, due to urban encroachment, will lower the eventual value of these forests to providing ecosystem services to working lands. | |
| **CORRIDORS** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Irrigation canals | Canals support working land productivity within the Wasatch Front. | Determine an appropriate buffer for water quality for canals based on purpose (irrigation, distribution of water, etc.). Evaluate how many places canals return flows to streams and water quality. |
| 2. Major roads | Roads support transportation of products. | |

1 See Utah DFFSL 2010 Statewide Assessment document available at http://www.ffsl.utah.gov/stateassessment.php

2 American Farmland Trust (2005). Rocky Mountain Agricultural Landowners: Guide to Conservation and Sustainability. http://www.farmlandinfo.org/documents/30427/FINAL_Rocky_Mountain_Guide.pdf

Forman, Richard T.T. 1995. Land Mosaics: The ecology of landscapes and regions. Cambridge University Press: New York, NY.

## WORKING LANDS ASSET NETWORK MAP – DESIGN CRITERIA

*Working Land Cores*

Create a new toolbox in ArcCatalog for Working Lands modeling – WorkingLandsAssets

Create cores

#1 Core Criteria – protected lands with working lands assets within them

Merge together county-based Agricultural Protection Areas and ag-related conservation easements → workinglands_protectedareas

Convert to raster → wkingprotect

Reclassify to 0 and 1 for analysis → ***RcWkingprot***

#2 Core Criteria – Agricultural lands on prime farmland soil

Merge cultivated land from AGRC dominant vegetation layer (AGRC_cultivatedland_Multipart), cultivated land from the National Land Cover Dataset (landcover_cultivated_land), and agricultural land from SWreGAP data (GAP_agriculture) → all_cultivated_land

Intersect all_cultivated_land with NRCS Prime_and_Unique_Farmland → cultivatedland_on_primefarmland

Convert to raster → aglandprime1

Reclassify to 0 and 1 for analysis → ***rc_ag_prime1***

#3 Core Criteria – Ranching and grazing lands

Select pasture and hay lands from National Land Cover Dataset →NLCD_PastureHayLands_multipart

Merge above layer with SITLA_Graze_Leases, Grazingallotments_BLM_activestatus, and Nevada_allotments → grazing_ranching_lands1

Convert to raster → grazingranch4

Reclassify → ***rc_ranchland1***

Merge cores together

Using single map algebra output, add each of the above 3 reclassified rasters together → wkngcores4

Reclassify so that only 0 or 1 value are present→***rcwkingcores3***

Create core exclusion layers

#1 Core Exclusion Factor – future and existing roads with 40 meter buffer

Clip major road data to project boundary (MajorRoads_buffer10km), merge with proposed road areas (Highway_newconstruction)→merged_roads

Buffer merged_roads by 40 meters → MergedRoads_40mbuff1

Convert to raster → roads_40mbuf1

Reclassify 1 values to 0 and NoData to 1 → ***rc_roads40m***

#3 Core Exclusion Factor – working lands next to noxious weeds

Clip noxious weeds layer from AGRC to project boundary →noxiousweeds_AGRC

Select noxious weeds from dominant vegetation shapefile (from AGRC, include cheatgrass, which is not on the noxious weed list but has significant ecological and productivity ramifications)→noxiousweeds_cheatgrass

Merge the above two noxious weeds layers →noxiousweeds_all

Convert the noxiousweeds_all layer to raster → noxiousweeds1

Reclassify 1 values to 0 and NoData to 1 → ***rc_noxweeds1***

#4 Core Exclusion Factor – saline soils

Dissolve all soils layer by name →allsoils_dissolve

Select those soil layers that are saline (MUKEY= 482121,482149, 482166, 482167, 482169, 482181, 482186, 482881, 482888, 482889, 483285, 482899, 483308, 483310, 483322, 483335, 482549, 503899, 483395) →soils_saline

Convert saline soils to raster for analysis → salinesoils1

Reclassify 1 values to 0 and NoData to 1 → ***rcsalinesoil1***

#5 Core Exclusion Factor – working lands adjacent to hydrological cores

Add core hydrology areas (hydro_cores24) to the map

Reclassify 1 values to 0 and 0 values to 1 → ***rc_hydrocores***

Using single output map algebra, multiply all of the exclusion layers together → ***wkcoreexfact***

Complete core analysis

Using single output map algebra, multiply the rcwkingcores2 layer with the wkcoreexfact layer → ***wkingcores5***

*Working Land Hubs*

Create hubs

#1 Hub Criteria – all soils of statewide importance

Clip all important soils layer to the project boundary → Soils_allimportant

Convert to raster →importantsoils

Reclassify to 0 and 1 for analysis → ***rc_importsoil***

#2 Hub Criteria – other working lands

Convert all_cultivated_land feature to raster → all_cult_land

Reclassify to 0 and 1 → rc_allagland

Using single output map algebra, add together rc_allagland and rc_ranchland2 reclassified rasters → allwkngland3

Reclassify to 0 and 1 → ***rcallwknglnd2***

#3 Hub Criteria – related land covers

Merge related land covers together into a single layer (same land cover types as in hydrology) → hydro_landcover

Use the single part to multipart tool to "undissolve" all of the land cover areas into individual parts (polygons) →hydro_landcover_multipart

Use the Euclidean distance tool to calculate distance from the working land cores layer (wkngcores1)→tmpwkngcordis

Reclassify the Distance layer to have 0-30 values as 1, and all other values to NoData→wkngcor30mbuf

Export this layer to .gdb file→wkngcores_30mbuf

Select by location all of those polygons within the hydro_landcover_multipart that intersect the wngcores_30mbuf→wkng_landcover_adj30m

Buffer the working cores layer by 300 m →wkngcores_300mbuf

Intersect the wkng_landcover_adj30m with the wkngcores_300mbuf to select all land cover areas adjacent to the cores→wkngcover_adjacenttocores2

Convert each the above layers to raster (output = wkngcoveradj); reclassify for analysis: rcwkngcoveradj;

Remove WUI areas from this layer (as per hub exclusion factor #3)

Clip WUI areas to project boundary→WUI_areas

Convert to raster and reclassify to only include areas that should be included within the analysis→wui_areas and rcwui_incl;

Conduct single output map algebra multiplying rc_wui_incl to rcwkngcoveradj to only select those land cover areas not in the WUI→ ***rcwkngcovadj1***

Merge hubs together

Using single output map algebra, merge the rcimportsoils, rc_allwkngland, and rcwkngcovadj1→wkng_hubs2

Reclassify so that only 0 or 1 values are present→***rc_wknghubs2***

Create exclusion layers

#1 Hub Exclusion Factor – aquifer discharge areas

Clip aquifer discharge areas to project boundary → dischargeareas_projectboundary

Convert to raster → dischargearea

Reclassify for analysis→rcdischargearea

Reclassify 1 values to 0 and 0 to 1 (to exclude these areas in the final analysis)→discharge_incl

#2 Hub Exclusion Factor – wildland urban interface

Convert Wildland Urban Interface file to raster → WUI_area

Reclassify 1 values to 0 and NoData to 1 → rc_wui_incl

Using single output map algebra, multiply the discharge_incl layer and the rc_wui_incl layer together → ***wkhubexfact***

Complete hub analysis

Using single output map algebra, multiply the final hubs layer (rc_wknghubs2) with the hub exclusion factor layer (wkhubexfact) → ***wkng_hubs3***

### *Working Land Corridors*

Irrigation canals serve as corridors supporting the working lands within the Wasatch Front. Least cost paths analysis was deemed an unsuitable process for working lands corridor design, as plant pollination and particle movement corridors cannot be defined by least cost paths.

## COMMUNITY & CULTURE ASSET NETWORK MAP CRITERIA

Community and culture asset network map includes military lands, tribal lands, SITLA lands, historic districts, transit stops, transit lines, railroads, cemeteries, historic trails, sites of community significance, parks and open space, community and regional trails, and other lands with community assets within them.

| **COMMUNITY AND CULTURE ASSET NETWORK CRITERIA** | | |
|---|---|---|
| **CORES** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Protected lands with community assets within them (Hill Air Force Base, tribal lands) | Protected lands have a higher likelihood of providing permanent green infrastructure services. Inclusion of protected lands is well-documented.[1] These lands are significant to the sense of community and the cultural (cultural okay here – different meaning – please leave) diversity of the region. | |
| 2. Historic districts and historic easements | Significantly noted history of the area. | |
| 3. Transit stops | Transit nodes - significant means to connect humans to community resources with reduced impacts. | Future prioritization by number of population served within ¼ mile (15 minute walk) (Fairfax Co, VA Planning Commission TOD Committee). |
| 4. Parks and open space (includes rivers and cemeteries) | These elements contribute to the physical and psychological health of residents. | |
| 5. Viewsheds and ridgelines | Provide aesthetic benefits to communities and residents. | These are open for future comment, and future mapping efforts should include these elements. |
| 6. Community institutions – libraries, zoos, schools, etc. | Community institutions promote health and learning and provide gathering locations, all of which benefit communities [2]. | |

| | | |
|---|---|---|
| **Exclusion Factors:** | | |
| 1. Exclude areas with threatened and endangered species present | Remove areas with threatened and endangered species within them to protect their habitat. | Future research efforts should conduct this exclusion – data was not available to this team to conduct it. |
| 2. Hazard areas (fire hazard, problem soils, landslide areas, fault lines) | Hazard areas should be avoided in future green infrastructure investment efforts. [3] | Not shown because too many core areas would be removed. |
| **HUBS** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Protected lands not listed above with community assets within them – SITLA, BLM, and remainder of military lands. | These lands contribute significantly to the economic health of the communities and region. | |
| **Exclusion Factors:** | | |
| 1. Exclude areas with threatened and endangered species present | Remove areas with threatened and endangered species within them to protect their habitat. | Future research efforts should conduct this exclusion – data was not available to this team to conduct it. |
| 2. Hazard areas (same as above) | See above. | Not shown because too many hub areas would be removed. |
| **CORRIDORS** | **SIGNIFICANCE/EXPLANATION** | **FURTHER RESEARCH** |
| 1. Transit lines and other mass transit connections, including all highways and major roads | Significant means to connect humans to community resources. | |
| 2. Multi-modal connections, including trail corridors from recreational assets | Regional trails and other connecting trails. | |
| 3. Canals | Important landscape corridors. | |
| **Exclusion Factors:** | | |
| 1. Hazard areas (same as above) | See above. | Not shown because too many corridors would be removed. |

1 See Utah DFFSL 2010 Statewide Assessment document available at http://www.ffsl.utah.gov/stateassessment.php.

2 Community institutions are as follows: Red Butte Arboretum, Hogle Zoo, Ogden Nature Center, faith-based activity areas (200 m buffer), universities (buffer sizes vary), libraries (200 meter buffer), schools (200 meter buffer), hospitals (400 meter buffer) and elderly-care facilities (200 meter buffer).
3 Hazard areas include fault lines, high to extreme fire hazard areas, areas with high liquefaction potential, problem soil areas (expansive soils) and areas susceptible to landslides.

**References:**

Fairfax County, VA Planning Commission TOD Committee – Walking Distance Research
http://www.fairfaxcounty.gov/planning/tod_docs/walking_distance_abstracts.pdf

**Experts consulted:**

Stephen Goldsmith, University of Utah, Department of Regional Planning

## COMMUNITY & CULTURE ASSET NETWORK MAP – DESIGN CRITERIA

*Community Cores*

Create a new toolbox in ArcCatalog for Recreational modeling - CommunityAssets

#1 Core Criteria – Protected and Public Lands with Community Assets

Merge Hill Airforce Base, Tribal Lands and Easements→ Cult_prot_lands_cores

Convert to raster→ comprotland

Reclassify to 0 and 1 for analysis→***rc_commprot***

#2 Core Criteria – Historic Elements

Merge Historic Districts with Historic Easements → Hist_Districts_Easements, convert to raster → hist_areas, reclassify to 0 and 1 for analysis → ***rc_histareas1***

#3 Core Criteria – Transit Stops

Merge together Commuter Rail Stops and Light Rail Stations → commuter_light_rail_stops, buffer by 400 meters (.25 mile) → transitstops_400mbuff, convert to raster → transstop_buf, reclassify to 0 and 1 for analysis → ***rc_stop_buf1***

#4 Core Criteria – Parks and Open Space

Merge together local parks and state parks → all_parks1, convert to raster →all_parks3, reclassify to 0 and 1 for analysis → rc_allparks4

Buffer cemeteries by 400 meters → cemeteries_400mbuff, convert to raster → cemetery_buff, reclassify to 0 and 1 for analysis → rc_cem400m

Buffer rivers by 100 meters → rivers_100mbuff, convert to raster → rivers_100m, reclassify to 0 and 1 for analysis → rc_rivers100m

Convert AGRC Great Salt Lake shapefile to raster → gsaltlake, reclassify → rc_saltlake

Use single output map algebra to add the above 4 layers→opencore, reclassify so all values 1 or higher equal 1 → ***rc_opencore8***

#6 Core Criteria – Community Institutions

Merge together all buffered points from footnote 2 →placepointsbuffer_all, convert to raster → placepoints4, reclassify to 0 and 1 for analysis → rc_plcpoints2

Merge together all polygons from footnote 2 → Comm_Areas, convert to raster → comm_areas, reclassify to 0 and 1 for analysis → comm_areas1

Use single output map algebra to add the above 2 layers → ***rc_cultcores4***

Merge together the core criteria 1 – 6

Use single output map algebra to add the above final, reclassified rasters together → cc_cores4

Use the reclassify tool to change any value above 1 to a 1, and then all nodata values to 0 → ***rc_cc_cores4***

*Community Hubs*

Develop hub criteria

#1 Hub Criteria – protected lands not covered in core #1 with community assets within them (BLM, SITLA, military lands other than Hill AFB)

Merge together all lands listed above →comm_protland_hub

Convert to raster → protland_hub2

Reclassify to 0 and 1 for analysis → ***rc_prot_hub4***

*Community Corridors*

iv. Develop corridor criteria

iii. #1 Corridor Criteria – transit lines, highways and major roads

Merge together Commuter Rail Routes, Light Rail Lines and Railroads →commuter_lightrail_railroad_routes, buffer by 200 meters → transitlines_200mbuff, convert to raster →translinebuf, reclassify to 0 and 1 for analysis → rc_trlinebuf1

Select major roads from AGRC (includes interstate highways, state highways, and local major roads) → roads500K_newboundary, buffer by 200 meters → major_roads_200mbuff, convert to raster → majroads_200m, reclassify → rc_mroads200m

Add the above two layers using single output map algebra → transitcorr, reclassify so all values above 1 equal 1 → ***rc_transcorr***

#2 Corridor Criteria – Multi-modal connections, including regional and local trails

Buffer trails by 50 meters → trails_50mbuff

Buffer regional trails by 50 meters → reg_trails_50mbuff

Merge the above two layers together → all_trails_50mbuff, convert to raster → alltrails_50m, reclassify → ***rc_trails50m***

#3 Corridor Criteria – Canals

Buffer canals by 50 meters → canals_50mbuff, convert to raster → canals50m, reclassify to 0 and 1 for analysis → ***rc_canals50m***

v. Merge together the corridor criteria 1 – 3

Use single output map algebra to add the above final, reclassified rasters together → cc_corridor

Use the reclassify tool to change any value above 1 to a 1, and then all nodata values to 0 → ***rc_cc_corr***

*Final Shapefiles for Agencies and Organizations*

| | |
|---|---|
| Merged Cores | Community_Cores |
| Merged Hubs | Community_Hubs |
| Merged Corridors | Community_Corridors |

*Note – merged files have been dissolved by layer – data is extremely simplified.*

| | |
|---|---|
| Core #1 – Protected lands with community assets | Protected_Cultural_Lands |
| Core #2 – Historic districts and historic easements | Historic_Districts_Easements |
| Core #3 – Transit stops | Transit_Stops_400mbuffer |
| Core #4 – Parks and open space | Open_Space_Areas |
| Core #5 – Viewsheds and ridgelines | *Not mapped* |
| Core #6 – Community sites | Community_Sites |
| Hub #1 – Other protected lands with community assets | Hub_Other_Protected_Lands |
| Corridor #1 – Transit lines and major roads | Transit_Lines_200mbuffer |
| Corridor #2 – Trails | Trails_50mbuffer |
| Corridor #3 – Irrigation canals | Canals_50mbuffer |