Bryce Valley Watershed Areawide Resource Plan

Garfield County, Utah

Cannonville, Henrieville, and Tropic, Utah
October 2009

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Areawide Resource Plan

Developed in cooperation with:
Bryce Valley area residents
Bryce Valley area representatives
Cannonville Irrigation Company
Henrieville Irrigation Company
Tropic and East Valley Irrigation Company
Garfield County Commission
Canyonlands Conservation District
Paria Grazers Association
National Park Service
US Forest Service
Bureau of Land Management

Prepared by:
United States Department of Agriculture
Natural Resource Conservation Service (NRCS)

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1.0 Preface

1.1 Acknowledgement

The Bryce Valley Watershed/Areawide Plan is the result of the efforts of numerous individuals representing many groups and organizations with a common interest in water resources and the protection of watershed resources. Many hours were spent gathering information, completing inventories, attending meetings, writing reports, analyzing data, and developing recommendations. We express our appreciation to those individuals who have assisted in the preparation of this document.

1.2 Areawide Planning

Areawide planning is both natural resource problem-solving and management process. It is a voluntary, comprehensive effort to consider all natural resources within the planning area along with economic and social considerations. Areawide planning through a voluntary locally-led effort assesses the natural resource conditions and needs, sets goals, identifies programs and resources to solve those needs, develops recommendations, implements those recommendations, and measures their success. Areawide plans are developed through informal or formal groups and may include any combination of interested stakeholders. These stakeholders include agricultural landowners, agricultural operators, urban landowners, homeowner associations, agencies, conservation groups, schools, organizations, and individuals. The stakeholders work as a team to create and implement ways to resolve natural resource issues within their specific watershed.

The NRCS objective in conservation planning is the sound use and management of soil, water, air, plant, and animal resources to prevent their degradation and ensure their sustained use and productivity while also considering related human social and economic needs.

1.3 Authority

Funding for this plan is provided through a Congressional Earmark. A Congressional Earmark is a sum of money appropriated by Congress for a specific project or purpose. During Fiscal Year 2008, Congress appropriated funds to USDA-Natural Resource Conservation Service (NRCS) to provide technical assistance to the Bryce Valley area and Garfield County to produce an areawide planning document to identify resource concerns in Bryce Valley and evaluate potential actions to solve those concerns within the area. Feedback from a local stakeholders' scoping meeting supports the area boundaries included in the study.

2.0 Executive Summary

2.1 Purpose

The Bryce Valley Areawide Plan (Plan) describes resource concerns within the watershed as identified by the local communities and other stakeholders. The Plan addresses potential solutions including the implementation of best management practices (BMPs). By looking at resource concerns on a watershed level, all land ownerships are taken into account in addressing potential solutions. The coordination of resource treatments provides for maximum resource and economic benefits.

The plan provides guidance and baseline resource information to implement conservation practices that can benefit natural resources in the Bryce Valley watershed. As they are implemented, the recommended actions and strategies will improve the condition of natural resources.

The plan provides direction and support to develop individual conservation plans and agency management plans. These conservation plans target specific needs of land managers while adhering to the objectives of the Plan. Conservation plans are voluntary and include practices, management strategies, and implementation timetables with the intent of conserving resources and improving agricultural production.

2.2 Existing Condition

Through coordination with stakeholders, seven key resource concerns in the watershed have been identified. The undesirable resource conditions include:

Irrigation system conditions. Naturally high rates of erosion occurring in the watershed cause siltation of storage ponds resulting in reduced storage capacity and a reduction of conveyance capacity due to sediment in pipes.

Condition of drainage corridors and pond above Tropic. The town of Tropic is lies below steep upper watershed slopes subject to high runoff flows generated from storm events. A series of channels and a pond embankment exists to protect the town of Tropic from flooding. The existing embankments are in poor condition. Numerous trees and other vegetation are growing in the embankments, compromising their integrity

Declining quality of rangeland vegetation. Range land is degraded in some areas where past management and recent droughts has resulted in invasive weeds, lack of cover, and loss of soil to erosion. In other areas Pinyon Pine and Juniper have become the dominant species, limiting the amount of browse available.

Encroachment of invasive species. Invasive species within the watershed include Salt Cedar (*Tamarix* sp.) or Tamarisk, cheat grass *(Bromus tectorum*) and Russian Olive (*Elaeagnus angustifolia*). Invasive and non-native species often displace and out-compete native species and can

contribute to changed environmental conditions. The problem of invasive plants are most severe in aquatic and riparian areas and less severe in uplands.

River corridor/streambank stability: Streambank erosion and the lack of woody riparian vegetation have resulted in a loss of some lands along the stream corridors in the study area.

Local economic and land use concerns. Economic development in agricultural areas is an ever increasing problem. Agriculture and ranching needs to be maintained as a sustainable economic and cultural lifestyle. Few opportunities exist for young people who wish to stay in the communities. The few productive lands available for agriculture are threatened by development.

2.3 Objectives and Potential Actions

Objectives are used to describe the intentions of the stakeholders in the study area. They are an expression of the desired future state of the resources compared to current conditions. The list of potential actions serves as a guide toward meeting the objectives resulting in enhanced natural and social resources within the watershed.

Objective 1: Reduced operation and maintenance costs of irrigation system. Reduced interruptions of service.

Potential Action(s):

- Repair and upgrade Cannonville, Henrieville, and Little Creek diversion structures.
- Repair and/or upgrade Mossy Cave structure.
- Upgrade conveyance lines and automate control structure.
- Evaluate sediment accumulation in ponds.
- Hold an irrigation management seminar for landowners and irrigators.

Objective 2: Improved hydraulic capacity of drainage corridors above the town of Tropic for high runoff events.

Potential Actions:

- Rebuild pond embankments above Tropic to meet current design standards.
- Development and implement embankment maintenance plan to ensure continued structure integrity.
- Replace current culvert road crossing for meet 25/100 year flow.
- Build diversion dike at Bryce Creek Bridge to ensure flows are contained to go under the road into Campbell Creek drainage.
- Dredge ponds to increase storage capacity

Objective 3: Improved Private and BLM allotment rangeland forage quality and quantity.

Potential Actions:

- Support BLM's initiative on rangeland improvement treatments.
- Make range improvements to private property with interested landowners.
- Create a plant materials demonstration plot.
- Support grazing technical assistance for allotment and land owners.

Objective 4: Reduced spread of invasive and noxious weeds in both range and riparian habitats.

Potential Actions:

- Remove Tamarisk and Russian olive along stream banks, and replant with native vegetation.
- Reduce noxious weeds as part of range improvement actions.

Objective 5: Restore riparian conditions to protect private land against loss from stream channel erosion and siltation of diversion ponds.

Potential Actions:

- Implement channel stabilization practices to restrict channel with and reduce flow velocities. Recommended treatments include placement and anchoring of coarse woody debris, root wads, and boulders. The upper portion of Henryville Creek is a priority area.
- Establish hydrophilic vegetation in areas where channel stabilization has been realized using appropriate mix of native trees, shrubs, greases, sedges and rushes.
- Remove tamarisk, Russian Olive, and other invasive species through chemical, physical (fire) or biological methods. Noxios weed control efforts should be coupled with restoration of desirable native vegetation.
- Implement BMPs for grazing management in riparian areas including exclosure and alternate water sources.
- Restore natural flows to the greatest extent possible by maintaining irrigation infrastructure, adopting water conservation policies, and other actions.

Objective 6: Protect and enhance the quality of life and the environment, while creating job opportunities for citizens in the Bryce Valley communities.

Potential Actions:

- Continue agricultural education in classrooms and local associations through the Canyonlands Soil Conservation District.
- Create small business opportunities that diversify the local economy.
- Create an economic strategy to take advantage of tourism that enhances agricultural and historical ties.
- Coordinate with Color Country/Canyonlands Resource Conservation and Development Council (RCD) to write grant proposals that focus on community and economic development.

Objective 7: Protect agricultural lands from development.

Potential Action(s):

- Identify local, state, and federal programs that can be used to protect agricultural land use

Table 1. Comparison of Costs and Benefits for Potential Resource Improvements.

Potential Resource Improvement	Cost Est.$	Benefits	Objectives
Objective 1			
Repair/replace Cannonville diversion structure		Increase efficient water delivery and use. Meet safety standards. Reduce maintenance costs. Reduce need for access to the structures either More efficient water use, higher crop vigor and reduced risk of salinization.	Reduced operation and maintenance costs of irrigation system. Reduced interruptions of service.
Repair/replace Henrieville diversion structure			
Repair/replace Little Creek diversion structure			
Upgrade conveyance lines			
Conduct irrigation management seminar			
Monitor water use, psi, maintenance costs and BMP implementation and effectiveness	$5,000		
Total Estimated Costs Objective 1			
Objective 2			
Rebuild pond embankment above Tropic		Reduced risk of structure failure that could result in flooding and damage to the town of Tropic.	Improved hydraulic capacity of drainage corridors above the town of Tropic for high runoff events.
Replace Culvert			
Build diversions structure at Bryce creek			
Dredge retention pond			
Develop and implement embankment maintenance plan			
Monitor structure integrity and storage capacity	Avg of $800/yr for 5 yrs		
Total Estimated Costs Objective 2			
Objective 3			
Mud Springs Seeding – 600 acres	60,000	Lands re-vegetated with the appropriate cover types will result in increased soil stability, greater browse, improved and wildlife habitat Reduced fire risk	Improved Private and BLM allotment rangeland forage quality and quantity. Reduced spread of invasive and noxious weeds in both range and riparian habitats.
Coal Bench Seeding – 2,000 acres	200,000		
Lower Sagebrush Benches Seeding – 3,000 acres	300,000		
Sub-Total Seeding Projects	**560,000**		
Bulldog Bench Brush Management– 900 acres	90,000		
Coal Bench Brush Management – 1,100 acres	110,000		

Sub-Total Brush Management Projects	**200,000**		
Prescribed Grazing	90,000		
Grazing Land Conservation Plans	100,000		
Plant materials Demonstration Plots	25,000		
Bulldog Bench Stockwater Development	35,000		
Total Rangeland Improvements	**1,010,000**		
(Objective 4 cost estimates are included in Objectives 3 and 5)			
Objective 5			
Remove invasive species and re-vegetate stream banks with native species		Reduced sediment delivery to the Paria River. Meet beneficial use standards for agriculture. Protect crop vigor and soil productivity. Increase the lifespan, reduce maintenance costs and maintain efficiency of irrigation infrastructure. In-stream and riparian habitat improved.	Reduced stream channel erosion on private land. Reduced spread of invasive and noxious weeds in both range and riparian habitats.
Develop BMP implementation plan for grazing management in riparian areas			
Implement BMP Management Plan possibly including exclosures and alternate water sources			
Establish permanent photo plots along stream bank. Conduct PFC assessment. Conduct BMP implementation and effectiveness monitoring			
Estimated Costs Objective 5			
Objective 6 and 7			
Conduct agriculture education		Create a more stabile economic and social structure that promotes the continuation of agricultural lifestyle	Protect and enhance the quality of life and the environment, while creating job opportunities for citizens in the Bryce Valley communities. Protect agricultural lands from development.
Cooperate in economic development planning			
Estimated Costs Objectives 6 and 7			

3.0 Watershed Description

The Bryce Valley watershed is located in the south central part of Utah (See Figure 1). It is within Garfield and Kane Counties, approximately 28 miles southeast of Panguitch, Utah. State Highway 12 is the principal transportation route through the study area connecting the towns of Cannonville, Henrieville, and Tropic. The area includes private, state, and federal lands, including Grand Staircase National Monument, Bryce National Park, and the Dixie National Forest.

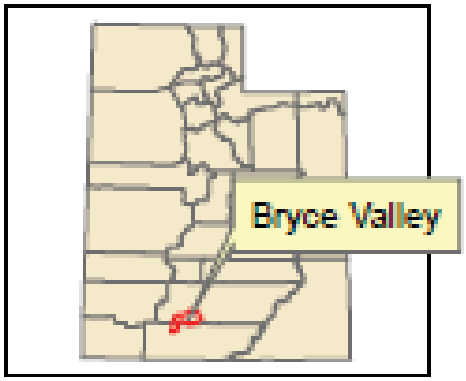

Figure 1. Watershed Vicinity

The Bryce Valley watershed study area includes two watershed sub-basins: the upper Paria River Sub-basin, and the Upper East Fork Sevier River Sub-basin. A portion of the Upper East Fork Sevier River watershed is also included in the study because irrigation water from the Sevier River is diverted from the Tropic Reservoir through a canal and pipe system into the Paria watershed.

3.1 History and Settlement

Archaeological surveys of the Paunsaugunt plateau show that people have been in the area for at least 10,000 years. Basketmaker-period Anasazi artifacts several thousand years old have been found south of Bryce Canyon National Park. Other artifacts from the Pueblo-period Anasazi and the Fremont culture (up to the mid-12th century) have also been found.

The Paiute Indians moved into the surrounding valleys and plateaus in the area around the same time that the other cultures left. These Native Americans hunted and gathered for most of their food, but also supplemented their diet with some cultivated products.

It was not until the late 18th and the early 19th century that the first European Americans explored the remote and hard-to-reach area. Mormon scouts visited the area in the 1850s to gauge its potential for agricultural development, use for grazing, and settlement (Tufts 1998).

U.S. Army Major John Wesley Powell led the first major scientific expedition to the area in 1872. Powell, along with a team of mapmakers and geologists, surveyed the Sevier and Virgin River area as part of a larger survey of the Colorado Plateaus. His mapmakers kept many of the Paiute place names.

The Church of Jesus Christ of Latter-day Saints sent Scottish immigrant Ebenezer Bryce and his wife Mary to settle land in the Paria Valley because they thought his carpentry skills would be useful in the area. The Bryce family chose to live right below Bryce Canyon Amphitheater. He built a road to the plateau to retrieve firewood and timber, and a canal to irrigate crops and water animals. Other settlers soon started to call the place "Bryce's canyon", which was later formalized into Bryce Canyon.

A combination of drought, overgrazing and flooding eventually drove the remaining Paiutes from the area and prompted the settlers to attempt construction of a water diversion channel from the Sevier River drainage. When that effort failed, most of the settlers, including the Bryce family, left the area. Bryce moved his family to Arizona in 1880. The remaining settlers dug a 10 mile (16 km) ditch from the Sevier's east fork into Tropic Valley.

In 1889 a shortage of water for irrigation and the consequent limitation of arable land in the upper Paria Valley gave rise to a scheme for diverting water from the East Fork of the Sevier River, a 14 mile distance on the Paunsaugunt Plateau, over the east rim of the Plateau and 1500 feet down into the Valley. Locally financed by the Cannonville and East Fork Irrigation Company, work was begun on May 15, 1890. During the summer of 1891, local confidence increased and a town site was laid out, named Tropic to reflect the locale's summer climate. The Tropic Canal was completed on May 23, 1891. This not only insured the village of Tropic's future, but also made it the most important settlement east of Bryce Canyon National Park (Park Service 2009).

3.2 DEMOGRAPHICS

The most recent demographic data for the area is the 2000 U.S. Census, which makes the detailed information in this section somewhat out of date. Assuming that the relative status of the local economy in comparison with Garfield County, the State of Utah, and the U.S. as a whole, has remained constant during the past eight years, the data can still provide a useful overview of the local community and its economy. The Census Bureau made population projections for 2007 for all three towns in the valley. The population in the valley is expected to have declined from 815 in the year 2000 to 743 in 2007, a net loss of 72 residents.

With a median[i] age of 35.9, the population of Bryce Valley is somewhat older than those of Garfield County, Utah, or the U.S. with 33.8, 27.1, and 35.3 years respectively. The population in the valley is less racially diverse than the populations of the comparison groups. Within Bryce Valley, slightly more than six percent of residents consider themselves non-white, Hispanic, or Latino. In contrast, more than 37 percent of all U.S. residents consider themselves either non-white, Hispanic, or Latino.

The average sizes of households and families in Bryce Valley are very similar to those of Garfield County and the State of Utah. The average household in the area is composed of 2.98 individuals, while average family size is 3.42, differing only slightly from the averages for the County and State, but larger than those of the U.S., for which average household size is 2.59 and average family size is 3.14. In Bryce Valley, 23.5 percent of housing units were vacant in 2000, compared to Garfield County at 43 percent, Utah at 8.8 percent, and the U.S. at nine percent. Sixty-two percent of housing units in the valley were occupied by their owners in the year 2000. See Appendix A for additional Census Data

3.3 Socio-Economic Characteristics

The majority of residents of Bryce Valley who are 25 years of age or older—88.9 percent—have earned a high school diploma or higher level of education. This percentage is higher than those of the County, State, or U.S. 20.62 percent of the population has obtained a bachelor's degree or higher. About half of the population over fifteen years of age was married at the time of the 2000 Census. This percentage is lower than those of any of the three comparison populations. Civilian veterans made up 9.33 percent of the population in Bryce Valley, and 15.83 percent of residents over the age of four were classified as having disability status. This disabled population ratio was just slightly higher than those of the County or State, but it was well below the U.S. percentage, which was 19.3 percent as of the year 2000.

Less than one percent of residents were born outside of the U.S., and just over two percent of residents spoke a language other than English within their homes. In contrast, 11.1 percent of the U.S. population was foreign born and 17.9 percent spoke another language at home.

Income in Bryce Valley is lower than in any of the comparison populations, as shown in Table 2. Although income is lower, poverty rates are lower in Bryce Valley than they are in the comparison areas. At 3.8 percent, the individual poverty rate in the study area is less than half of those of Garfield County and the State of Utah, at 6.1 and 6.5 percent, respectively, and it is less than one third of the individual poverty rate of the U.S., which was 12.4 percent as of the 2000 Census.

Table 2. Income by Geographic Area. Income in Bryce Valley, median household, median family, and per capita (per person) incomes in the community are all lower than Garfield County, the State of Utah, and the U.S. as a whole. (US Census 2000)

Income	Bryce Valley	Garfield County	State of Utah	U.S.
Median household income in 1999 (dollars)	$33,250	$35,180	$45,726	$41,994
Median family income in 1999 (dollars)	$37,125	$40,192	$51,022	$50,046
Per capita income in 1999 (dollars)	$12,536	$13,439	$18,185	$21,587

The median value of homes in Bryce Valley is lower than the median values of homes in the County, State, or nation. In the valley, the average median home value is $86,867, while it is $90,500 in Garfield County as a whole, $146,100 in the State of Utah, and $119,600 in the U.S. With average median monthly mortgage costs of $814 and average median rental costs of $191, Bryce Valley is a more affordable place to live than is either the State of Utah as a whole or the U.S. At $786, Garfield County median monthly mortgage costs are slightly lower than those of Bryce Valley, but median rental costs in the county—$213 per month—are somewhat higher than they are in the valley.

3.3.1 Previous Economic Planning and Analysis Efforts

The economic aspects of the Bryce Valley areawide natural resources plan fit within a framework of previously developed economic plans. Over recent years, the County, Utah State University (USU) Extension, University of Utah Bureau of Economic and Business Research (BEBR), Southern Utah University (SUU), Envision Garfield, the Southwest Utah Planning Authorities Council (SUPAC), and managers of federal and state lands and their respective agencies have undertaken various planning efforts. Some of these efforts were conducted in cooperation with the Governor's Office of Planning and Budget (GOPB) and with support from various elected officials' offices and staffs.

Figure 2. Bryce Valley Church

In December 2007, Garfield County published an economic development plan that summarized the results from a twelve-month planning effort conducted by a fifteen-member planning team with contributions from additional members of the community and from regional, state-level, and university system resources. The plan identifies economic challenges and opportunities within the county and lays-out goals, objectives, and action items with the intent to "achieve a more widely shared and sustainable quality of life, to increase local tax base, and to create industry/job diversification." The plan makes eight specific recommendations for economic development within the County as a guide to County leaders.

One of the studies conducted in the course of developing the economic development plan was an assessment of each sub-region of the County identifying strengths, weaknesses, opportunities, threats. The report's table summarizing these characteristics for the Bryce Valley area is shown as below.

Goal 3 in the County's economic development plan is "With the appropriate partners, work to support and strengthen the Agriculture and Natural Resources sectors of Garfield County's economy." The current areawide planning effort for Bryce Valley is consistent with this county-wide goal and provides support in reaching the agriculture-related objectives that fall under this goal, including searching for new agricultural opportunities and identifying new markets for locally-raised agricultural products.

CENTRAL REGION: **Bryce valley, Tropic, Cannonville, Henrieville**	
Strengths	**Weaknesses**
Locally owned utilities	Distance to medical care
Strong work ethic	Lack of access to resources
Strong families and family values	Cyclical work
Good schools	Lack of cultural diversity
Good geographic location in the County	Small private land base
	Loss of local control (federal lands)
	Cultural attitude
Opportunities	**Threats**
Outdoor adventure	Lack of local networking
Tourists	Federal lands
Alton Coal	
Oil in Johns Valley	
Winter visitors - keep highway (143) open above Panguitch Lake	
Brewery/vineyards	
Winter tourism	

Figure 3 Socio-Economic Characteristics of Bryce Valley

SUPAC holds regular meetings during which representatives from multiple land management agencies, planning entities, and local, regional, State, and national government agencies and offices present reports on planning within the region and discuss various issues of interest to the attending individuals and the organizations they represent.

In 2008, the BEBR at the University of Utah, under the direction of the Southwestern Utah Economic Consortium, prepared an extensive report on the demographic and socio-economic trends in Beaver, Garfield, Iron, Kane, and Washington counties (Utah 2008). This report states that while other counties in the region have experienced rapid population growth, Beaver and Garfield counties have remained relatively stable in terms of total population. BEBR projects that in the year 2020, the population of Garfield County will reach 5,843. This represents an increase of 1,080 over the county population in 2000, putting Garfield County at the lowest projected percent increase in population out of the five counties studied in the report. As stated above, Census Bureau projections indicate that the population of Bryce Valley is expected to have actually declined during the period of 2000 to 2007. Only future data gathering will confirm whether this expectation is realized.

The USU Economics Department, in cooperation with the Extension program, prepares agricultural profiles for each of the counties in Utah. The most recent profile of Garfield County indicates that in 2002 there were 79,879 acres in farms or ranches within the County, as reported by the 2002 Census of Agriculture. The value of livestock and crops produced in the County was worth $6,000,000 at the time. The report lists Tropic as one of the main agricultural areas in the County, with alfalfa being its main crop. The majority of irrigation in the area uses wheel line sprinklers, although a few pivot sprinkler systems have been installed.

In addition to the studies and planning efforts mentioned above, multiple small-scale and ongoing planning efforts have been completed or are underway within the County or region. The Five County Association of Governments, in cooperation with USU Extension and SUU's Regional Services, provides a "circuit planner" to assist smaller communities that do not have planning staffs of their own. The various federal agencies with land holdings in the County each follow their own planning procedures, working together with the County and other local government entities to plan and carryout various types of economic and natural resource enhancement projects.

All of the planning efforts described in this section were initiated with the intent to improve economic conditions within Garfield County and the surrounding region. Economic and demographic data have shown that economic conditions have improved in the region; however, the economy of Bryce Valley does not necessarily follow the same trends as the economies of Garfield County, the State of Utah, or the U.S.

One of the characteristics that attract people to places such as Bryce Valley is the combination of traditional rural landscapes and beautiful outdoor surroundings. This set of characteristics opens the door to many possible opportunities for economic development through diversified

activities and events. Some possible activities that could bring more business to the community include:

- Music, agriculture, outdoors, recreation, arts, cultural, or sports festivals
- Additional types of running or bicycle races
- Bird-watching tours or events
- Scientific conferences or tours
- Winter sports activities (cross-country skiing, snowshoeing, etc.)
- Roadside produce and/or specialty goods stands

Figure 4 Aesthetic Improvements in downtown Tropic

3.4 Land Ownership and Land Use

The Bryce Valley watershed is approximately 197,777 acres (Plate 1). A large percentage of the land is administered by Federal Agencies, including the BLM (Grand Staircase Escalante National Monument), the Forest Service (Dixie National Forest), and the Park Service (Bryce Canyon National Park). Kodachrome State Park and other state lands are also located within the study area. These lands are used for multiple purposes such as grazing for livestock, wood production, hunting, fishing, and camping. Only eight percent of land in the study area is privately owned (Table 3). While payment to the state for "lost" tax revenue helps pay for state and county services in the study area, it also limits possibilities for development. Much of the privately owned land is the most productive agricultural land. When development occurs, productive lands are lost. Most of the privately owned land either is used for agriculture or is developed.

Table 3. Land Ownership within the Bryce Valley Watershed, by Area and Percent of Watershed. *Area includes the Tropic Reservoir watershed area due to use of the reservoir for irrigation water in Bryce Valley.*

Managing Agency	Acres	Percent
Private Lands	15,201	8%
State Trust Land	2,048	1%
BLM	62,550	32%
US Forest Service	95,039	48%
State Parks and Rec.	3	0%
National Park Service	22,934	12%
Total	**197,777**	**100%**

3.5 Climate

Due to the wide range in elevation within the watershed, there is also a wide variation in the climate. The lower elevations of the watershed are semiarid, characterized by low precipitation with hot summers and cold winters, with fall thunderstorms. The upper most slopes of the planning area receive most of its moisture in the form of snow during the winter months.

Average annual precipitation in the watershed varies from 12 inches in the valley to 19 inches on the plateau. The Tropic weather station shows that July, August, and September are the wettest months with over one inch of moisture falling each month.

Temperatures at Bryce Valley range from -32° F in January to 106° F in June. January usually has the coldest average monthly temperature at 15° F and the highest average in July of 85° F. The average growing season (number of days between the last killing frost in the spring and the first killing frost in the fall) in Tropic is 119 days.

See section 4.2 for more discussion on climate of specific Ecological Zones within the study area

3.6 Topography

The study area is bordered on the west by the Paunsaugunt Plateau and on the northeast by the Table Cliff Plateau with an elevation range of 7200 to 9100 feet above sea level. Cliffs, hoodoos (rock chimneys), cathedrals, narrow mesas, and buttresses form at the edge of the plateau, where the elevation drops to the valley floor. The town of Tropic lies in the upper part of the valley, at 6595 feet above sea level. Moving south from Tropic, the elevation drops gradually along the Paria River corridor.

3.7 Geology

The Paria River flows through a series of benches and cliffs that form the Grand Staircase region. From its headwaters approximately five miles northeast of Tropic, Utah, to where it joins

the Colorado River near the town of Lee's Ferry, Arizona, the Paria River cuts through seven sedimentary strata of several geologic formations ranging from Late Triassic to Early Tertiary (middle to late Eocene) in age (UT DWQ).

The upper section of the Paria River flows through the Claron Formation in the northwestern part of the study area. The Claron is characterized by upper white limestone and lower pink limestone members (Bowers, 1972), which are continuous throughout the Markagunt, Paunsaugunt, Seiver and Table Cliffs Plateaus (GSA, 2002).

As the river flows south to Cannonville, it crosses the Wahweap Sandstone and Tropic Shale Formation and Dakota Sandstone. The Wahweap is composed of interbedded mudstones, siltstones, sandstones, and conglomerates (Doelling, et al., 2000), that accumulated in fluvial, flood plain and lacustrine environments. Locally rich fossil-bearing sections of the Wahweap contain petrified wood, vertebrates (including dinosaurs), and gastropods. The Tropic Shale is characteristically blue-gray in color and represents deposition of muds in a deep water marine environment. It forms distinctive slopes that are prone to landslides and slumps that likely contribute much of the sediment loading to the Paria. Bentonite beds are abundant throughout the Tropic Shale and are correlated with well established ammonite biozones (Cobban, et al., 2000) The lower part of the Tropic Shale contains limestone concretions, rich in molluscan fauna, whereas the upper Tropic becomes sandy (GSA, 2002). The Dakota Sandstone is composed of sandstone, conglomerate, mudstone, siltstone and coal deposited in coastal flood plain and shallow marine environments (UT DWQ).

3.7 SOILS

3.7.1 Sedimentation

For general planning purposes, a simple evaluation of the potential sediment yield from Paria and Henrieville Watersheds was calculated using the Pacific Southwest Interagency Committee (PSIAC) sedimentary yield procedure. The watersheds encompass approximately 183 square miles or 117,511 acres (see Map Plate 3). Sediment yield for the study area was calculated to be 544,068 tons per year using the 1996 PSIAC study. This amounts to approximately 4.63 tons/acre per year. However, there is a large variability within the watershed as some areas have a calculated sediment yield of 0.5 tons/acre per year on the Lower Watershed Sagebrush Benches up to 10 tons/acre per year at the Upper Watershed Badland slopes of Henderson Creek.

The Upper Sevier Watershed was not evaluated because it has no significant sedimentation issues. It lies completely within the Paunsaugunt plateau and mostly consists of gentle forested slopes with a high percentage of ground cover.

3.8 HYDROLOGY AND WATER RESOURCES

The Paria River drains the GSENM's west central area into Arizona and eventually the Colorado River. The towns of Tropic, Cannonville, and Henrieville, located high in the drainage, are the

highest concentration of private and municipal water rights. Most of the mainstem of the Paria River within the GSENM flows on a perennial basis, with small reaches near the upper and lower extremities of the river within the Monument that are typically dry. The flowing reaches are fed by subsurface flows, springs and other groundwater expressions, and by bank storage after high flows. Map Plate 2, Stream Hydrology, shows the primary stream network. Many of the stream reaches are not perennial. The BLM estimates that 10% of the 2,500 miles of stream channels and washes on the GSENM are perennial, (BLM 1999). All depletions upstream from GSENM result from direct diversions. Outside the irrigation season, lesser upstream depletion results from the municipal uses of the towns of Tropic, Cannonville, and Henrieville (DEQ, 2006).

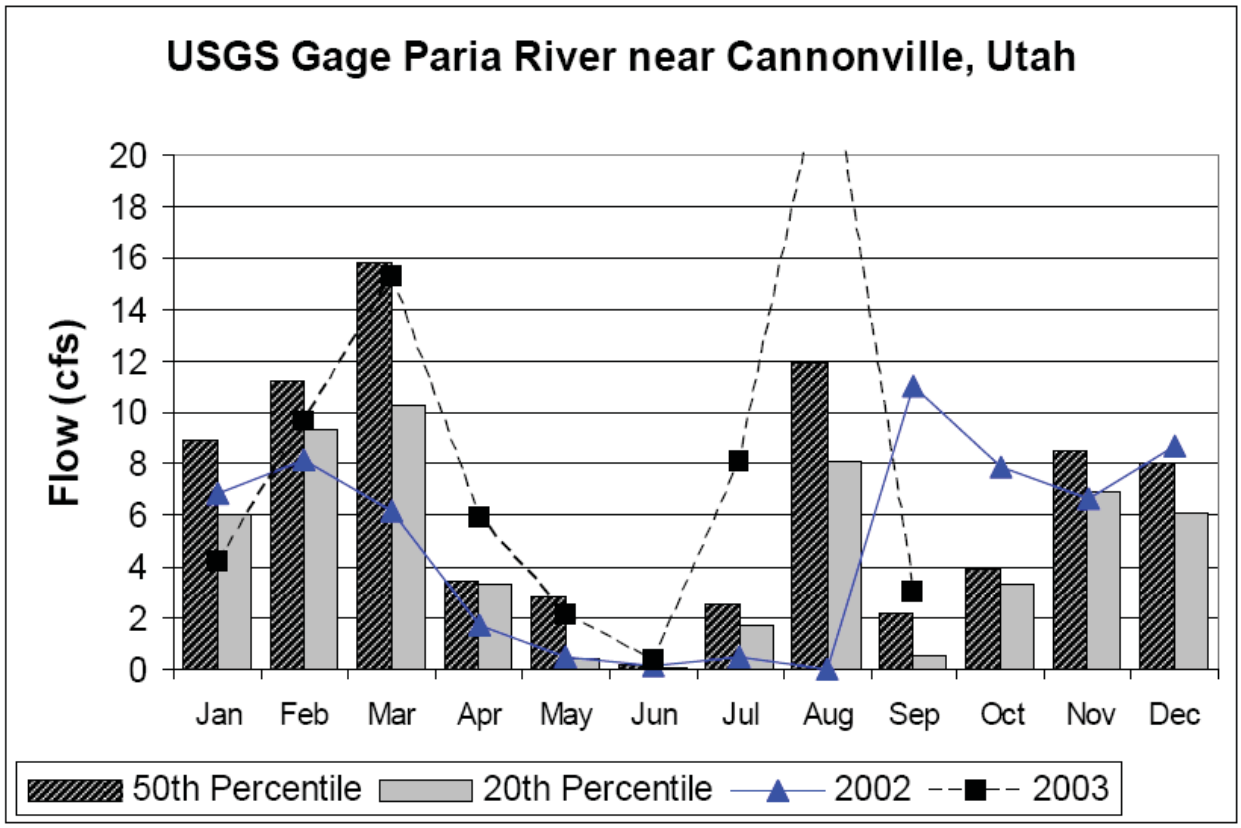

Figure 5. Average monthly flows of Paria River in 2002 and 2003. from Utah Department of Env. Quality

3.8.1 Hydrologic Soil Groups

Hydrologic groups are used to estimate runoff from rainfall. These estimates are needed for solving hydrologic problems that arise in planning watershed protection and flood-prevention projects, for planning or designing structures for the use, control, and disposal of water. They pertain to the minimum steady ponded infiltration under conditions of a bare wet surface.

Assignment of soils to hydrologic groups is based on the relationship between soil properties and its hydrologic characteristics. Wetness characteristics, water transmission after prolonged wetting, and depth to very slowly permeable layers are properties that assist in estimating hydrologic groups.

Table 4. Hydrologic Soil Group Descriptions.

Classification	Description
A	Well-drained sand and gravel; high permeability.
B	Moderate to well-drained; moderately fine to moderately coarse texture; moderate permeability.
C	Poor to moderately well-drained; moderately fine to fine texture; slow permeability.
D	Poorly drained, clay soils with high swelling potential, permanent high water table, clay pan, or shallow soils over nearly impervious layer(s).

3.8.2 Surface Water

The Paria River and its tributaries are identified as having the following beneficial uses: Class 2-B secondary contact recreation, Class 3C- non-game fishery, and Class 4 - agriculture (Standards of Quality for Waters of the State § R317-2, UAC). Two reaches of the Paria River are listed on Utah's 2002 303(d) list (DWQ, 2002) for waters requiring the development of a Total Maximum Daily Loads (TMDL) due to the exceedence of Total Dissolved Solids (TDS) criteria for beneficial use Class-4 (agriculture), including irrigation of crops and stock watering.

Cooperative monitoring by Division of Water Quality (DWQ) and BLM have identified several monitoring stations where Total Dissolved Solids (TDS) concentrations exceeded State criteria. Therefore, DWQ prompted development of a TMDL to identify and quantify sources contributing to TDS increase in the Paria River watershed. High concentrations of TDS are a criterion for the protection of agricultural uses because of the negative effect of high salinity on crop production.

According to DWQ, the upper and lower sections of the Paria River remained on the 303(d) list in 2006 as not supporting the agricultural beneficial use classification because of high concentrations of total dissolved solids. During the extreme drought that was in southern Utah, the Paria River dried up and it was not possible to collect samples during the intensive monitoring survey.

A Proper Functioning Condition survey was completed in April 2010 and is included as Appendix E of this plan. It includes more detailed information about stream conditions and treatment recommendations for streams in the plan area.

3.8.3 Ground Water Hydrogeology

Hydrogeology refers to the occurrence and movement of water below the Earth's surface. The source of groundwater and its quality, and whether the Paria River loses or gains water along the 303 (b) Listed Sections, are of particular importance. Surface water and groundwater interactions with saline (marine) rocks and soils can significantly increase Total Dissolved Solid (TDS) concentrations in the Paria River. Five regional aquifers occur within the watershed. In descending aquifer location, these are the:

(1) Mesaverde aquifer, including Straight Cliffs and Wahweap Formations;
(2) Dakota Formation aquifer;
(3) Morrison Formation aquifer;
(4) Entrada Formation aquifer; and
(5) Glen Canyon aquifer including the Navajo, Kayenta, and Moenave (Wingate) Formations

The Glen Canyon aquifer is the thickest and most extensive of the principal aquifers. The rocks of the Glen Canyon aquifer are exposed in the Grand Staircase and in the Escalante Canyons. The volume of water contained within the aquifer is estimated to be greater than 400,000,000 acre-feet (Freethy, 1997). In recharge areas of the Glen Canyon aquifer, or where water table conditions exist (unconfined parts of the aquifer), the water is generally fresh (<1,000 mg/L total dissolved solids (TDS) and of the type calcium magnesium, bicarbonate. Where the Glen Canyon aquifer is confined, primarily beneath the Kaiparowits Plateau, ground water is generally slightly saline (1,000 to 3,000 mg/L TDS), and is sodium, sulfate type. The lowest TDS concentration in ground water occurs in the Glen Canyon aquifer (191 mg/L). The highest TDS concentration in ground water occurs in the Mesaverde aquifer (5,920 mg/L). The lowest TDS concentration in streams is in Boulder Creek (172 mg/L). The highest TDS concentration in streams is in the Paria River (3,980 mg/L).

Public Water Reserves were established by Executive Order of April 17, 1926. They were established to reserve for general public use all important springs and water holes on public lands, and to prevent monopolization of the public domain through control of these water sources.

3.9 Fish & Wildlife

Biodiversity in the Study Area is characteristic of the Colorado Plateau and Great Basin Ecoregions, with broad changes in species diversity and composition along the elevational gradient from subalpine mountaintops to desert scrub valley bottoms. Common throughout the area are populations of large and small mammals, raptors, resident and neotropical migratory birds, bats and reptiles. Fish and amphibians are limited to stream, reservoir, and wetland habitats.

The major habitat types in the Bryce Valley Study Area (each comprising > 15% of the land cover) are: Sub-Alpine Conifer, Ponderosa Pine, Pinyon-Juniper, Shrubsteppe, and Cliff. This habitat classification system was developed by the Utah Division of Wildlife Resources based on mapping of vegetative cover by the Gap Analysis Program (GAP) and Southwest Regional GAP (SWReGAP) and is used in the Utah Comprehensive Wildlife Conservation Strategy. Other habitat types found in the Study Area, comprising < 5% of the land cover are: Agriculture, Grassland, High Desert Scrub, Lentic (open standing water), Lowland Riparian, Mountain Riparian, Mountain Shrub, Rock, and Urban. Though these habitats occupy small areas, they are critically important to some species and contribute to the overall diversity of wildlife in the Study Area.

In addition to the habitats listed above, small areas of the Wetland and Wet Meadow Habitat Types can be found as inclusions. Such wetlands often occur as springs or seeps, or in narrow

bands adjacent to streams or reservoirs. The Lotic (open flowing water) Habitat Type occurs throughout the Study Area in streams and ditches. For a description of the major Habitat Types, see Appendix B.

Over 600 species of vertebrate wildlife occur in Utah. All wildlife species have four basic habitat needs: food, water, cover, and space provided by the habitat types described above. Some species, such as southwestern willow flycatcher are very specialized, and their habitat needs can only be met by one habitat type or a portion of it. Others, like deer mice, have needs that are more general and are widely distributed across many habitat types.

Important game species found in the Study Area include blue grouse, elk, greater sage-grouse, wild turkey, mule deer, and pronghorn.

Fish habitat in the Study Area is mostly limited to Tropic Reservoir and the Upper East Fork of the Sevier River. Rainbow and cutthroat trout are stocked for recreational fishing. A number of native fishes may also occur in the Upper East Fork, including mottled sculpin, speckled dace, mountain sucker, mountain whitefish, redside shiner, and Utah chub. The Paria River contains "losing reaches" that are typically dry. The dry sections of stream channel are exacerbated by irrigation diversions and limit the ability of fish to use these streams.

Amphibians documented to occur in the Study Area include tiger salamander, Great Basin spadefoot toad, northern leopard frog, western (boreal) toad, and western chorus frog. Additionally, suitable habitat occurs in the Study Area for Arizona toad, Great Plain's toad, Woodhouse's toad and canyon tree frog. The toads, with the exception of the western toad, may be found in a variety of habitats and need water only for breeding. The salamander, frogs, and western toad are confined to areas near water.

A variety of reptiles occur in the Study Area. Some of the more common lizards are plateau striped whiptail lizard, greater short-horned lizard, ornate tree lizard, sagebrush lizard, and western (tiger) whiptail lizard. Common snakes of upland habitats include gopher (bull) snake, Great Basin (western) rattlesnake, and nightsnake. Snakes usually found near water include striped whipsnake, and common and terrestrial gartersnakes. Suitable habitat can also be found in the Study Area for common side-blotched lizard, eastern fence lizard, eastern racer, long-nosed leopard lizard, western skink, milksnake, ring-necked snake, and Sonoran mountain kingsnake.

More than 234 species of birds have been documented in Garfield County, and most of them occur in the Bryce Valley Study Area. Waterfowl, such as mallards, and other waterbirds, including American coots, are limited to the Tropic Reservoir and other areas of open water at lower elevations. Upland game birds are found throughout the Study Area in suitable habitat. Raptors such as red-tailed and Cooper's hawks are common as well. Common species found in the lower elevations and more open habitat types include white-throated swift, black-chinned hummingbird, Say's phoebe, common raven, western bluebird, American robin, chipping sparrow, and red-winged and Brewer's blackbirds. In the woodlands and forestlands at higher elevations

of the Study Area, broad-tailed hummingbird, Stellar's jay, Clark's nutcracker, violet-green swallow, mountain chickadee, white-breasted and pygmy nuthatches, mountain bluebird, Townsend's solitaire, yellow-rumped warbler, dark-eyed junco, Cassin's finch and pine siskin are among the most common species.

Mammals in the Study Area include several species of shrews; many species of bats; cottontail rabbits and jackrabbits; a wide diversity of rodents, from mice, voles, gophers, and woodrats, to chipmunks and squirrels, to yellow-bellied marmot, beaver and muskrat; carnivores such as grey fox, coyote, black bear, ringtail, long-tailed weasel, American badger, striped skunk, and mountain lion; and ungulates such as elk, mule deer, and pronghorn.

3.9.1 Threatened and Endangered Plant and Animal Species

Species protected under the Endangered Species Act that occur in Garfield County and extreme northern Kane County are shown in Table 5 and described below. Descriptions for those species that have suitable habitat, are known to occur in the study area, or exist downstream. See Appendix B for additional information on Protected Species.

Table 5: Protected and Endangered Species in Garfield and Northern Kane Counties.

Common Name	Scientific Name	Listing Status	Suitable Habitat Present or Known Occurrence in Study Area?
Autumn buttercup	*Ranunculus aestivalis*	E	No
Bonytail	*Gila elegans*	E	Downstream
California condor	*Gymnogyps californianus*	E	Yes
Colorado Pikeminnow	*Ptychocheilus lucius*	E	Downstream
Humpback Chub	*Gila cypha*	E	Downstream
Jones' cycladenia	*Cycladenia humilis var. jonesii*	T	No
Kodachrome bladderpod	*Lesquerella tumulosa*	E	Yes
Maguire Daisy	*Erigeron maguirei*	T	No
Mexican Spotted Owl	*Strix occidentalis*	T	Yes
Razorback Sucker	*Xyrauchen texanus*	E	Downstream
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E	Yes
Utah Prairie Dog	*Cynomys parvidens*	T	Yes
Ute Ladies'-tresses	*Spiranthes diluvialis*	T	No
Yellow-billed Cuckoo	*Coccyzus americanus*	C	Suitable habitat
Listing Status: E = Endangered, T = Threatened, C = Candidate for listing			

3.9.2 Sensitive Species

Table 6 lists species of concern to the State of Utah with recent records of occurrence (in **Bold** font), historic records of occurrence, or suitable habitat in the Study Area. The Bonneville and Colorado River cutthroat trout and northern goshawk are additionally considered Conservation Agreement Species by the State. Conservation Agreement Species receive special management under a conservation agreement developed or implemented by the state to preclude the need for listing under the Endangered Species Act.

Table 6: Utah Species of Concern, Primary and Secondary Habitat Types.

Common Name	Scientific Name	Primary Habitat	Secondary Habitat
American three-toed woodpecker	*Picoides tridactylus*	Sub-Alpine Conifer	Lodgepole Pine
Arizona toad	*Bufo microscaphus*	Lowland Riparian	Wetland
Bald eagle	*Haliaeetus leucocephalus*	Lowland Riparian	Agriculture
Bonneville cutthroat trout	*Onchorhynchus clarkii utah*	Lotic	Mountain Riparian
Burrowing owl	*Athene cunicularia*	High Desert Scrub	Grassland
Colorado river cutthroat trout	*Onchorhynchus clarkii pleuriticus*	Lotic	Mountain Riparian
Ferruginous hawk	***Buteo regalis***	**Pinyon-Juniper**	**Shrubsteppe**
Fringed myotis	***Myotis thysanodes***	**Northern Oak**	**Pinyon-Juniper**
Greater sage-grouse	***Centrocercus urophasi-anus***	**Shrubsteppe**	**None**
Lewis's woodpecker	*Melenerpes lewis*	Ponderosa Pine	Lowland Riparian
Long-billed curlew	*Numenius americanus*	Grassland	Agriculture
Northern goshawk	***Accipiter gentilis***	**Mixed Conifer**	**Aspen**
Short-eared owl	***Asio flammeus***	**Wetland**	**Grassland**
Southern leatherside chub	*Lepidomeda aliciae*	Lotic	Mountain Riparian
Spotted bat	*Euderma maculatum*	Low Desert Scrub	Cliff
Townsend's big-eared bat	***Corynorhinus townsendii***	**Pinyon-Juniper**	**Mountain Shrub**
Western (boreal) toad	***Bufo boreas***	**Wetland**	**Mountain Riparian**

3.10 VEGETATION

In the upper elevations of the watershed, on the Pansuagant plateau, the principal vegetative communities include ponderosa pine, aspen, spruce, fir, oak, and maple. In the foothills and lower elevations pinyon-juniper, bitterbrush, and sagebrush predominate. Vegetative communities of the lower valley area include irrigated alfalfa fields and dry pasture. Riparian vegetation is limited to the stream corridor as they traverse the valley (Plate 6).

Forest areas are dominated by Ponderosa pine mixed with other conifer species including Subalpine fir, Douglas fir, and spruce. In wetter areas, aspen, gamble oak, and other western de-

ciduous tree species are found. These are mostly found in the higher wetter elevations, mostly limited to the Dixie National Forest lands in the east and northern portions of the watershed.

Stands of pinyon pine and western juniper characterized with low stand densities and grass or shrub undergrowth is common on the drier sites in higher elevations). Much of the barren and rocky areas are not vegetated. Few pinyon pine and juniper occasionally grow in these difficult areas. Steep slopes and high rates of sediment loss characterize them. These include the tan to pink colored spires and cliffs characteristic of Bryce Canyon National Park. There are also sand dune areas with no vegetation.

Figure 6. Pinyon pine and Juniper woodland in foreground Paunsaugunt plateau and cliffs in background.

About 3,188 acres of irrigated land provides livestock feed mostly in the form of alfalfa hay.

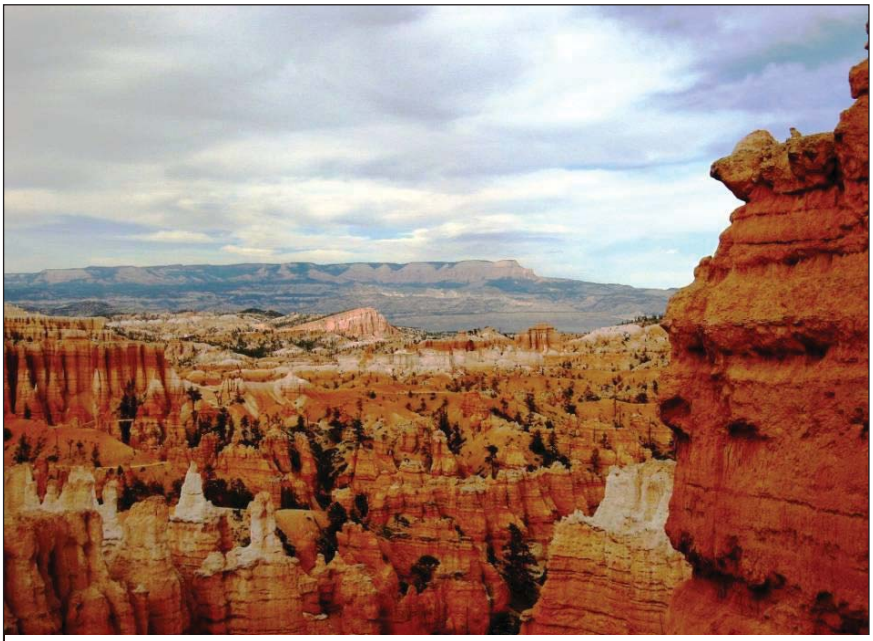

Figure 7 A typical view of Bryce National Park with hoodoos and cliffs.

4.0 Agronomy and Rangelands

4.1 AGRONOMY

The primary crops gown in the area is a mix of 80-90 % alfalfa and 10-20% oats grown for forage. There are also some irrigated pastures in the valley. Alfalfa hay is fed to mother cows in local cow-calf operations during late winter and early spring. Hay quality is much higher than the nutrient needs of range cattle; however, alfalfa is the most productive crop that can be grown in this area due to the short growing season.

Some cheat grass and other weeds are present in the alfalfa fields. This would be an issue if dairy quality hay was being produced and sold out of the valley. However, it is not a significant concern when the hay is fed to local beef cattle.

Several fruit tree orchards previously existed in the watershed. Some have been abandoned.

4.1.1 Agronomic Opportunities

Cropland

Extend the grazing season by inter-cropping grass with the alfalfa. Grasses are able to continue growing in colder weather than the alfalfa. This would be a practical solution because the quality of alfalfa/grass hay is nutritionally adequate for beef cattle.

Alternative crops such as camelina or safflower as a local biodiesel crop may be economical. Camelina is a spring growing crop, using water when water is most available and then is harvested mid-summer. The infrastructure for harvesting grain crops is not currently available in the area.

Surghum-sudangrass may be a productive rotation crop with alfalfa. It can be left standing and grazed in the field during the winter

Irrigation and Water Control

Bryce Valley has several functional gravity pressurized irrigation systems. Some components of the systems are ageing; users are seeing a reduction of flows in older pipelines where it is likely that lime has accumulated on the inside of the mainline pipe. This usually occurs in the larger diameter low pressure end of the system because lime is more soluble under pressures above 15 pounds per square inch.

Some older wheel lines and hand lines show cracks and leaks from metal fatigue and wear. They should be evaluated on a field by field basis and replaced as needed. Some of the irrigation mainlines have outlived their lifespan.

There are approximately 2900 acres irrigated with sprinklers and 160 acres flood irrigated irrigation systems within the study area.

Irrigation and Water Control Opportunities

Many of the irrigation structures in the watershed do not meet NRCS or standards and specifications; they are maintained by temporary repairs to continue conveyance, but require more long term solutions. Maintenance of the systems is costly in terms of time and resources needed. See Appendix C for additional photos of irrigation structures.

Four specific areas were identified as needing improvements: 1) the Cannonville diversion; 2) Henrieville Creek diversion; 3) Little Creek diversion; and 4) Mossy Cave water control structure.

The Cannonville irrigation diversion directs water from the Paria River into a pipeline that frequently fills with sediment, interrupting irrigation service. The right cut bank upstream of the diversion is vulnerable to erosion. Erosion of the bank could make the diversion structure inoperable, and damage the pipeline downstream. The Cannonville Irrigation Company would like to look at the possibility of automating the gate on this structure. Currently if a flood comes down the Paria, the water master must drive to this location and close the gate manually to prevent the pipeline from filling up with sediment.

Figure 8 Cannonville Diversion

The Henrieville Creek diversion requires manual control. If the diversion structure becomes inaccessible during a storm, the structure may be damaged. The Henrieville Irrigation Company would like to look at the possibility of automating the gate on this structure. Erosion is occurring downstream of the sluice gate; if left unchecked, active head-cutting will undermine the sluice structure and wash out the access road. Erosion at the right bank of the diversion structure appears to be increasing.

Figure 9 Henrieville Diversion

The Little Creek diversion structure has sustained damage to the concrete crest which effectively lowered the water level. Temporary measures have been installed across the crest to facilitate diversion of the flow. Undercutting at the downstream end and both sides of the diversion is threatening the structure. The corridor downstream of the structure is unstable and degrading.

The Mossy Cave water control structure has a number of problems including undercutting on the downstream face, cracks in the concrete, and displaced support for the downstream pipe. Replacement of the structure would be costly given its location on federal land adjacent to a

scenic byway. Considerable engineering analysis will be required for a full replacement. An alternative to replacing the structure should be considered.

Agricultural waters are diverted from Tropic Reservoir to the Mossy Cave control structure then into the irrigation system. The East Fork of the Sevier River and Tropic Reservoir (Sevier watershed) lie completely within Forest system lands, therefore we will defer to the FS for proposed improvement measures.

The town of Tropic is lies below steep upper watershed slopes subject to high runoff flows generated from storm events. A series of channels and a pond embankment exists to protect the town of Tropic from flooding. The existing embankments are in poor condition. Numerous trees and other vegetation are growing in the embankments, compromising their integrity. The embankment and associated infrastructure should be evaluated more thoroughly for safety and possible replacement.

Better tools for irrigation management would result in having more water available for use later in the year. Since reservoir storage is not expandable, it could be advantageous to use soil moisture monitoring sensors to assist in irrigation scheduling. A second advantage of soil moisture monitoring is to aid landowners in determining how much land to irrigate when a full supply of water is not available.

Furrow irrigation was used on two grain fields within the study area. The fields are too steep for this type of irrigation and severe erosion occurred in the spring of 2008. Wheel lines could replace the furrows.

Changing some systems from wheel lines (side roll sprinklers) to center-pivot systems will improve overall irrigation efficiency; however, few fields are large enough for center-pivot irrigation.

Economics of a changing marketplace may justify a second look at building infrastructure to support fruit crops in the Bryce Valley Watershed.

4.2 RANGELANDS

Inventory of Ecological Sites

There are 37 different ecological sites found in the Bryce Valley watershed. This represents a relatively high level of ecological diversity across the landscape.

For more information about the ecological sites mentioned in this report, visit http://www.ut.nrcs.usda.gov/technical/technology/range/ecosites.html to access descriptions of each individual ecological site. A large scale map of Ecological Soil Types can be found in the project record.

Major Land Resource Areas (MLRA)

There are two Major Land Resource Areas represented in the Bryce Valley Watershed. They are the Colorado Plateau area (D35XY) and the Wasatch Mountains, South (E47XB). The major difference between these MLRAs is their soil temperature regimes, D35XY is mesic (warmer) and E47XB is frigid or cryic (cooler).

Ecological Zones

Several ecological zones are represented in the Bryce Valley watershed, including Semi-desert, Upland, Mountain, and High Mountain.

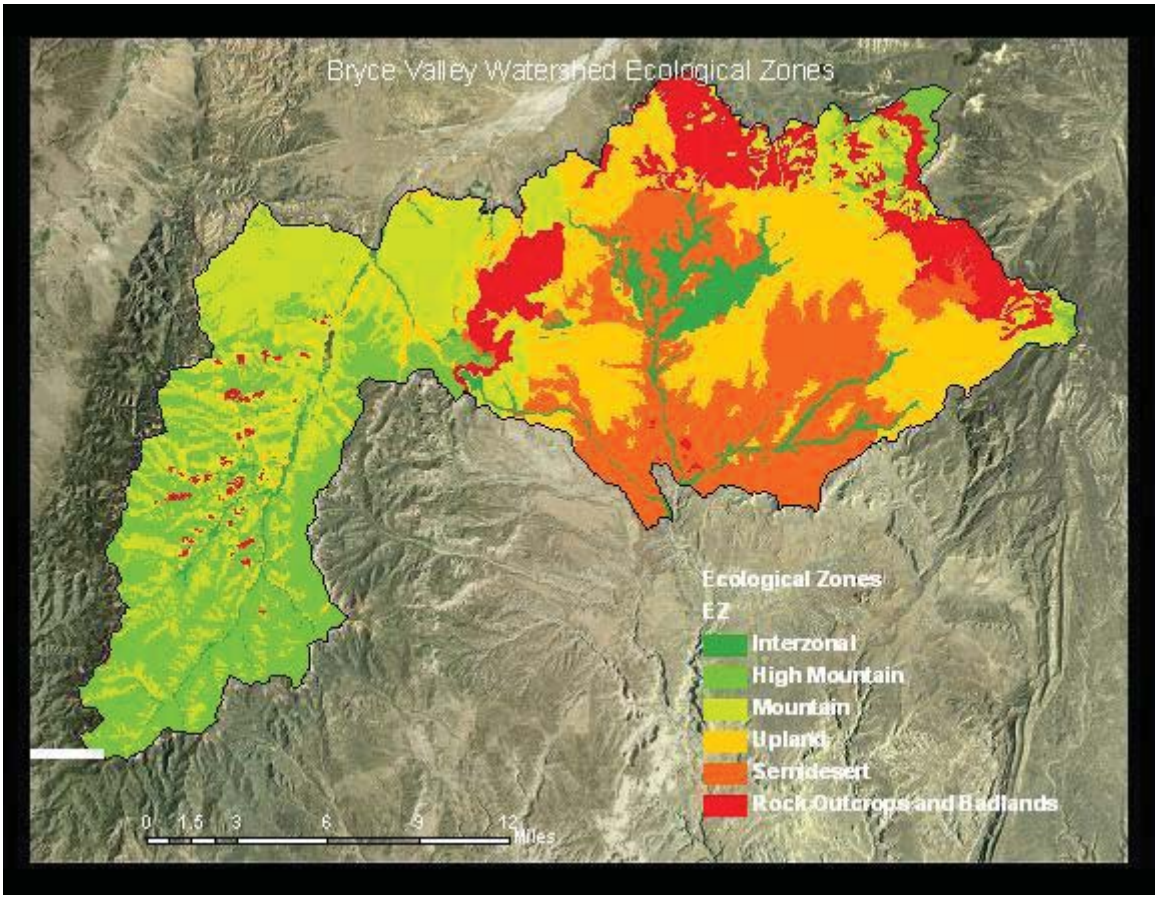

Figure 10 Ecological Zones in the Bryce Valley Watershed

Semi-Desert Zone

The Semi-desert ecological zone in the Bryce Valley watershed comprises the majority of the lowest elevations of the watershed. The average precipitation in this zone is typically 8-12 inches, the soil moisture regime is ustic-aridic and the soil temperature regime is mesic. There is inadequate moisture for Pinyon pine or various species of browse (snowberry, cliffrose, etc.) to dominate. It is dominated primarily by sagebrushes, occasionally by Utah junipers.

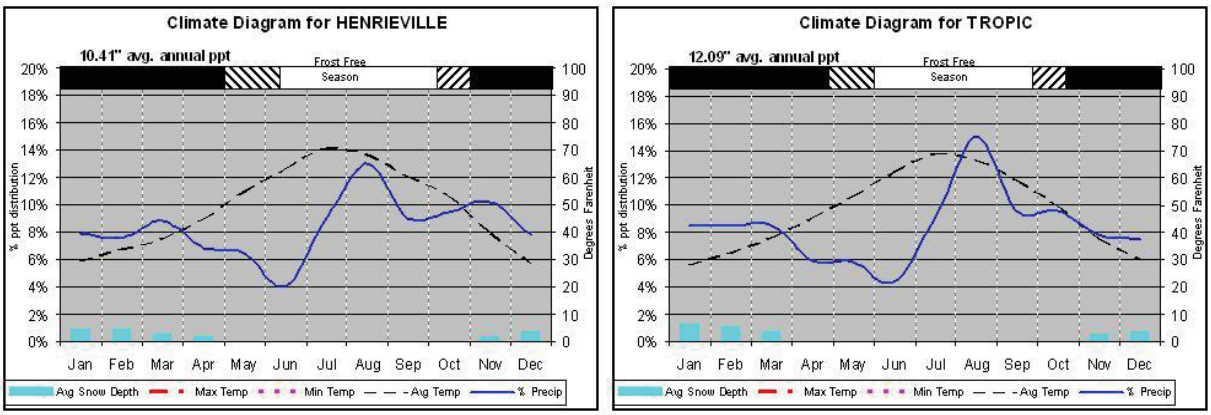

Figure 11 Climate Diagrams for Henrieville and Tropic, UT

Two climate stations in the Bryce Valley watershed occur in the Semi-desert zone. They exhibit a unique climate regime with relatively high amounts of precipitation received during a very short growing season. Typically, this would result in a dominance of warm season plants, but the very cold winter temperatures ensure that cool season plants dominate.

Vegetation manipulation projects are at a high risk of failure in the Semi-desert ecological zone, and there are only a few plant materials that have any hope of establishing in a seeding project. Semi-desert zone ecological sites can be very difficult to rehabilitate.

Upland Zone

The Upland Ecological Zone in the Bryce Valley watershed comprises the mid-elevation portion of the watershed. The average precipitation here is typically 12-16 inches, the soil moisture regime is ustic and the soil temperature regime is mesic (D35XY) or frigid (E47XB). Pinyon pine and various species of browse (snowberry, cliffrose, etc.) can dominate in this zone. A majority of the upland zone in the Bryce Valley watershed is comprised of badlands, outcrops, and steep shallow soil sites.

Vegetation manipulation projects are at a moderate risk of failure in the Upland Ecological Zone. The soil type is a very important consideration for determining risk of failure in the upland zone in Bryce Valley watershed.

Mountain Zone

The Mountain Ecological Zone in the Bryce Valley watershed comprises the majority of the higher elevations in the watershed, especially in Bryce Canyon National Park and the adjacent national forest. It is completely within MLRA E47XB Wasatch Mountains South. The average precipitation in this zone is typically 16-22 inches, the soil moisture regime is ustic and the soil temperature regime is frigid. It is dominated primarily by ponderosa pine.

One climate station in the Bryce Valley watershed occurs in the low end of the Mountain Zone. It exhibits a typical climate regime in mountainous areas with relatively high amounts of precipitation received during a very short growing season.

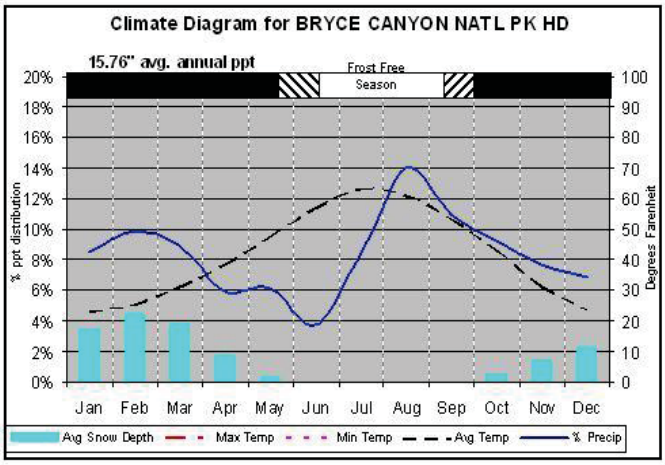

Figure 12 Climate diagram for Bryce Canyon NP

Vegetation manipulation projects are typically easy to establish in the Mountain Ecological Zone.

High Mountain Zone

The High Mountain Ecological Zone in the Bryce Valley watershed comprises the highest elevations. It is completely within MLRA E47XB Wasatch Mountains South. The average precipitation in this zone is typically above 22 inches, the soil moisture regime is ustic or udic and the soil temperature regime is frigid or cryic. Primarily conifers like white fir and Douglas fir dominate, however stands of aspen are also present.

Geomorphic Units

There are a large number of ecological sites (37) in the Bryce Valley watershed , but because of the similarity in ecological functions and response to management of many of the ecological sites, rangelands were subdivided into eleven 'Geomorphic Units' following the concepts established in a previous investigation[ii]. These geomorphic units are conglomerates of ecological sites.

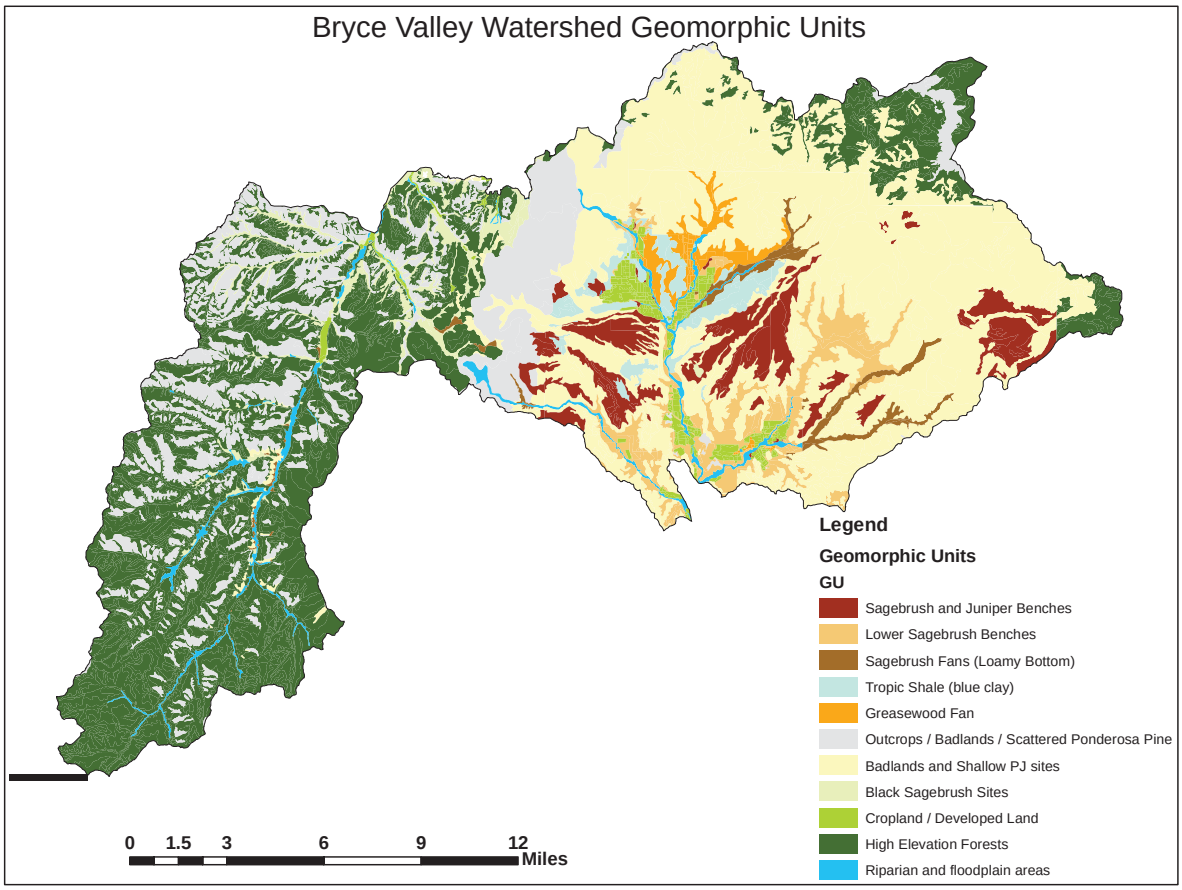

Figure 13 Map of geomorphic classification

Table 7. Geomorphic Units by Area in Bryce Valley.

Geomorphic Unit	Acres	Percent
Badlands and Shallow PJ sites	66173.90	33.46%
Black Sagebrush Sites	5108.45	2.58%
Cropland / Developed Land	3836.09	1.94%
Greasewood Fan	2641.44	1.34%
High Elevation Forests	63823.68	32.27%
Lower Sagebrush Benches	7781.95	3.94%
Outcrops / Badlands / Scattered Ponderosa Pine	28180.00	14.25%
Riparian and floodplain areas	3187.35	1.61%
Sagebrush Fans (Loamy Bottom)	2436.47	1.23%
Sagebrush and Juniper Benches	10525.47	5.32%
Tropic Shale (blue clay)	3992.21	2.02%

Sagebrush and Pinyon/Juniper Benches

This unit is a combination of the following four ecological sites: Upland Stony Loam (pinyon/juniper) in E47XB, Upland Stony Loam (pinyon/juniper) in D35XY, Upland Loam (mountain

big sagebrush) in E47XB, and Upland Loam (mountain big sagebrush) in D35XY. These areas include Coal Bench, Mud springs area, and Bulldog Bench.

Figure 14 Photo of Sagebrush and Pinyon /Juniper bench site Upland Loam (mountain big sagebrush) D35XY308UT. *The dominant shrub is mountain big sagebrush; the understory is practically devoid of grass. Because of the common association of this site with adjacent Pinyon and Juniper sites, it is common to find encroaching trees on this site as shown. This is representative of most of the untreated Upland Loam ecological sites within the Sagebrush and Pinyon/Juniper Benches geomorphic unit. Photo taken 8/13/08 by Shane Green (NRCS), NAD83 N0405538 E4163445.*

The rangelands in this geomorphic unit are very important to the local economy as the primary source of rangeland livestock forage. Their importance is emphasized by the fact that they comprise only 5.3% of the rangelands in the watershed, surrounded by a sea of less productive and inaccessible sites for livestock forage. This has been noted by others in previous investigations of this area[iii].

About half of this geomorphic unit has been treated by chaining/seeding type practices during the late 1960's and 1970's. These treatments remain today in various circumstances, mostly re-encroached by pinyon and juniper with decaying understory plant communities.

The other half of this geomorphic unit is comprised of untreated rangelands with native plant communities also with decaying understory plant communities.

Badlands and Shallow Pinyon / Juniper sites
This unit is a combination of Badlands and the following four ecological sites: Semi-desert Shallow Clay (shadscale/juniper), Semi-desert Shallow Clay (mat saltbush), and Upland Shallow Loam (pinyon/juniper) in D35XY and Upland Shallow Loam (pinyon/juniper) in E47XB. This unit comprises the majority of the mid and high elevation lands in the Paria River watershed.

This unit is the largest in the watershed, representing about one-third (33.5%) of the land area. Although the natural levels of erosion are high on these lands, they have not been affected by past grazing management practices because the steep slopes and lack of forage and water have always deterred heavy livestock use. The erosion from these lands is not accelerated and they offer no opportunities for land treatment practices.

Black Sagebrush sites
This unit is a combination of the following four ecological sites: Upland Shallow Hardpan (black sagebrush), Upland Stony Loam (black sagebrush), Upland Loam (black sagebrush), and Mountain Loam (black sagebrush) in E47XB. This unit comprises only a small portion of land (2.5%) mostly on the divide between the Paria River and East Fork of the Sevier River. These sites are generally intact and offer no opportunities for land treatment practices.

Cropland / Developed Land
This unit is comprised of several soils and ecological sites that have been converted into agricultural, residential, or recreational land uses. It includes the farms and city limits of Cannonville, Henrieville, Tropic and Bryce Canyon National Park headquarters and campgrounds. These lands and their uses pertaining to resources concerns for soil, water, air, plants and animals found there are covered in other sections of this watershed plan. Upon inspection of the private lands in the watershed, it appears that arable land, not water, was a limiting factor in the amount of cropland that exists in the watershed. This conclusion is drawn from the fact that almost every acre of arable soil on private lands has been converted to cropland.

Figure 15. Photo of Badlands Shallow Pinyon/Juniper site. *Overlook view of the Badlands / Shallow Pinyon/Juniper sites geomorphic unit taken from Bulldog Bench. Photo by Shane Green (NRCS) taken 8/13/2008. NAD83 N0402523 E4161408.*

Figure 16. Photo of Cropland/Developed Land site . *Alkali Flat (black greasewood) D35XY009UT. The dominant shrub is black greasewood, the understory is practically devoid of grass. This is representative of most of this site in the watershed. Photo taken 8/15/08 by Shane Green (NRCS), NAD83 N0405228 E4166943.*

Greasewood Fan

This unit is comprised of the Alkali Flat (black greasewood) ecological site. It occupies a small part in the lower elevations of the watershed between the Badland/Shallow Pinyon/Juniper geomorphic unit above and the Arable and Riparian lands below.

This unit comprises a minute (1.3%) portion of the watershed, but its role as a buffer and filter for water delivered into the Paria River is important. These lands are high risk for treatment because of the high pH in the soils, but some successful planting with alkaline tolerant species such as tall wheatgrass may be possible.

High Elevation Forests

This unit is comprised of the Mountain Stony Loam (oak), Mountain Shallow Loam (ponderosa pine), Mountain Gravelly loam (ponderosa pine), High Mountain Shallow Stony Loam (mixed conifer), High Mountain Shallow Loam (Douglas fir), High Mountain Loam (Douglas fir), High Mountain Stony Loam (aspen), High Mountain Loam (aspen), and High Mountain Stony Loam (white fir) ecological sites. It occupies the majority of the Sevier River portion of the watershed, including most of Bryce Canyon National Park. This unit is also found in the high elevation por-

tions of the northeast corner of the Paria River watershed on Table Cliff Plateau. Approximately a third (32.3%) of the Bryce Valley Watershed is made up of this unit. This unit is not a significant producer of salt or sediment to the main river systems.

Figure 17. Photo of High Elevation Forest site. *Typical view of the forest lands in the High Elevation Forest geomorphic unit. Photo taken by Shane Green (NRCS) 8/14/08 in Bryce canyon National Park.*

Lower Sagebrush Benches

This unit is comprised of the Semi-desert Loam (Wyoming big sagebrush), Semi-desert Sandy Loam (Wyoming big sagebrush), and Semi-desert Sandy Loam (fourwing saltbush) ecological sites. This unit occupies some of the lowest elevations in the southern portions of the Paria River watershed near Cannonville and Henrieville. The rangelands in this geomorphic unit are very important to the local economy as a primary source of rangeland livestock forage. Their importance is emphasized by the fact that they comprise only 3.9% of the rangelands in the watershed, surrounded by a sea of less productive and inaccessible sites for livestock forage.

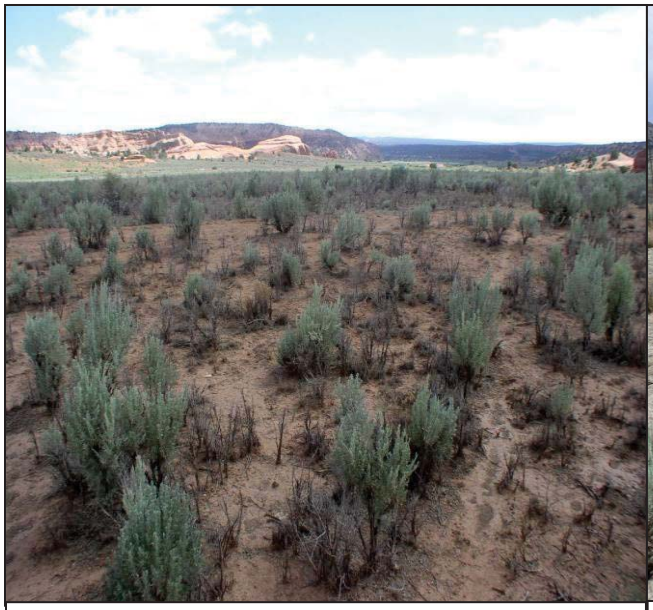

Figure 18: Semi-desert Sandy Loam (Wyoming Big Sagebrush) D35XY216UT. *This is a monoculture of Wyoming big sagebrush, likely resulting from past improper grazing use. The potential is great to improve the ecological function and forage production on sites like this one by reestablishing the herbaceous component of the community. Photo taken 8/15/08* by Shane Green (NRCS), NAD83 N0408523 E4157201.

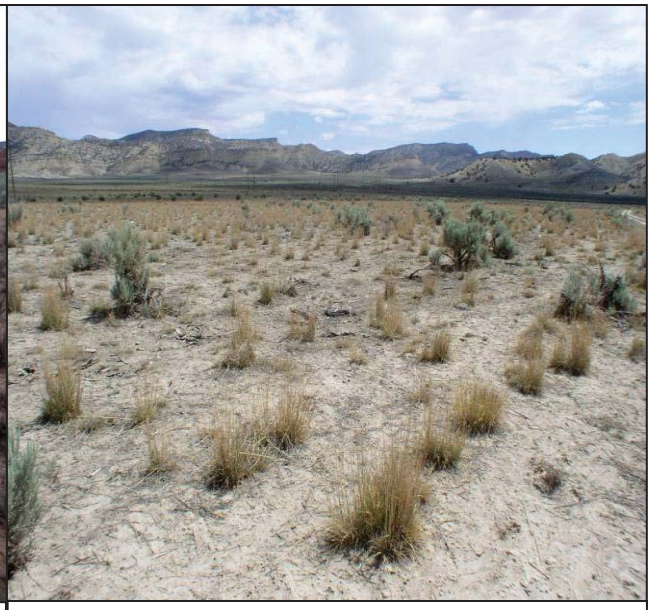

Figure 19: Semi-desert Sandy Loam (Wyoming big sagebrush) D35XY216UT. *The dominant shrub is Wyoming big sagebrush, the understory is a Russian wildrye seeding. This plant community is a result of past vegetation manipulation that included seeding the introduced grass species. Photo taken 8/15/08 by Shane Green (NRCS), NAD83 N0413835 E4162598.*

This geomorphic unit is located near the agricultural and population centers in the watershed, and this has produced several expressions of the primary ecological site (Semi-desert Sandy Loam (Wyoming big sagebrush) in the watershed resulting from varying past disturbance regimes. The accompanying photographs illustrate some of the variability.

These lands are high risk for treatment because of the high pH in the soils, but some successful planting with alkaline tolerant species such as Tall wheatgrass may be possible.

Outcrops / Badlands / Scattered Ponderosa Pine

This geomorphic unit is a combination of rock outcrops, a few badlands and a scattering of the Mountain Shallow Loam (Ponderosa Pine) ecological site. It is mainly found in Bryce Canyon national park and provides the landscape that made the area famous. This geomorphic unit makes up 14% of the Bryce Valley watershed area.

Figure 20: Typical view of the Outcrops / Badlands / Scattered Ponderosa Pine geomorphic unit. *Photo taken by Shane Green (NRCS) 8/14/08 in Bryce canyon National Park.*

Sagebrush Fans

This unit is comprised of the Loamy Bottom (Basin big sagebrush) ecological site. It occupies a small part in the lower elevations of the watershed along Henderson Creek.

This unit comprises a minute (1.2%) portion of the watershed, but it's role as a buffer and filter for water delivered into the Paria river is important. These lands are not high risk treatment areas and include some of the best soils in the watershed. Much of this site is in poor health and could be improved with vegetation manipulation practices, potentially with establishment of native species such as Basin wildrye.

Figure 21: Loamy Bottom (Basin big sagebrush) D35XY011UT. *The dominant shrub is basin big sagebrush; the understory is practically devoid of grass. This is representative of most of this site in the watershed. Photo taken 8/15/08 by Shane Green (NRCS), NAD83 N0409266 E4165871.*

Riparian and Floodplain Areas
This geomorphic unit is made up of the ecological sites that are adjacent to the streams in the watershed such as Loamy Bottom (basin wildrye), Alkali Bottom (greasewood), Semi-wet Saline Streambank (Fremont cottonwood), Semi-wet Fresh Meadow, and River Wash areas. These sites are extremely important to wildlife and agriculture in this arid landscape. They are typically heavily impacted where they occur near population centers with reduced amounts of riparian vegetation and eroding cut banks. This unit makes up about 1.6% of the watershed area. A detailed assessment of these areas is planned in a separate document.

Tropic Shale (blue clay)
This geomorphic unit is a mixture of the Alkali Fan (Castle Valley saltbush), Upland Clay Loam (low sagebrush), and Semi-desert Shallow Clay (mat saltbush), ecological sites. These ecological sites, which could easily be mistaken for badlands, are in the early stages of soil formation. They are made up of low hills and random exposures of Tropic Shale or like materials that are weathering. The native vegetation on theses sites is among the most degraded of any in the watershed, the palatable shrubs having been removed long ago through historic improper grazing use. These sites are not conducive to improvement through rest or vegetation manipulation, although it has been attempted with little success.

4.2.1 Rangeland Resource Problems and Opportunities

<u>Rangeland Hydrologic Function</u>

Figure 22: Upland clay loam (low sagebrush) D35XY301UT. *The current plant community is a monoculture of Tropic Goleneye. This plant community resulted from an attempt to plow and seed the site. Photo taken 8/13/08 by Shane Green (NRCS), NAD83 N0404533 E4160972.*

Figure 23: Semi-desert Loam (Wyoming Big Sagebrush) D35XY209UT. *The dominant shrub is Rabbitbrush, the understory is comprised of various introduced weeds. This plant community is a result of severe past disturbances. There is opportunity to change the plant community for improved hydrologic function as this site receives water from the slopes in the background. Photo taken 8/15/08 by Shane Green (NRCS), NAD83 N0413835 E4162598.*

Previous investigations have shown that the highest amounts of sediment delivery in the watershed originate from the Badlands and Shallow pinyon and juniper, the Outcrops / Badlands / Scattered ponderosa pine, and the Tropic Shale (blue clay) geomorphic units[iv]. These naturally high sediment producing lands are generally buffered from the stream channels by the Greasewood Fan, the Sagebrush Fan, and the Lower Sagebrush Benches geomorphic units. These areas should be in good ecological health in order to function as a filter, capturing sediment before it is delivered to the stream channel. This function is possible when the number of concentrated flow paths (gullies) is minimized and the vegetative cover is at its ecological potential. An assessment of rangeland health for the GSENM[v] (which includes a portion of the Bryce Valley Watershed Area) concluded that the Hydrologic function of the Semi-desert Loam (Wyoming big sagebrush) ecological site (part of the Lower Sagebrush Benches geomorphic unit) was significantly more impaired than other ecological sites in the watershed. There are opportunities to improve the hydrologic function of these lands in the watershed through vegetation manipulation to increase herbaceous cover and consequent improved sediment filter function.

Figure 24: Upland Loam (Mountain Big Sagebrush) D35XY308UT. *Coal Bench area. The current plant community is a monoculture of mountain big sagebrush, the understory is practically devoid of plants. This condition resulted from a crested wheatgrass seeding that died during a recent extended drought. Because of the common association of this site with adjacent pinyon and juniper sites, it is common to find encroaching trees on this site as shown. This is representative of approximately 2,000 acres of land in the watershed that is in dire need of treatment. Photo taken 8/13/08 by Shane Green (NRCS), NAD83 N0411795 E4163384.*

Rangeland Soil Stability

Conditions observed during field reconnaissance in the Bryce Valley watershed align with the findings of a prior assessment of the rangeland health for the GSENM[vi] in the finding that the Upland Loam (mountain big sagebrush) and the Semi-desert Loam (Wyoming big sagebrush) ecological sites have a wide departure from the soil stability that is expected in the reference condition. Many of these areas have been treated through brush management and seeding practices in prior decades, particularly on Bulldog Bench, Coal Bench, and Mud Springs. These areas have largely been re-encroached by pinyon and juniper. Some areas have experienced die-off of the introduced crested wheatgrass understory during the extended drought of the past decade. These conditions have created a situation where these rangeland soils are susceptible to accelerated erosion.

Plant Productivity, Health and Vigor

The sagebrush ecological sites in the Bryce Valley watershed are often found in poor ecological health with low plant vigor. Past land treatments have not been maintained and succession, natural disturbances (such as severe droughts) and grazing management decisions have resulted in degraded plant communities. These range from increasing woody vegetation components suppressing understory species to complete eradication of the herbaceous plants. Ecological sites that have not been subjected to past heavy grazing use or other severe disturbances are in relatively good ecological health.

Domestic Animals – Inadequate Quantities and Quality of Feed and Forage

Figure 25: Upland Stony Loam (pinyon/juniper) D35XY321UT. *The current plant community is a mixture of woody species dominated by pinyon and juniper with a suppressed herbaceous understory of both native and introduced plants. This condition resulted from an old chaining that was done in the 70's. This is representative of approximately 2,200 acres of land on Bulldog Bench that is in need of treatment to release the existing herbaceous and browse species. Photo taken 8/13/08 by Shane Green (NRCS), NAD83 N0402523 E4161408.*

Although the Bryce Valley watershed covers a vast area, the lands that produce livestock forage and are accessible for grazing make up a relatively small portion. Almost all of the arable private land in the watershed is being irrigated and farmed. This makes these lands very important to the local economy and when their forage production steadily drops over a period of 23-30 years, the risk of losing local agricultural economies and culture increases. Opportunities exist to bring these lands back up to their forage productivity potential while improving ecosystem function and wildlife habitat values.

Domestic Animals – Inadequate Stock Water

Infrastructure has not been adequately maintained nor improved since the 1970's. The basic needs of adequate livestock water in order to achieve good distribution of grazing use is a basic principle of range management. There is a need to provide this kind of infrastructure improvement on Bulldog Bench so that managed grazing is a possibility.

Lower Sagebrush Benches

The Semi-desert sagebrush ecological sites in the Bryce Valley watershed exist in a number of different states and plant communities. Many of them would benefit from seeding practices; especially areas where practically no perennial grasses remain (see photos in section (I.C.7 and II.A). These sites could be improved for hydrologic function, soil stability, and forage production. Careful selection of treatment areas, plant materials to seed, and methods to use will be necessary because of the low precipitation in these areas. Approximately 3,000 acres within these areas need treatment.

Plant Materials Demonstration Plots

Because of the amount of seeding practices being recommended, and because of the unique climate in Bryce Valley, and because of the past performance of some of the plant materials that were used on rangelands in this area, it is recommended that demonstration plots of various plant materials, both warm season and cool season, both native and introduced, be established. A site should be chosen that will be accessible where many people in the community as well as passersby can stop and take notice. Somewhere in the Semi-desert zone would be appropriate to observe the performance of the plants at the harshest condition in the watershed.

Stock Water Development on Bulldog Bench

A cursory examination of the range improvements on public lands in the Bryce valley watershed shows a lack of stock water availability on the Bulldog Bench area. The only water available on the bench is from 3 small reservoirs that are unreliable and typically dry during the fall dormant season. This restricts grazing management because it is impossible to utilize the forage at appropriate times. It is recommended that a pipeline and trough system be designed and installed on Bulldog Bench to permit better grazing management. Approximately five miles of pipeline and five troughs will be required.

5.0 Objectives and Action Items

Based on Public Scoping and the results from the technical committees inventory and analysis, seven objectives have been identified to improve natural and socio-economic resources in the study area:

5.1 OBJECTIVE #1: Reduce operation and maintenance costs of irrigation system. Reduce interruptions of service.

The current designs of these structures are inadequate for addressing sedimentation and erosion. Many of the irrigation structures in the watershed do not meet NRCS or State safety criteria; they are maintained by temporary repairs to continue conveyance, but require more long term solutions. Maintenance of current systems is costly in terms of time and resources needed.

Four specific areas were identified as needing improvements: 1) the Cannonville diversion; 2) Henrieville Creek diversion; 3) Little Creek diversion; and 4) Mossy Cave water control structure.

Action Items

- Repair and upgrade or automate Cannonville, Henrieville, and Little Creek diversion structures.
- Repair and/or upgrade Mossy Cave structure.
- Upgrade conveyance lines.
- Hold an irrigation management seminar for landowners and irrigators.

Benefits

Repaired, upgraded and fully functioning infrastructure will increase efficient water delivery and use. Infrastructure will meet NRCS and State safety standards and maintenance costs will be reduced. Automating control structures will increase efficiency of operation and will reduce the need for access to the structures either immediately before or during rainfall events .

An irrigation management seminar will help inform landowners and irrigators of irrigation water management and systems BMPS which could result in more efficient water use and higher crop vigor and reduced risk of salination.

Monitoring

Success will be measured by increased capacity within the pipes, reduced maintenance costs and reduced or more efficient water use.

Table 8: Objective 1 implementation cost estimate.

Type of Expenditure	Description	Cost Estimate
Project	Repair or replace Cannonville diversion structure	$
Project	Repair or replace Henrieville diversion structure	
Project	Repair or replace Little Creek diversion structure	
Project	Repair or upgrade Mossy Cave Structure	
Project	Upgrade conveyance lines and automate control structures	
Technical assistance	Conduct Irrigation Management seminar	$5,000
Monitoring	Monitor water use, psi and maintenance costs. BMP implementation monitoring	$3000/yr for 5 yrs
Total	N/A	

5.2 OBJECTIVE #2: Improve hydraulic capacity of drainage corridors above the town of Tropic for high runoff events.

The town of Tropic is lies below steep upper watershed slopes subject to high runoff flows generated from storm events. A series of channels and a pond embankment exists to protect the town of Tropic from flooding. The existing embankments are in poor condition. Numerous trees and other vegetation are growing in the embankments, compromising their integrity.

Action Items

- Rebuild pond embankments above Tropic to meet current design standards.
- Development and implement embankment maintenance plan to ensure continued structure integrity.
- Replace current culvert road crossing for meet 25/100 year flow.
- Build diversion dike at Bryce Creek Bridge to ensure flows are contained to go under the road into Campbell Creek drainage.
- Dredge ponds to increase storage capacity

Benefits

Reduced risk of structure failure that could result in flooding and damage to the town of Tropic.

Monitoring

Success will be measured by structure strength and integrity that meets safety standards and amount of amount of increased storage capacity.

Table 9: Objective 2 implementation cost estimate.

Type of Expenditure	Description	Cost Estimate
Project	Rebuild pond embankment	$
Project	Replace culvert	
Project	Build diversion structure Bryce Creek Bridge	
Project	Dredge retention pond	
Technical assistance	Develop and implement embankment maintenance plan	$
Monitoring	Monitor structure strength and storage capacity every two years	Avg. of $800/yr for 5 yrs.
Total	N/A	

5.3 OBJECTIVE #3: Improve Private and BLM allotment rangeland forage quality and quantity.
Range land is degraded in some areas where past improvement projects have resulted in invasive weeds, lack of cover, and loss of soil to erosion. In other areas Pinyon Pine and Juniper have become the dominant species, limiting the amount of browse available.

Action Items

- Support BLM's initiative on rangeland improvement treatments.
- Make range improvements to private property with interested landowners.
- Create a plant materials demonstration plot.
- Hold a rangeland management seminar for allotment and land owners.

Benefits

Lands re-vegetated with the appropriate cover types will result in increased soil stability and greater browse. Reduced fire risk

Monitoring

Success will be measured by increased quantity and diversity of native plants. Standard monitoring methods such as Dauben Mier plots and Robel Pole visual obstruction readings will be implemented.

Table 10: Objective 3 implementation cost estimate.

Type of Expenditure	Description	Cost Estimate
Project	Prescribed Grazing	$90,000
Project	Mud Springs Seeding	$60,000
Project	Coal Bench Seeding	$200,000
Project	Lower Sage Benches seeding	$300,000
Project	Plant Materials Demonstration plot	$$25,000
Project	Bulldog Bench Brush Management- 900 acres	$90,000
Project	Coal Bench Brush Management – 1100 acres	$110,000
Project	Bulldog Bench Stockwater Development	$40,000
Monitoring	Standard methods for cover type and density	$20,000 for 5 years
Total	**N/A**	**$1,030,000**

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5.4 OBJECTIVE #4: Reduce the spread of invasive and noxious weeds in both range and riparian habitats.

Native plant communities have evolved in response to the physical and biotic characteristics of the region and are uniquely suited to regional, local and micro habitats. Non-native species may reduce biodviersity, degrade habitats and displace native vegetation. Tamarisk, for instance absorbs large amounts of water and creates large salt deposits which may change stream flow characteristics and reduce biodiversity in riparian areas.

Invasive species within the watershed include Salt Cedar (*Tamarix* sp.) or Tamarisk, cheat grass *(Bromus tectorum*) and Russian Olive (*Elaeagnus angustifolia*. The problem of invasive plants extends from aquatic and riparian areas to uplands.

Action Items

- Remove Tamarisk and Russian olive along streambanks, and replant with native vegetation (Objective 5).
- Reduce noxious weeds as part of range improvement actions (Objective 3).

Benefits

- Native plant communities have adapted to survive local conditions and are resilient in the landscape.
- Increased biodiversity and habitats.
- Increased soil stability, habitat cover and browse.

Monitoring

Monitoring and cost estimates are included in Objectives 3 and 5.

5.5 OBJECTIVE #5: Restore riparian conditions to protect private land against loss from stream channel erosion and siltation of diversion ponds.

Streambank erosion and the lack of woody riparian vegetation have resulted in instable stream banks, increased sediment delivery to the Paria River and to irrigation systems, and TDS concentrations that exceed state water quality standards.

Action Items

- Implement channel stabilization practices to restrict channel with and reduce flow velocities. Recommended treatments include placement and anchoring of coarse woody debris, root wads, and boulders. The upper portion of Henryville Creek is a priority area.
- Establish hydrophilic vegetation in areas where channel stabilization has been realized using appropriate mix of native trees, shrubs, greases, sedges and rushes.
- Remove tamarisk, Russian Olive, and other invasive species through chemical, physical (fire) or biological methods. Noxious weed control efforts should be coupled with restoration of desirable native vegetation.
- Implement BMPs for grazing management in riparian areas including exclosure and alternate water sources.
- Restore natural flows to the greatest extent possible by maintaining irrigation infrastructure, adopting water conservation policies, and other actions.

Benefits

Stable streambanks and reduced sediment delivery to the Parai River will reduce TDS concentrations which will meet beneficial use standards for agriculture and will protect crop vigor and soil productivity. Reduced sediment will increase the lifespan, reduce maintenance costs and maintain efficiency of irrigation infrastructure. Instream habitat will be improved. Riparian habitat will be improved.

Monitoring

Success will be measured by increased stream bank stability or by achieving Proper Functioning Condition and by the number and effectiveness of BMP implementation.

Table 11: Objective 5 implementation cost estimate.

Type of Expenditure	Description	Cost Estimate
Project	Remove invasive species and re-vegetate streambanks with native plant s	$ See Objective #4
Technical assistance	Develop BMP assessment and implementation plan for grazing management in riparian areas (PFC assessment)	$30,000
Project	Implement BMP management plan	$ Dependant on above
Monitoring	Establish permanent photo points along stream-bank. Conduct PFC assessment in yr 1 , 3 and 5. Conduct BMP implementation and effectiveness monitoring.	$6,000
Total	N/A	

5.6 OBJECTIVE #6 and #7 : Protect and enhance the quality of life and the environment, while creating job opportunities for citizens in the Bryce Valley communities. Protect agricultural lands from development.

Objectives 6 and 7 are closely related. Economic development in agricultural areas is an ever increasing problem. Agriculture and ranching needs to be maintained as a sustainable economic and cultural lifestyle. Few opportunities exist for young people who wish to stay in the communities. The few productive lands available for agriculture are threatened by development. Much work has already been done developing recommendations that will provide economic and social sustainability of the Bryce Valley area. See Section 3.33

Action Items

- Continue agricultural education in classrooms and local associations through the Canyonlands Soil Conservation District.
- Coordinate with Garfield County and SUPAC to implement economic development strategies
- Identify local, state, and federal programs that can be used to protect agricultural land use.
- Implement Acton items from Objectives 1 through 6 above to improve or sustain economic return of agriculture in the region.
- Identify areas suitable for housing or economic development outside of the most productive agricultural lands, if available.
- Coordinate with Canyonlands Conservation and Development Council to write grant proposals that focus on community and economic development.

Benefits

These efforts will promote a more stabile economy, which may in turn ameliorate expected population declines. Providing a more stabile social and economic base which strengthens the agriculture and natural resources sectors of Garfield County's economy will provide opportunities and incentives for young people to remain in or relocate to the area and to continue the agricultural way of life

Monitoring

Success will be measured by the number of students reached through educational efforts, stabile or increasing population trends, increased tax base and the amount of productive lands that remain in agricultural use.

Table 12: Objective 6 and 7 implementation cost estimate.

Type of Expenditure	Description	Cost Estimate
Technical assistance	Conduct agriculture education	
Technical assistance	Cooperate in economic development planning	
Total	N/A	

6.0 Achieving Planning Goals

Where applicable, action Items to achieve a particular planning objective will be implemented through voluntary participation by developing conservation plans with individuals or groups of landowners. These plans will be tailored to address specific resource problems and opportunities that pertain to each particular property. Implementation of the measures outlined in this plan can result in improved runoff control, rangeland health, fire management, and wildlife habitat. When outside funding is available, it can be used to assist private landowners and agency personnel to implement measures identified in the plan.

6.1 Technical and Financial Assistance

Technical assistance may be available from the state and federal agencies participating in the development of this areawide plan. NRCS will provide planning and technical assistance to develop individual cooperator plans as well as group plans and for the implementation of BMPs on private lands. The U.S. Forest Service, Bureau of Land Management, and the National Park Service can provide technical assistance for planning and implementation of BMPs on federal lands administered by their agencies. Technical assistance may also be provided jointly, as the need dictates, by these agencies.

This plan can also be used as a tool to obtain funding on the federal, state and local levels to implement identified practices on private lands and may help prioritize where further analysis of NEPA is required. The Utah Agriculture resource development Loans program also provides

low interest loans for agricultural improvement projects. The local SCD has personnel who may assist in writing grants for funding assistance. Each objective and subsequent action will provide some potential funding resources to implement. See Appendix D for possible Watershed Funding Sources.

6.2 MONITORING

Strategic monitoring goals are associated with each of the Objectives. The results of the monitoring will be shared with the community, partners and stakeholders. Based on the results of the monitoring, Action Items may be continued, revised or replaced.

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[i] A “median” value is the observed value that falls in the middle of the data set with half of the data observations falling above the median and half of observations falling below the median. For example, the median age is the age at which half of the population is older than and half is younger than that specific age.
[ii] (Upper Colorado River Basin Rangeland Salinity Control Project, Pariah River Sub-Basin, Tropic Watershed, Resource Conservation Evaluation Report, SCS 1996).
[iii] Miller, Mark E., Broad Scale Assessment of Rangeland Health, Grand Staircase-Escalante National Monument, USA, Rangeland Ecol. Manage. 61:249-262, May 2008
[iv] (Upper Colorado River Basin Rangeland Salinity Control Project, Pariah River Sub-Basin, Tropic Watershed, Resource Conservation Evaluation Report, SCS 1996)
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