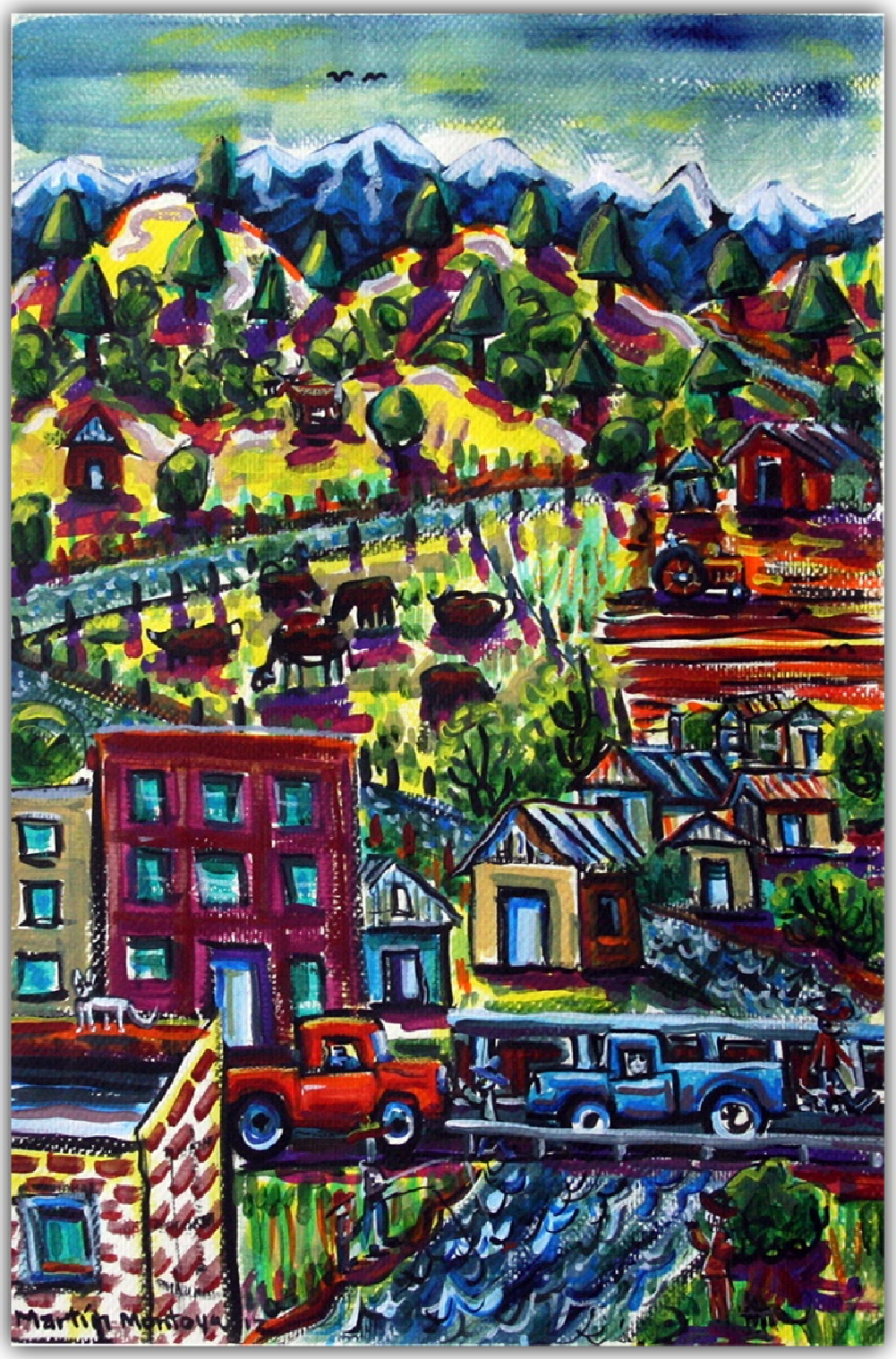
Updated Watershed Based Plan for the Upper Gallinas River



Hermit's Peak Watershed Alliance
Nuestra Tierra, Nuestro Futuro

(Formerly Citizens Watershed Monitoring Team)

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Federal Clean Water Act Section 319 (h) Nonpoint Source Grant
10-H-Updated Watershed Based Plan for the Gallinas River
Surface Water Quality Improvement Projects
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Prepared by Lea Knutson and Katie Withnall
of
Hermit's Peak Watershed Alliance

Cover painting by Martin Montoya titled: Las Vegas and the Gallinas Watershed

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LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
ARMAS	Achieving in Research Math and Science – Internship program at NM Highlands University
AU	Assessment Unit
BMP	Best Management Practice
CCPI	Cooperative Conservation Partnership Initiative
CRP	Conservation Reserve Program
CWA	Clean Water Act
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
GIS	Geographic Information Systems
HPWA	Hermit's Peak Watershed Alliance
HQCWAL	High Quality Coldwater Aquatic Life
HQCWF	High Quality Coldwater Fishery
HWI	Healthy Watersheds Initiative
LA	Load Allocation
LV	Las Vegas
MM	Management Measure
MOS	Margin of Safety
NEPA	National Environmental Policy Act
NM	New Mexico
NMED	New Mexico Environment Department
NMHU	New Mexico Highlands University
NMOSE	New Mexico Office of State Engineer
NRCS	Natural Resources Conservation Service
QAPP	Quality Assurance Project Plan
SMC	San Miguel County
SSTEMP	Stream Segment Temperature Model
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
UWC	United World College
W/D	Width to depth ratio
WBP	Watershed Based Plan
WHIP	Wildlife Habitat Incentives Program
WLA	Waste Load Allocation
WQCC	Water Quality Control Commission
WQS	Water Quality Standards
WREP	Wetlands Reserve Enhancement Program

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ACKNOWLEDGEMENTS

A heartfelt thank you is extended to the many people that helped make this project a success: to Chris Cudia, our Project Officer, who personally helped us navigate the institutional requirements; to the HPWA Board of Directors, especially Ben Gillock and Rock Ulibarri for their support and insight; to our contractors Abigail Groskopf, Bill Zeedyk, Deanna Einspahr, to NM Highlands University professors, especially Dr. Edward Martinez and ARMAS program and the ARMAS interns: Tara Cusack, Zach Armijo, Ernesto Sandoval; to Amy Caldwell (artwork), Carlos Herrera (macroinvertebrates), Mitch Barker (editing). Thank you to Tierra y Montes SWCD, especially Steve Reichert and the NM Forest and Watershed Restoration Institute, especially Joe Zebrowski. Thank you to all the stakeholders that shared their knowledge and time with us. Thanks to the La Placita Fire Company for use of the Fire Station. Thanks to United World College-USA for use of facilities and equipment on numerous occasions. A special thank you to the people of the Gallinas for opening up their lands for our studies and their homes for our conversations, it's been great getting to know you. Thanks to Dave, Jamie and Cory Knutson and Adam Caldwell for their undying support.

INTRODUCTION

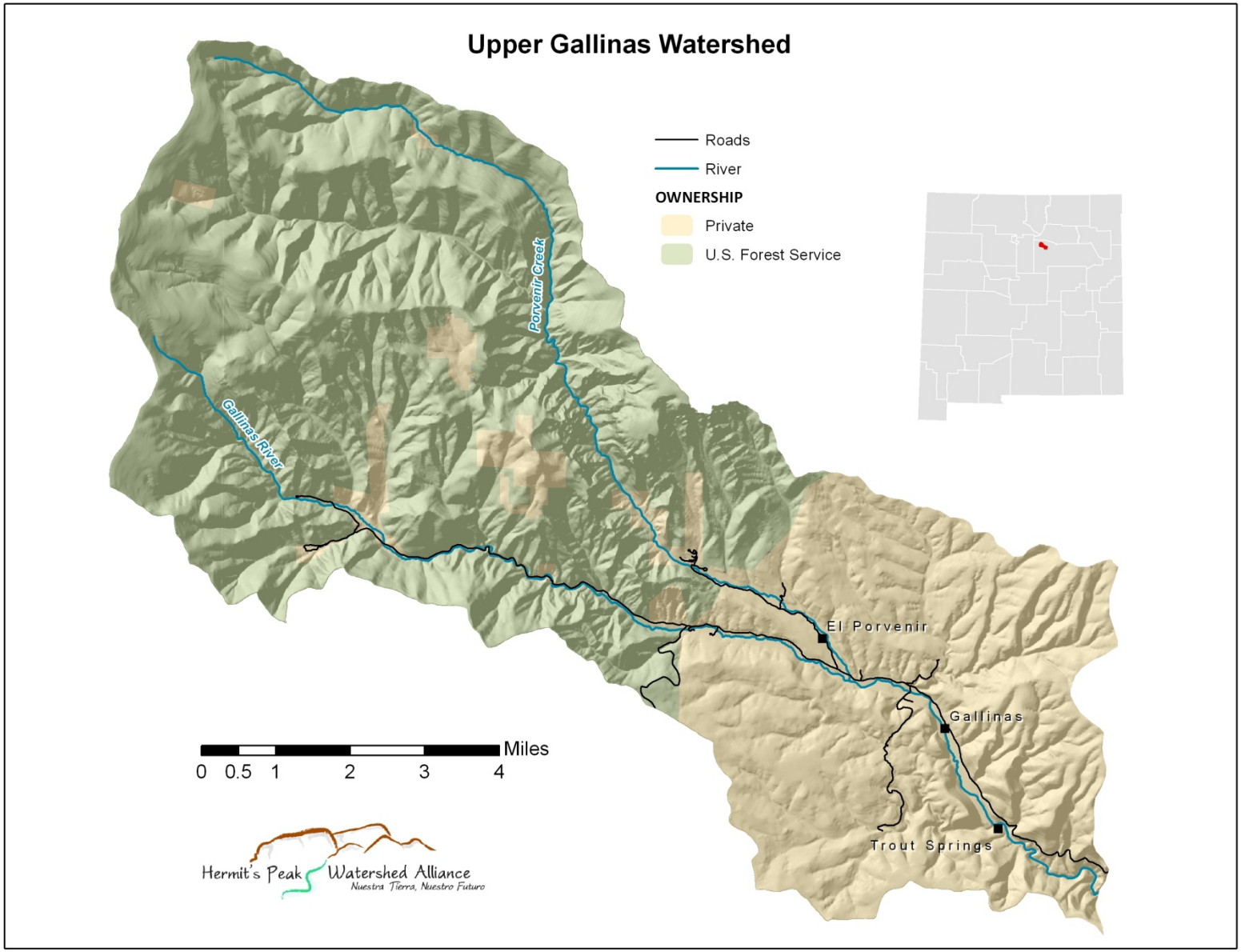
The purpose of this Updated Watershed Based Plan for the Upper Gallinas River is to help guide land management and restoration efforts in the Gallinas Watershed from the Las Vegas Diversion to its headwaters including Porvenir Creek, Assessment Unit NM- 2212_00 (Map 1). The types of land management and restoration efforts covered here focus on those that directly affect stream condition, specifically as they pertain to restoring and maintaining stream temperatures so they meet state standards.

This plan's impetus is the Federal Clean Water Act Section 319 Nonpoint Source Grant that provides funding through the New Mexico Environment Department. This plan is based on the insightful Nine Key Elements (US Environmental Protection Agency, 2008) of a sound watershed plan. It provides an opportunity to examine the current condition of the Gallinas River and Porvenir Creek, identify specific causes and sources of compromised condition (impairment) and recommend efforts that can help restore healthy conditions considering the existing ecological and social circumstances. Future 319 implementation grants will then help provide the support to put this plan into action. The ultimate goal of the WBP and its implementation is to remove the Gallinas River and Porvenir Creek from the list of impaired waters through improved land management and restoration efforts.

The Total Maximum Daily Load (TMDL) for the Pecos Headwaters Watershed approved by the New Mexico Water Quality Control Commission (WQCC) in June of 2005 lists the Gallinas River (Las Vegas Diversion to headwaters), as temperature impaired (SWQB, 2005). It was determined that the Gallinas River from the Las Vegas Diversion to headwaters and its tributary Porvenir Creek, do not support its designated high quality coldwater aquatic life use. The designated uses, according to New Mexico Standards for Interstate and Intrastate Surface Waters of the Gallinas River and Porvenir Creek include: domestic water supply, high quality coldwater fishery, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply, and secondary contact. In order to support high quality coldwater aquatic life, water temperatures should not rise above 68 degrees F (20 C) (SWQB, 1999).

Addressing stream temperature issues in the Gallinas Watershed provides an avenue to simultaneously improve many other key stream and watershed health related concerns. Furthermore, by addressing temperature issues, we will also deal with fundamental challenges related to climate change (Seavy, 2009).

The component of stream systems that contributes most significantly to stream temperature regulation and is controllable by anthropogenic activities is riparian vegetation, through stream shading and anchoring streambanks to prevent stream channel widening. Ground water inputs and the quantity of stream flow play a significant role; we cannot however, largely control those aspects. Because riparian vegetation management and restoration is within our direct control, is the focus of EPA load reduction requirements, and riparian vegetation offers ecosystem services related to other important aspects of water quality and quantity it is the focus of this plan.



Map 1- Updated watershed based plan project area

Beyond stream shading, healthy riparian vegetation plays a vital role by: anchoring streambanks that reduce erosion which keep streams channels narrow and deep (optimal temperature conditions); retaining a moist and cool microclimate that is less prone to evapotranspiration; holding moisture in soils for slow release; slowing and spreading water flow to help mitigate floods; filtering sediments; and providing vital organic materials to the stream ecosystem. Intact and fully functional riparian vegetation also helps to augment consistent stream flows by reducing stream entrenchment and maintaining water access to floodplains. Water stored in soils and adjacent wetlands (aided by riparian vegetation) is slowly released to the stream over time, helping to maintain consistent stream flows and reducing erosion of streambanks during flood events.

The riparian area along some stretches of the Gallinas River is sparsely vegetated providing limited stream shade. Many riparian areas lack tall woody vegetation, have limited plant diversity, and are not sufficiently wide to fully support functional and sustainable riparian vegetation. Management measures presented here address these deficiencies in order to facilitate reducing stream temperatures and the long-term provision of the numerous ecological services provided by riparian vegetation.

Proposed management measures in this plan reflect the need to address causes and sources on non-attainment directly as required by EPA 319. However, this suite of measures also advances the holistic watershed approach set forth in EPA's new Healthy Watersheds Initiative (HWI) (US Environmental Protection Agency, 2011). While the primary goal of this Watershed Based Plan is to address water quality impairments identified in the TMDL, neglecting to address the protection and restoration of overall watershed integrity reduces its long-term effectiveness. Any accomplishments we make could be reversed or offset unless TMDL implementation is part of a broader systems-based watershed assessment and management strategy, similar to that proposed in HWI. Addressing the breadth of watershed concerns is beyond the scope of this planning effort but it was constructed to address that broader context whenever possible within the framework of meeting the TMDL.

An example of this is that reduced stream flow is perhaps the largest contributing factor to elevated temperatures in the Gallinas River and Porvenir Creek. While a wide variation of stream flow has occurred throughout history (U.S. Geological Survey, 2012), the current severity of low flows appears to be greater than in the past (Hermit's Peak Watershed Alliance, 2012a). Some significant contributing factors to this may be beyond local control; however, other factors may be related to local watershed conditions and are indirectly related to stream temperature through flow. Low flows can be attributed in part to stream entrenchment, lost sinuosity, removal of riparian vegetation, loss of wetlands and the subsequent loss of floodplain water storage capacity and overall desiccation of stream sides. Efforts to restore healthy stream functions to produce maximum potential flows and lessen the effects of rapid water loss during flood events are introduced in this plan in an attempt to address more comprehensive concerns than the direct temperature impairment.

Geographical, Ecological, Social, and Historical Context

The Upper Gallinas Watershed is a sub-watershed of the Pecos Watershed and is located in northeastern New Mexico. The watershed is 48,969 acres (76 mile^2) from its headwaters on Elk Mountain to the Las Vegas Diversion near Montezuma, NM, including Porvenir Canyon to the headwaters of Beaver Creek. This total of 32.5 miles of stream length descends from 11,661' to 6,800'.

This entire project area covers the Gallinas River, Gallinas Creek and Porvenir Canyon Hydrologic Unit Codes (HUC) 130600010801, 130600010802 and 130600010805 (see Map 2). Table 1 provides a description of this entire project area.

Table 1- Project area description for the Updated Watershed Based Plan for the Upper Gallinas River

NAME	HUC (12)	HUC SIZE (acres)	MAIN STEM LENGTH (miles)	DESCRIPTION
Porvenir Canyon	130600010801	18,028.6	14.4	Entire length of Porvenir Cr. up to headwaters of Beaver Cr.
Gallinas Cr.	130600010802	16,072.9	12.4	Gallinas Cr. from confluence with Porvenir Cr. up to its headwaters
Gallinas R.	130600010805	14,866.6	5.7	Gallinas R. from Las Vegas Diversion to its confluence with Porvenir Cr.
TOTAL	**1306000108**	**48,968 acres**	**32.5 miles**	

Porvenir Creek is an important tributary of the Gallinas River, although its watershed (all of HUC 130600010801) lies mostly within the Pecos Wilderness, where riparian conditions and water quality are generally thought to be good and management opportunities are limited by Wilderness Act protections. For this reason, the project focused on the lower Porvenir Creek Watershed (downstream of the National Forest boundary). Since the focus area did not include Porvenir Creek above the Forest Service boundary the actual length of river addressed was 21.5 miles rather than the 32.5 listed above.

The Upper Gallinas Watershed is comprised of 92% forest, 6% rangeland, 2% barren and less than 1% agriculture and tundra. Land ownership is 52% U.S. Forest Service and 48% private and local government (SWQB, 2005). Private land is comprised of approximately 315 parcels that are an average of 61 acres in size. There are generally smaller land parcels near the river, especially in the Gallinas village, while the uplands tend to be comprised of larger ranches. Land use has transitioned over the last few decades from agriculture, focusing on timber, livestock, and hay production, to primarily full-time and part-time residential use and summer recreation. Currently, agriculture is limited to small, non-commercial production of livestock, hay (restricted to the valley bottom) and timber as well as personal subsistence farming.

The project area includes dispersed residential development with the highest density of population centering in the unincorporated village of Gallinas. Census Bureau data are not of sufficient resolution to offer population estimates of Gallinas village and surrounding rural areas in the Upper Gallinas Watershed. However, based on the average household size of 2.31 for San Miguel County (2010 Census) and an estimated number of houses in the watershed, we estimate the population size to be 508 with a population density of 6.7 people per square mile.

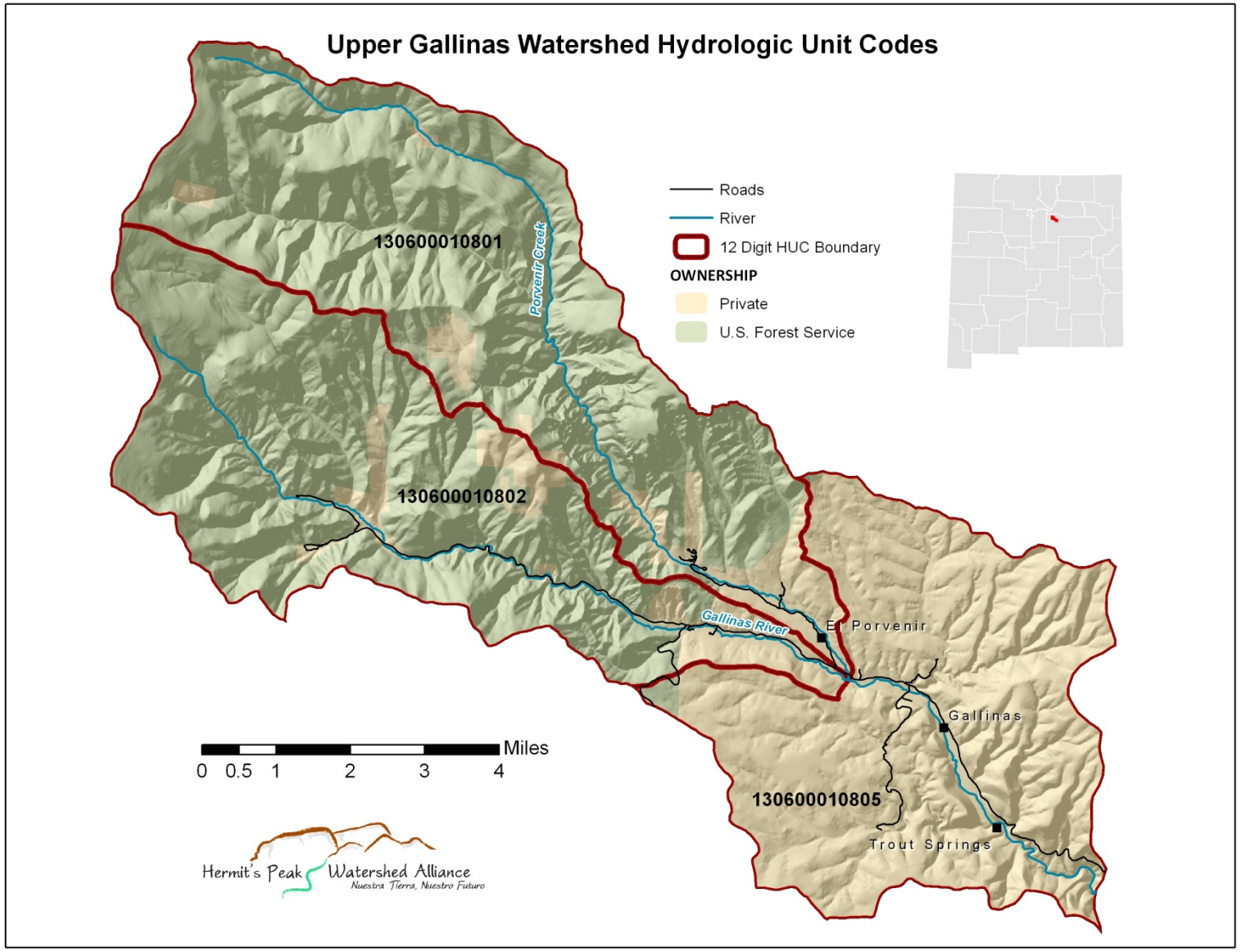
The Gallinas Watershed provides the community of Las Vegas with 90% of its water supply. The 13,753 people that live in the City of Las Vegas (U.S. Census Bureau, 2010) and some outlying areas like the Storrie Project, is therefore heavily dependent on the Gallinas River that only produces average flows of 17.371 cfs (annual mean discharge for the past ten years) (U.S. Geological Survey, 2012). City water storage capacity is also limited, so maintaining consistent stream flows of high quality water is of utmost concern to Las Vegas.

Access to the Gallinas Watershed is by NM State Highway 65 that largely parallels the Gallinas River until it turns into Forest Roads 263 and 261 that follow the upper stretches of the Gallinas and Porvenir Creek. Both State and Forest roads are located very close the river courses, limiting some river and riparian restoration project possibilities.

According to the Wildland Urban Interface Community Wildfire Protection Plan (San Miguel County, 2008)the communities in the upper Gallinas Watershed have a Community Hazard to wildfire rank of High (possible ranks of low, moderate, high, very high, extreme) which corresponds to a high risk according to the New Mexico Fire Planning Task Force. To reduce the threat of large scale, high intensity crown fire, the USFS developed a plan to treat 8,169 acres of Federal forest land in the upper Gallinas Watershed (USDA Forest Service, 2005). New Mexico State Forestry and Tierra y Montes Soil and Water Conservation District are also involved in forest treatment projects on private lands to reduce the threat of catastrophic wildfire in the Gallinas.

A complex interplay of ecological, cultural, economic, and bureaucratic forces have shaped the land in northern New Mexico including the Gallinas watershed over the last 300 years (deBuys, 1985). These have given rise to the compromised condition of streams and the overall health of watersheds. A relatively arid climate, fragile soils and vegetation, and complex historical interactions between Native American, Hispanic and Anglo residents and the environment has also led to depressed economies, short-term land management objectives, and land used in excess of its capacity to regenerate.

This less than healthy condition, as indicated by current and potential future stream impairments (e.g. high water temperature, limited flow, excessive sedimentation), is rooted in the type of relationship humans have with the land. For stream impairments and overall watershed health to improve and brace itself for unpredictable future conditions, addressing and improving this relationship is essential. To do this we must address the basic understanding of the value of ecological services provided by a healthy watershed, what it takes to restore and maintain a watershed, provide community support to motivate people to do so and provide the financial and technical assistance to get the job done. These key elements are addressed in Education and Outreach efforts within the capacity of HPWA and the mission of 319 projects.



Map 2- Gallinas watershed Hydrologic Unit Code (HUC) boundaries

PROJECT OVERVIEW

The overall approach to this planning project was to assess ecological and social conditions of the Gallinas River and Porvenir Creek. That information was then used to recommend means of improving on identified problematic conditions within the social context of the area. Recommendations provide the support and direction to request future funding to put the plan into action.

In order to establish a clear understanding of the specific factors affecting the temperature impairments and the overall stream condition, HPWA conducted a variety of studies during 2011. These studies examined numerous aspects of stream condition including:

- Stream temperature
- Stream shading
- Channel width to depth ratio
- Fluvial geomorphology
- Riparian vegetation condition
- Physical instream habitat condition
- Macroinvertebrate population composition
- Beaver occurrence

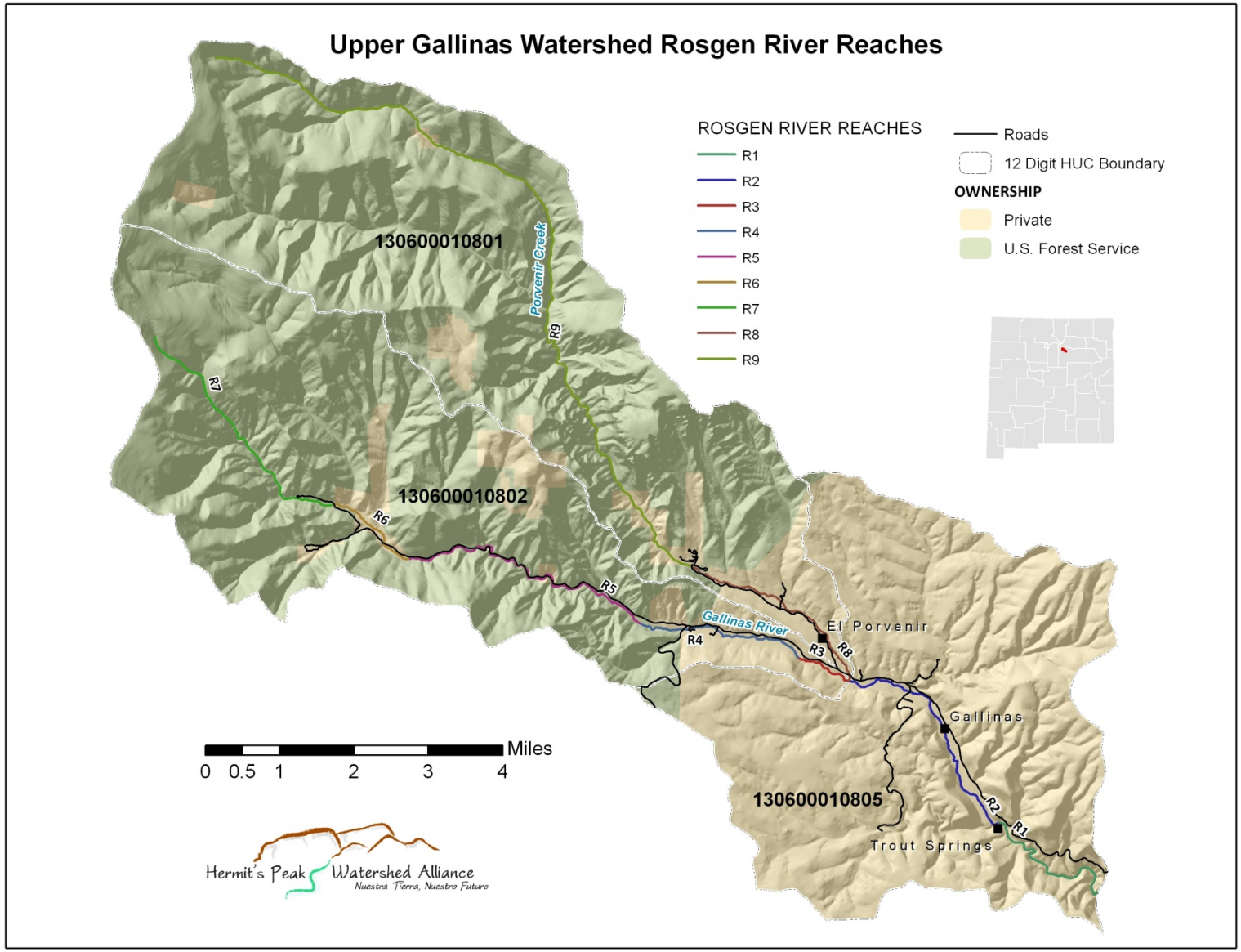
For all of the above field studies, the sample sites were chosen based on Rosgen Level II river designation and stream order. The river was divided into 9 distinct reaches based on geomorphic river type and condition. The report "Physical Condition of the Upper Gallinas River" (Hermit's Peak Watershed Alliance, 2011) details this delineation. See Map 3 for the locations of these reaches.

Social perceptions, interests, impediments and resources were then examined by interviewing riverfront private landowners and other public and private stakeholders in the area (Hermit's Peak Watershed Alliance, 2012e).

Results of these studies are contained in ancillary reports (available from the Hermit's Peak Watershed Alliance upon request) and provide the basis for this plan.

An assessment of stream temperature conditions in order to isolate high temperature inputs and important cold temperature sources is contained in the report titled "Stream Temperature of the Upper Gallinas Watershed" (Hermit's Peak Watershed Alliance, 2012a). The report titled "Physical Condition of the Upper Gallinas River" contains results of field data collection on the two principal factors affecting stream temperature that are controllable by management: stream shading and stream width to depth ratio (Hermit's Peak Watershed Alliance, 2011). It also contains results of other studies that help illuminate the general condition of the Gallinas River including: fluvial geomorphology, instream conditions, and riparian area condition. Results from two surveys of animal populations as indicators of stream health including macroinvertebrates and beavers are presented in separate reports. The social conditions in the Gallinas Watershed as they pertain to interest and ability to participate in stream restoration activities is discussed in a report titled "Interviews with Public and Private Stakeholders in the Gallinas Watershed" (Hermit's Peak Watershed Alliance, 2012e). This report summarizes interviews of Gallinas River and Porvenir Creek landowners and private and public stakeholders.

Three public meetings were held to solicit input from the Gallinas community and other stakeholders.



Map 3- Project area Rosgen river reaches

NINE KEY ELEMENTS OF A WATERSHED BASED PLAN

EPA has adopted Nine Key Elements to guide the development of Watershed Based Plans (WBP). They explain (USEPA 2008) that key components of a successful WBP include stakeholder participation, careful planning, watershed characterization, and scientifically-sound data collection and analysis. This planning process and the resultant plan embrace those Nine Key Elements to ensure a sound and comprehensive approach to developing a WBP.

These elements are addressed in the following sections of this plan, more specifically they are:

1. Identify the Causes and Sources of Temperature Impairment
2. Estimate Load Reductions
3. Management Measures to Support Load Reductions
4. Technical and Financial Assistance Needed
5. Education and Outreach
6. Implementation Schedule
7. Measurable Milestones of Implementation
8. Criteria for Evaluating Load Reduction Achievements
9. Monitoring Program

IDENTIFY THE CAUSES AND SOURCES OF TEMPERATURE IMPAIRMENT

Cause of Impairment

The New Mexico Standards for Interstate and Intrastate Surface Waters designates use of water in the Gallinas River and its tributaries, including Porvenir Creek, as domestic water supply, high quality coldwater fishery (HQCF), irrigation, livestock watering, wildlife habitat, municipal and industrial water supply, and secondary contact.

One of the designated uses of the Gallinas River (Las Vegas diversion to headwaters) including its main tributary Porvenir Creek, according to New Mexico's water quality standards, is high quality coldwater aquatic life. The New Mexico Environment Department (NMED) determined in 2005 that high quality coldwater aquatic life is not fully supported in the Gallinas River (Las Vegas diversion to headwaters) and that temperature is the cause of that impairment.

The Total Maximum Daily Load (TMDL) for the Pecos Headwaters Watershed approved by the New Mexico Water Quality Control Commission (WQCC) in June 2005 lists the Gallinas River (Las Vegas Diversion to headwaters), Assessment Unit NM -2212_00, as temperature impaired (SWQB, 2005). EPA approved the TMDL in September 2005.

The NMED Temperature Assessment Protocol states that High Quality Coldwater Aquatic Life Use Support is fully supported if: instantaneous (hourly) temperature does not exceed 23° C (or the segment specific maximum temperature) and temperatures do not exceed 20° C (or the segment specific 4T3 temperature) for four or more consecutive hours in a 24 hour cycle for more than 3 consecutive days (4T3). Conversely, HQCWAL is considered not supporting when: instantaneous (hourly) temperature exceeds 23° C (or the segment specific maximum temperature) or temperatures exceed 20° C (or the segment specific 4T3 temperature) for four or more consecutive hours in a 24 hour cycle for more than 3 consecutive days (4T3) (SWQB, 1999).

The 2005 TMDL states that 2001 temperature data exceeded at 2 out of 24 data stations with a maximum temperature of 22.4° C. This temperature data that exceeded standards is also confirmed in a separate report conducted in 2001 by NMED (Hopkins, 2001). In 2003, recorded temperatures exceeded standards 250 of 1795 times with a maximum temperature of 30.4° C. At another site in 2003 (USGS gage) recorded temperatures exceeded the HQCWF criterion 26% of the time with a maximum temperature of 28.1° C (SWQB, 2005). Finally, a 2009 report of a 2007 study by NMED states that temperature exceeded at multiple sites with maximum recorded temperatures of 26.2° C (SWQB, 2009).

The TMDL for temperature is WLA (0) + LA (99.30) + MOS (11.03) = 110 j/m^2/sec/day. The TMDL establishes a goal for target load reduction of 54.65 joules/m^2/s. As there are no permitted point sources for temperature impairment on this segment of the Gallinas River, this load reduction goal can only be met by addressing nonpoint sources of pollution.

Sources of Impairment

The TMDL lists nonpoint pollution sources of temperature impairment for the Gallinas River as: highway/road/bridge runoff, livestock (grazing or feeding operations), loss of riparian habitat, rangeland grazing, streambank modification/destabilization, and natural (SWQB, 2005). The TMDL establishes a target of 61.5% stream shade in order to meet load reduction goals based on SSTEMP modeling. The target load reduction therefore is the percent increase from established or current stream shade levels to the target stream shade goal of 61.5%. Reduced stream shade is accepted to be the source of impairment for all three sub-watersheds in the project area.

While SSTEMP may accurately determine the effect of increased shade on temperature, according to the TMDL "reducing Width's A term had an insignificant effect on the predicted maximum temperature". However, the TMDL lists (Figure 1) channel widening, or increased width to depth ratios that increase stream surface area exposed to solar radiation as the first cause of "the elevated summertime stream temperatures attributable to anthropogenic causes". The other two causes listed are "riparian vegetation disturbance" and "reduced summertime base flow that results from instream withdrawals or insufficient riparian vegetation". That said, it is apparent that numerous variables, both uncontrollable and controllable such as low flows, sediment, turbidity, and width to depth ratios also contribute heat to the river. Of the variables that can be manipulated, the next most sensitive variable besides riparian vegetation enhancement is modifying width to depth ratio in order to reduce water surface area that is readily available to exchange heat with the atmosphere. Best Management Practices (BMPs) that improve width to depth ratio and floodplain connectivity can reduce heat exchange.

However, as previously mentioned, the SSTEMP model is not sensitive to geomorphic changes and also does not discern the relationship between stream shade and width to depth despite the fact that the segments of river that are narrower have better center stream shade than those that are wider. Due to this fact, only percent shade can be used to calculate load reductions on the Gallinas River.

Hermit's Peak Watershed Alliance collected data in 2011 to confirm the temperature impairment listed in the TMDL and to establish current stream shade and width to depth data. All data was collected in accordance to the approved Quality Assurance Project Plan (QAPP). HPWA followed the New Mexico Environment Department Standard Operating Protocol for temperature datalogger deployment and data collection periods (SWQB, 2011). Procedures were employed with no modifications. Twelve sites were chosen throughout the watershed based on reach designation. Several of the sites were chosen to determine what the temperature inputs of Trout Springs and Porvenir Creek were to the Gallinas River. Four of the sites were located at the exact coordinates of previous NMED datalogger collections. Datalogger results determined that 9 out of 12 sites exceeded temperature standards, while 2 of the sites were not applicable as Porvenir Creek was dry for almost the entire duration of the field season (Table 2). See Map 4 for temperature datalogger deployment locations.

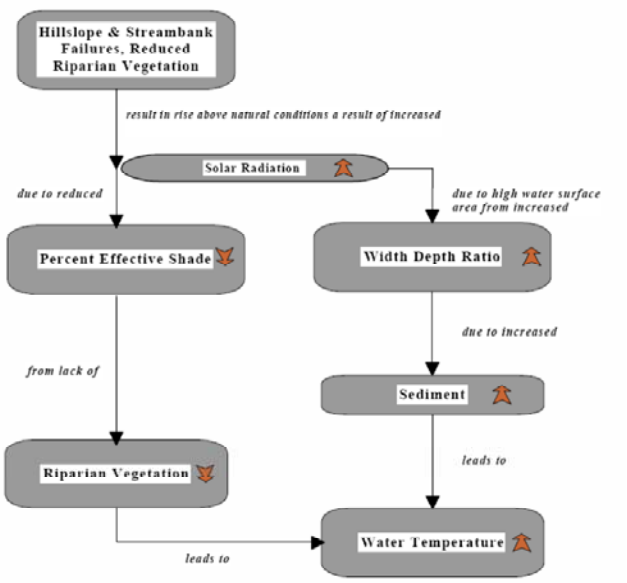


Figure 1- Factors that Impact Water Temperature (from TMDL)

There are a small number of cold water inputs to the Gallinas River and Porvenir Creek, most notably Trout Springs. Trout Springs yields consistent 11 C water at its headwaters which makes its way down to the Gallinas through a half mile of stream. HPWA is collecting temperature data in the summer of 2012 to confirm the temperature at the spring's headwaters and at its confluence with the Gallinas in order to calculate the heat accumulation along Trout Springs. Additionally there are a number of small springs in Gallinas Village and other locations along the river which contribute cold groundwater, although their specific contribution is unknown.

Table 2- Water Quality Standards Assessment

SITE ID	DATALOGGER DEPLOYMENT LOCATION	MAX TEMP	DETERMINATION*
T1	Reach 1- City Watershed	29.065° C	Exceeds- Instant
T2	Reach 2- below confluence Trout Springs	25.25° C	Exceeds- Instant
T3	Reach 2- above confluence Trout Springs	27.16° C	Exceeds- Instant
T4	Reach 2- Gallinas	22.08° C	Exceeds- 4T3
T5	Reach 2 – Gallinas	25.9° C	Exceeds- Instant
T6	Reach 2 – below confluence Porvenir	24.5° C (stream)/ 37.18° C (air)	Exceeds- Instant
T7	Reach 3- above confluence Porvenir	24.48° C	Exceeds- Instant
T8	Reach 4- USFS abandoned cabin	22.8° C	Exceeds- 4T3
T9	Reach 6/7- USFS near headwaters trail	18.5° C	Does not exceed
T10	Reach 8- Porvenir near confluence with Gallinas	34.9° C (air)	Not Applicable- Porvenir dry
T11	Reach 8- Porvenir	43.6° C (air)	Not Applicable- Porvenir dry
T12	Reach 9- Porvenir Campground	21.8° C	Exceeds- 4T3

***Type of exceeding standards for High Quality Cold Water Aquatic Life Use Support** (SWQB, 1999)**:**

Instant- Temperature exceeds 23 C at least once

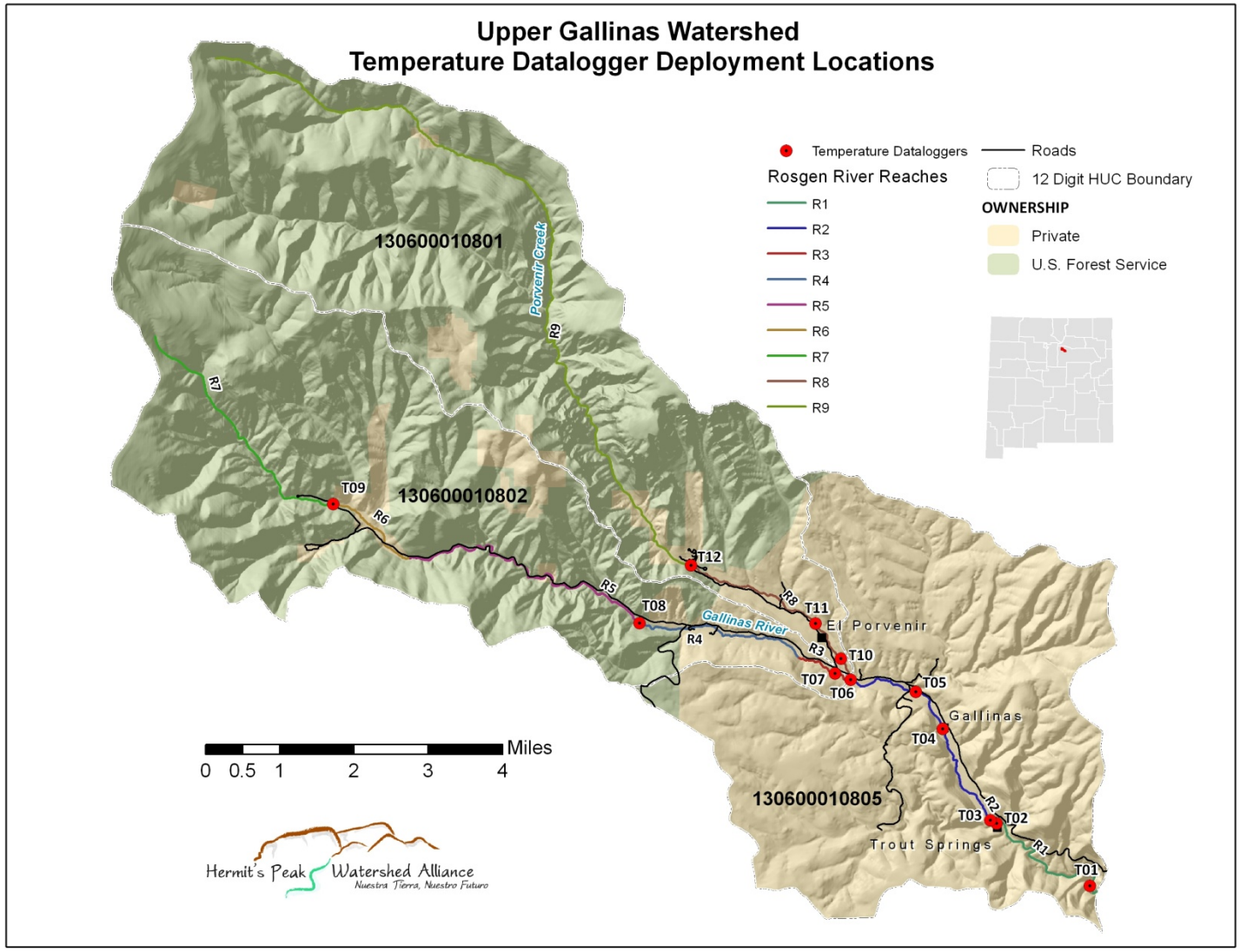
4T3- Temperatures exceed 20 C for four or more consecutive hours in a 24 hour cycle for more than three consecutive days.

Stream shade data was also collected in order to identify specific sources and calculate load reductions. Canopy cover was assessed with two different methods; a GIS/aerial photography analysis (dot grid sampling) that estimated stream shade along the entire river length broken down into 16 different segments based on similar canopy cover and a field sampling of 50 sites, which was used to verify GIS estimates. HPWA chose to use SWQB NMED 2011 Standard Operating Procedures (NMED SWQB, 2011) to measure percent stream shade in the field. This methodology was used because it is the state standard and a similar but older version was used to determine canopy cover for the TMDL. Procedures were employed with no modifications.

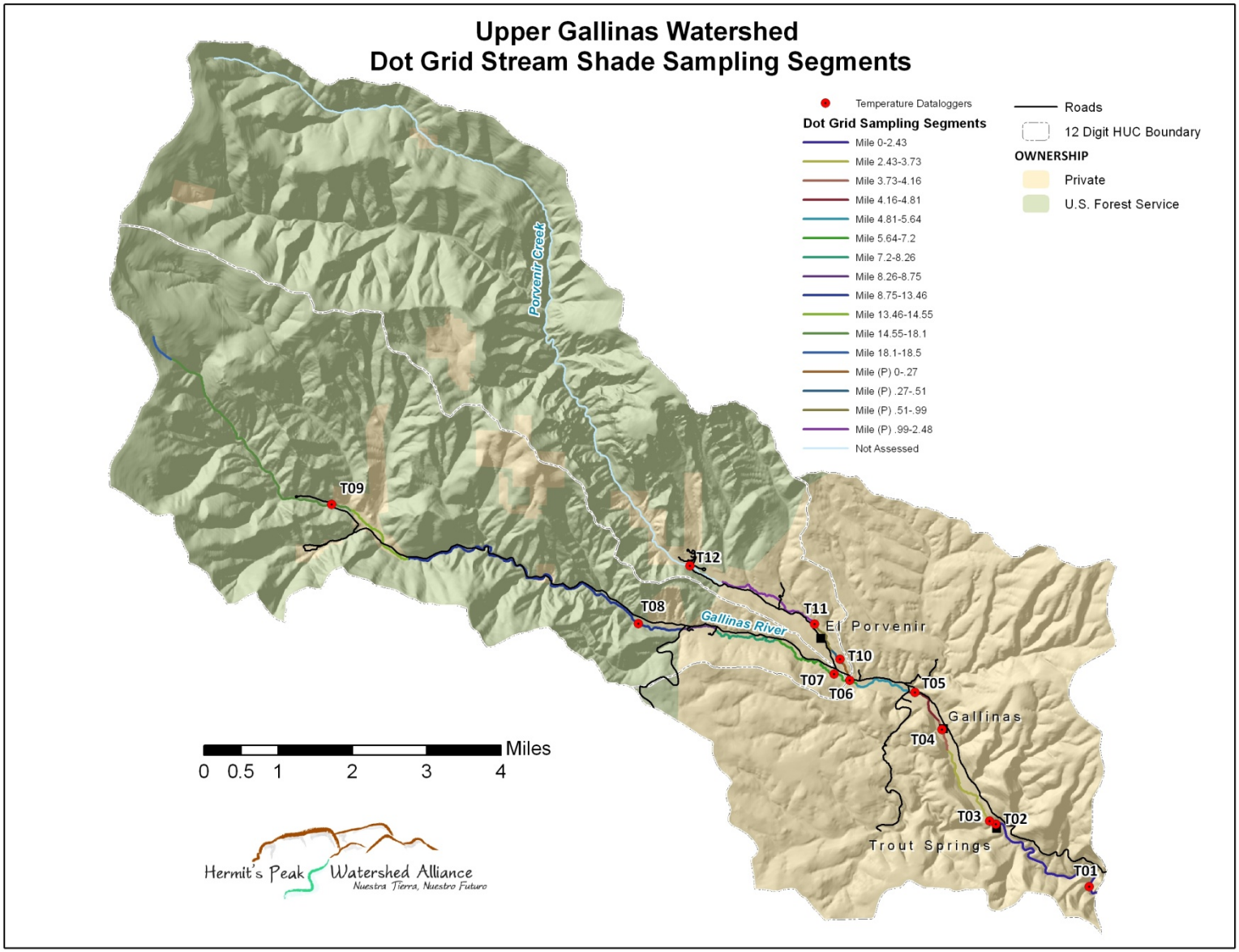
Canopy data collected via dot grid sampling method and in field identified 11 out of 16 segments, or a total of 9.9 miles, of inadequate stream canopy cover. Aerial photography was used to delineate stream segments of various lengths that had equivalent stream shading values. Sixteen segments were delineated, of these, 11 segments had shade values below the TMDL target. These 11 segments are therefore restoration priorities. The 11 priority segments were then ranked from lowest to highest stream shade value (the number one priority being the segment with the lowest percent stream shade). Of the segments with insufficient stream shade levels, 96 percent of the total lengths of these segments are located on private lands. Contributing factors of low stream shade levels include stream entrenchment, streambank erosion, livestock grazing, agricultural fields, roads, residential development, recreational use, widening of the river, and natural conditions that might prohibit woody vegetation. See Map 5 for dot grid stream shade segment locations. See Map 6 for priority segments.

Finally, width to depth ratio data was collected in accordance with NMED 2011 Standard Operating Procedures. While these data are not used to calculate load reductions, as discussed above, the monitoring found numerous locations where high width to depth ratios are resulting in increased water surface areas exposed to solar radiation.

While data collection for temperature, stream shade and width to depth ratios was according to standards and sampled appropriately, it is recommended to revisit and confirm data at identified sites prior to implementation.



Map 4- Temperature datalogger deployment locations



Map 5- Dot grid stream shade segments

ESTIMATE LOAD REDUCTIONS

Source Identification

The following table identifies, prioritizes and lists the calculated load reduction for specific stream segments identified as contributing to the temperature impairment on the Gallinas River. Map 6 shows the geographic locations of these priority stream segments. Please see Appendix A for Load Reduction calculation methods.

Data for stream withdrawals has not been available in the past. In the summer of 2012, the NMOSE installed gages on irrigation ditches therefore withdrawal data should be available in the future. Furthermore, no irrigation withdrawals occurred during the data collection period of 2011 due to drought conditions.

Because the withdrawal data is not available, we are not able to calculate the loadings related to withdrawal. The surface area per unit volume of water increases as flow decreases; therefore there is more potential heat exchange per unit volume of water. Additionally the flow-temperature relationship cannot be sufficiently calculated due to insufficient data to identify the stage of flow in which heat loading becomes critical. HPWA will be coordinating with NMHU to pursue more in-depth temperature-flow monitoring.

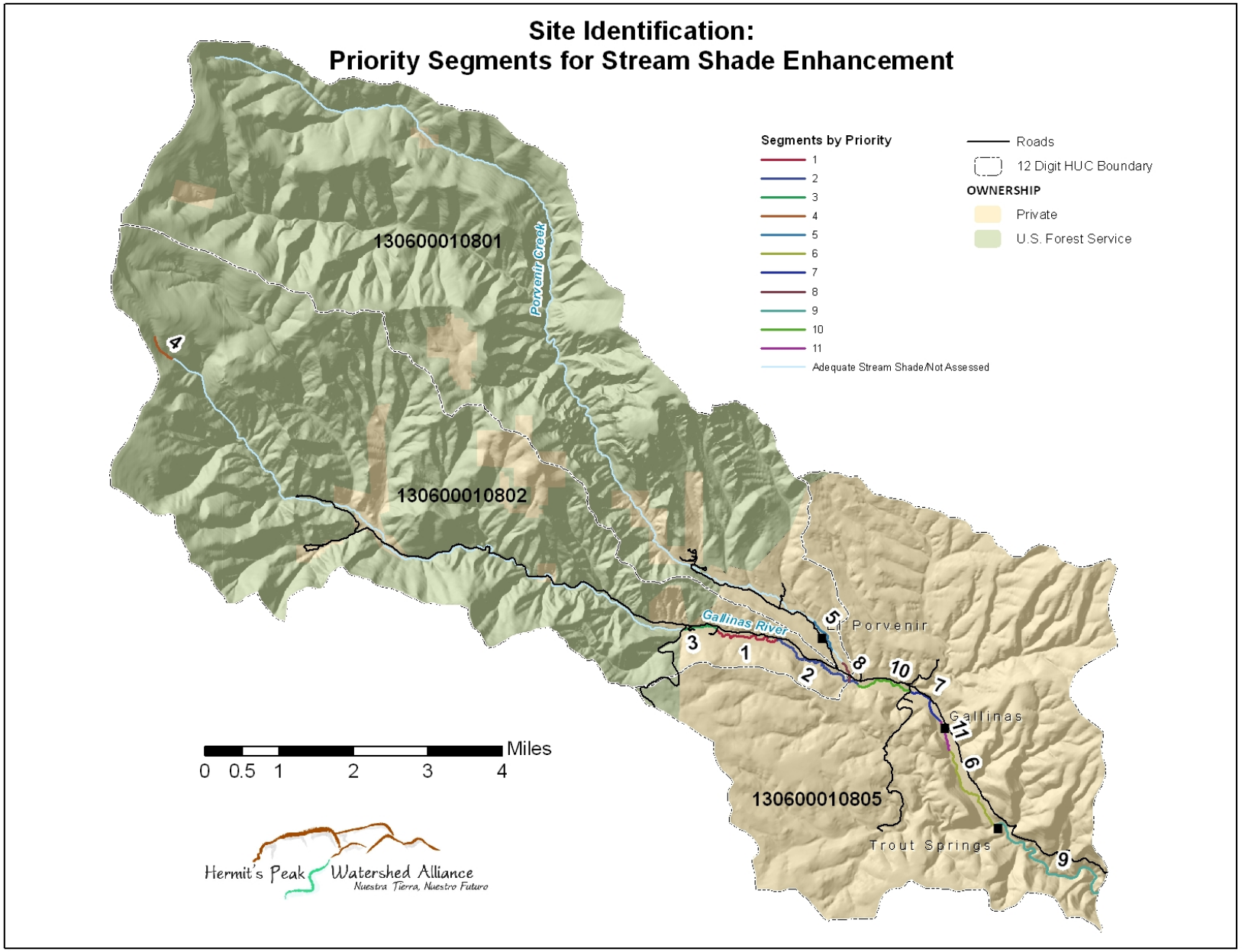
The following segments in Table 3 are prioritized based on total load reduction in $j/m^2/s$ from the highest reduction to the lowest. A total of 9.9 miles of stream length require stream shade enhancement; that is 46% of the total 21.5 miles of stream length in the study area. It must be noted that although the segments are ranked in this order, a few sites within the segments, located in wetlands and box canyons, may not be appropriate for restoration or canopy enhancement due to natural environmental conditions that may prohibit growth of woody vegetation.

Table 3- Required increase in stream shade necessary to achieve TMDL load reduction targets

PRIORITY	RIVER SEGMENT	LENGTH (MILES)	% STREAM SHADE 2011	% STREAM SHADE STANDARD	REQUIRED INCREASE %	TOTAL LOAD REDUCTION ($J/M^2/S$)
1	Mile 7.2-8.26	1.06	33.98	61.5	27.52	**69.89932**
2	Mile 5.64-7.2	1.56	39.72	61.5	21.78	**55.33057**
3	Mile 8.26-8.75	0.49	41.67	61.5	19.83	**50.37667**
4	Mile 18.1-18.5	0.4	43.59	61.5	17.91	**45.49205**
5	Mile P 0.51-0.99	0.48	48.89	61.5	12.61	**32.03222**
6	Mile 2.43-3.73	1.3	50.43	61.5	11.06	**28.10565**
7	Mile 4.16-4.81	0.65	51.67	61.5	9.83	**24.97667**
8	Mile P 0-0.27	0.27	54.54	61.5	6.95	**17.66455**
9	Mile 0-2.43	2.43	56.08	61.5	5.41	**13.74913**
10	Mile 4.81-5.64	0.83	58.90	61.5	2.59	**6.593562**
11	Mile 3.73-4.16	0.43	60.97	61.5	0.52	**1.331951**

While these priorities are based on Load Reductions, it must be recognized that during project implementation, other factors may come into play in determining the order in which projects will occur. These priorities will drive implementation order but factors such as cost, landowner willingness, only generally assessed thus far (Hermit's Peak Watershed Alliance, 2012e), and project feasibility will practically need to be considered.

Trout Springs, a significant source of high quality, cold water to the Gallinas River was not included in field sampling, hence was not included in the above priority listing. Data on this key tributary will be added during subsequent phases of work. Because of its significance, restoration and improved land management work will be pursued along with the above priority reaches.



Map 6- Low stream shade segments by priority

MANAGEMENT MEASURES TO SUPPORT LOAD REDUCTIONS

Management Measures to address stream temperature reductions focus on the management, restoration, protection and enhancement of riparian vegetation. The reasons for this focus are three-fold: 1) reliable load reduction calculations (required by NMED and EPA) are only available for stream shade; 2) riparian vegetation provides stream shading which can be controlled by human actions so is the most direct means of reducing stream temperature, and 3) intact riparian vegetation provides substantial benefits to other, related stream ecosystem functions. Map 6 shows locations of priority stream segments in need of riparian vegetation (stream shade) improvements.

While planned Management Measures focus on riparian vegetation, they also cover efforts that indirectly support riparian vegetation but are more directly geared toward improving flow conditions (that also affect temperature). Management Measures that aid in regaining water access to the river's floodplain and facilitate natural storage in adjacent soils, the aquifer and in wetlands are also included. These measures will help to offset irrigation withdrawals and expected drought conditions. By helping to rewet floodplains, irrigation needs (thus withdrawal rates) may also be reduced in pastures and hay fields in the valley bottom.

All applicable land management and restoration tools available were assessed and ranked (see Appendix B). Table 6 contains the most effective Management Measures, and their associated load reductions, that have the greatest likelihood of reducing temperature on the 11 priority stream segments.

For recommended Management Measures to be effective, however, public support for management and enhancement generally and the Management Measures specifically must be addressed. Efforts needed to gain that public support are covered in the Education and Outreach section. These efforts are an integral part of all recommended Management Measures. The importance of this community support cannot be overemphasized since all the land management and restoration practices focus on private lands and require landowner cooperation and long-term maintenance for them to be successful.

In this plan we use the term Management Measures (MMs) to describe on-the-ground treatments, sound management, and planning or regulatory tools that are used to improve riparian and stream conditions. The term Management Measures is considered to be synonymous with Best Management Practices in this plan.

Existing Management Measures

As background, we evaluated MMs that have occurred in the recent past or are currently in use in the Upper Gallinas Watershed in terms of their effectiveness at creating conditions that maintain and improve riparian vegetation and low stream temperature. Some effective Management Measures have occurred, however, their scope has been limited so have been ineffective at reducing stream temperatures. Measures that have effectively helped to restore and maintain healthy riparian vegetation in some areas include restricting access to livestock and people, reconnecting the river to its historic channel and carefully managed grazing. That evaluation is summarized below in Table 4.

Table 4- An evaluation of existing Management Measures that affect riparian canopy cover currently in effect in the Upper Gallinas Watershed

EXISTING MANAGEMENT MEASURES	STAKEHOLDER	EFFECTIVENESS
Livestock removal	Misc. private landowners	Has been effective at restoring riparian vegetation but historic impacts (e.g. lack of overstory canopy and entrenchment) have not been addressed in most cases. Livestock removal has only occurred in a few locations.
Restrict all access (human and livestock)	City Municipal Watershed	Effective at recovering riparian vegetation (mainly willows) but historic impacts (e.g. lack of overstory canopy and entrenchment) have not been addressed. This practice has only occurred in the Municipal Watershed.
Reconnect river with historic channel	One private landowner with help from Tierra y Montes SWCD and Bill Zeedyk	Excellent results but limited to one landowner and a short stretch of river. Restoration also did not include replanting of tall woody vegetation so this area is still well below recommended stream shade. Follow up monitoring has been good.
Flood Damage Prevention Ordinance No. SMC 10-19-10	San Miguel County	Ordinance covers the likely extent of riparian vegetation and is conceptually adequate. However, most floodplain developments predate this ordinance and some gaps in recent enforcement have occurred. Floodplain residential developments do occur and have negatively affected streamside conditions. No specific mention of riparian vegetation protection and management occurs in the Ordinance.
Forest Practices BMPs	USFS, NM State Forestry	Evaluation of effectiveness is needed.
EQUIP, WHIP, CCPI, CRP, WREP, funding programs	NRCS	No river related projects have occurred in the Gallinas. A few small-scale upland erosion control projects have occurred and have been very effective.
USFS Grazing Permits with annual operating plans and monitoring	USFS	A 10-year permit renewal cycle with NEPA and annual operating plans. Effectiveness of specific permits is determined and evaluated in that cycle with public input. No review of the effectiveness has occurred in this planning process.
Fish habitat enhancement	One private landowner, USFS	Some structures installed on a short stretch of river on private land. The design and installation of these structures were not effective at improving fish habitat nor have they solved high W/D ratios and entrenchment, or riparian vegetation degradation issues at the site. Very old log dams were installed in various locations on public and private lands (USFS); these

EXISTING MANAGEMENT MEASURES	STAKEHOLDER	EFFECTIVENESS
		structures have generally increased stream width and should be removed.
2 riparian fencing projects, 1 fencing project for grazing rotation purposes, 2 willow planting projects, 1 instream structure, 2 upland erosion control projects, a few forest thinning projects	Tierra Y Montes SWCD	Projects have had mixed effectiveness, some good, some marginal. Follow up monitoring and support has been inconsistent. Projects have been limited in scope.
Managed Grazing	Private landowners	Effective where they occur. Limited in scope, only applied on one or two parcels.

Planned Management Measures

Planned and recommended MMs are broken down into three groups: Land Management, Restoration, and Conservation Programs, Planning and Regulatory. Land management activities are prioritized because typically, if management issues are not first addressed, restoration activities will have limited effectiveness. While planning and regulatory measures may help motivate appropriate Land Management and drive Restoration, they can involve lengthy processes and a more direct approach is preferred by our organization.

While recommended MMs focus on the management, restoration, protection and enhancement of riparian vegetation, they have secondary benefits related indirectly to reducing stream temperatures and improving overall river ecosystem health, in keeping with the more comprehensive approach to watershed improvements contained the Healthy Watersheds Initiative. Many MMs indirectly and perhaps subtly reduce stream temperatures by improving flow conditions. They also strive to reduce solar exposure through reductions in stream width, and by rerouting and storing water into adjacent soils where it can be cooled.

Table 5 lists priority MMs and summarizes rationale for these selections. Appendix B provides a complete list of MMs considered and details on the ranking system used to select priority measures.

Land Management Measures

Emphasis on improving approaches to land management occurs in this plan because sound management must first occur if restoration is to be effective. The two primary areas of land management that affect the condition of riparian vegetation and hence stream temperatures in the Gallinas and Porvenir are related to livestock and domestic use and recreation.

Livestock Management

Seven of the 10 miles of stream segments that require stream shade improvements are related to livestock use. Livestock grazing without consideration of riparian vegetation health has significantly affected its condition and ability to shade the stream. Assisting landowners in the development and implementation of Riparian Sensitive Grazing Plans was identified as a high priority for implementation. Providing financial and technical assistance to develop and implement Riparian Sensitive Grazing Plans customized to meet landowner needs and objectives is critical. These grazing plans will include the use of tools such as: fencing, herding, development of alternative water sources and alternatives to grazing or supported rest periods. Nine out of the 11 priority stream segments identified include development of Riparian Sensitive Grazing Plans (see Table 6).

Riparian Sensitive Grazing Plans to direct stocking rates, timing, duration and grazing intensity include use of the following tools:

- **Riparian fencing** – Total enclosure of riparian area with livestock proof fencing. Livestock use of riparian pastures can then be carefully controlled and monitored. Riparian fencing is likely required in combination with other tools to effectively manage livestock use.
- **Discourage livestock use** – Partial fencing or other structures to discourage livestock access to specific stream locations (e.g. highly erodible streambanks).
- **Livestock herding** – In lieu of pasture fencing, implement livestock herding to manage use.
- **On river water access** – Restrict livestock access to specific locations for watering with fencing.
- **Off river water development** – Well development or water pumping to pastures outside of riparian areas to discourage concentration near streams and encourage use of uplands.
- **Salting –** Provide salt and minerals in upland pastures to encourage use outside of riparian areas.
- **Establish/use grass banks** – Develop and then utilize local grass banks to offer periods of rest for riparian pastures.
- **Payments to defer grazing** – Provide payments to offset lost revenues in order to rest riparian pastures or locate alternative pastures.
- **Enhance non-riparian pastures** – Improve non-riparian pastures by developing irrigation systems or supplemental pasture seeding. While this will improve utilization of upland pastures, it must be done in combination with riparian fencing. Potential productivity of riparian pastures is commonly 10 times greater than even improved upland pastures. Without riparian fencing this effort alone will not improve riparian condition.
- **Convert grazed areas to recreational leases** – Restrict grazing in riparian areas by offsetting revenues with eco-tourism and other recreational uses like fishing or birding. May require fencing, improved access and enhancement of fish or wildlife habitat.

Domestic and Recreational Use Management

MMs to address Domestic and Recreational use related to degraded riparian vegetation affect 5.2 of the 10 miles that are in need of improvements. Impacts to riparian areas are either unintentional consequences of general riparian area use or are related to intentional landscaping (usually riparian vegetation removal) for aesthetics or access to the river for recreational purposes (Hermit's Peak Watershed Alliance, 2012e). Often impacts can be reduced with thoughtful and educated changes to landscaping considering the value of riparian vegetation and intact streambanks. Other causes of

degraded riparian vegetation occur because buildings and other infrastructures are located in riparian areas. Seven out of 11 identified priority stream segments involve domestic and recreational use management (see Table 6). MMs to address these concerns are:

- **Guided vegetation management and landscaping** for domestic and recreational access and aesthetics. Provide technical assistance, tools and incentives to manage riparian vegetation to meet landowner objectives and local site specific conditions to maximize shade. Tools might include planting fruit trees, ornamentals or other desirable woody vegetation, and developing well placed paths and river access points. Development of landscaped riparian vegetation should focus on tall shade plants and trees with a focus on south bank shade.
- **Manage recreation use** – Assist USFS with evaluating and improving recreational use areas as it affects riparian vegetation and streambanks. Improvements may be to trails, high intensity use areas, garbage management, and access points.
- **Relocate infrastructure out of riparian areas –** identify infrastructure in riparian areas that is causing impacts to riparian vegetation and could be easily relocated. Assist with relocation, financially and technically.

Restoration Measures

While land management efforts must be prioritized, some measures are necessary to restore riparian and stream functions that cannot be corrected with management alone or cannot be corrected in a reasonable time frame. In most cases, land management improvements should occur or be deemed adequate prior to beginning restoration projects. Restoration projects usually involve planting riparian vegetation and modifications to the stream channel that require installation of structures. Restoration projects can also help demonstrate the appearance and function of healthy streams and riparian areas so a visualization of the goals of land management measures can occur within the community. All 11 identified priority stream segments (9.9 miles) involve some level of restoration work. Priority Restoration Measures are:

Riparian Area

- **Plant riparian vegetation** – Emphasize planting tall woody vegetation including tall willows (e.g. peachleaf willow), cottonwoods, alder, or aspen in riparian areas that will support woody vegetation and have land management measures in place to maintain it. Planting upland species (e.g. pine, fir, oak) may be appropriate in some locations. Use local sources of plants whenever possible. Plant herbaceous vegetation if needed on eroding streambanks and severely damaged adjacent areas where erosion is preventing the establishment of healthy woody riparian vegetation.

Stream Channel Enhancements

Installation of structures to improve stream geomorphology, streambank and in channel conditions must be examined and planned for each specific site. Priority stream segments will undergo further detailed assessment in order to direct appropriate projects. The suite of needed improvements and tools are:

- **Reduce width to depth ratio** – Using instream structures (e.g. vanes and baffles), heal streambank erosion to prevent further widening and restore appropriate width/depth ratio (Zeedyk B. a., 2009)(Rosgen, 1996). Usually accompanied with planting riparian vegetation to

facilitate repair and provide shade. These structures are often used in concert with structures to increase stream sinuosity.

- **Reduce entrenchment to regain floodplain access** – Using appropriate instream structures, arrest future entrenchment, address areas where access to the floodplain can be reinstated and raise the level of the streambed through capture of sediments where suitable, with a variety of methods for restoring incised stream channels (Zeedyk, 2009) (Rosgen, 1996). This work can have the added benefit of increasing alluvial storage and raising the water table.
- **Increase sinuosity** – Increase stream length in straightened areas with induced meandering methods (Zeedyk, 2009) (Rosgen, 1996).
- **Reconnect channel with historic channel –** In appropriate areas (e.g. where channel has been artificially straightened and where existing development allows), relocate the stream to its historic channel in order to reduce entrenchment, expose floodwaters to an optimal floodplain, increase sinuosity, or move the channel away from hazards like roads or other immovable infrastructure (Rosgen, 1996).
- **Create/Enhance Wetlands –** While a wetland inventory was not the goal of this planning project, relatively few wetlands occur in the Gallinas Watershed and it is expected there were considerably more in the distant past. For that reason and because wetlands offer numerous ecological services, create or enhance non-riverine wetlands in appropriate areas as locations to store water and sediments, provide enhanced growing conditions for riparian vegetation and add below ground water storage areas that can cool water. New, improved or protected wetlands can be added to Wetlands Mitigation Banks to help fund restoration efforts.
- **Reduce beaver/human conflicts –** Beaver occurrence is currently limited to a few locations in the Gallinas in spite of the likelihood of their historical widespread occurrence. With improved riparian conditions and enhanced wetlands, it is anticipated that beaver may expand their range in the watershed. With that expansion it is expected that beaver/human conflicts will increase. Because beaver provide numerous ecosystem services that significantly contribute to river health, the resources to reduce those conflicts are needed. Installation of structures that protect infrastructures from flooding, keep beavers out of irrigation systems and culverts and protect valuable trees from felling will be offered to landowners so humans and beavers can coexist. Active education on the benefits of beaver to watershed health and techniques for living with beaver are also needed (Hermit's Peak Watershed Alliance, 2012e).
- **Remove old ineffective stream structures –** Although the removal of ineffective stream structures was not selected as a high priority management measure because it affects relatively little area, this measure can be easily accomplished and should be revisited in the future. Log dams were installed at various locations in the 1960's and 1970's on public and private lands for fish habitat improvements. These structures do not appear to have improved conditions for fish and have caused stream widening.

Road Improvements

Seven of the 11 stream segments are located very close to roads and require further examination to explore needed road drainage improvements and ensure adequate riparian buffers. Fifteen low water crossings were identified that require improvements.

- **Narrow and modify low water crossings** – Using appropriate structures (e.g. installing cross vanes, changing the bed material, or reconstruction of crossing), stabilize or modify road crossings to prevent future widening and reduce current width. Conduct a complete inventory and assessment of low water road crossings.

- **Road drainage improvements –** Improve road drainage to route stormwater runoff through effective, well vegetated buffers and filter zones before it reaches stream courses to cool the water. This may need to be done at numerous locations to distribute runoff. Stormwater runoff directly from warm road surfaces can elevate temperatures (Zeedyk B. , 2012). Reroute problematic road drainage areas that jeopardize streambanks and riparian vegetation during severe floods. A comprehensive road assessment is needed to determine improvement locations and to identify other road issues (e.g. inadequately sized culverts).
- **Riparian buffers –** In areas where roads are located close to and parallel to streams, ensure that adequate riparian vegetation occurs between the stream and road.

Uplands

- **Arrest upland erosion** – Install gully and sheet erosion structures and re-vegetate areas where upland erosion jeopardizes healthy riparian vegetation or contributes to stream sedimentation. A known location of needed upland erosion control work is directly upstream of Trout Springs, an important tributary to the Gallinas River. A comprehensive assessment of upland erosion problems did not occur in this planning effort and is needed.

Conservation Programs, Planning and Regulatory Measures

Numerous Conservation, Planning and Regulatory tools exist to facilitate implementing the land management and restoration measures described above. They should be pursued to increase the incentives, financial support, and long-term strength of recommended MMs. These tools are not associated with load reductions in Table 6 but are an integral part of accomplishing those MMs. They are:

Conservation Programs

- **Leverage other funding sources** – Funding sources beyond 319 can offer additional resources for land management and restoration projects, especially on private lands, and should be pursued where appropriate. Some relevant sources are the Natural Resource Conservation Service sponsored Wildlife Habitat Incentives Program, Environmental Quality Incentives Program (including the National Water Quality Initiative in priority watersheds), and Wetlands Reserve Enhancement Program, and the US Fish and Wildlife Service sponsored Partners for Fish & Wildlife Program. New Mexico Water Trust Board support for Restoration and Management of Watersheds and Flood Prevention Projects may also be suitable.
- **Conservation Easements and Land Trusts** – Pursue these tools with interested landowners to provide incentives for the protection and maintenance of natural areas.
- **Wetlands Mitigation Banking** – In areas where wetlands can be created, enhanced or protected, pursue enrolling those wetlands in a Wetlands Mitigation Bank as a means of offsetting the costs of restoration, protection, creation or lost revenues if those areas were developed or used for other purposes.

Planning and Collaboration

- **Establish Riparian Buffers and BMPs** – No local riparian buffers are recognized nor are there accepted BMPs to guide riparian activities. Develop recommended riparian buffer widths and

allowable and recommended management practices in riparian areas to serve as guidelines for planning documents, local regulations, or private and public land management plans.

- **Work with State and County road departments** to assess road drainage and adequate vegetated buffers between streams and roads.
- **Encourage low impact developments and green infrastructure** – In county or local planning documents, include goals to maintain low impact developments and green infrastructure in areas adjacent to streams.

Regulations and Guidelines

Work with various government entities to improve upon regulations and guidelines as they pertain to protection and enhancement of riparian vegetation and cool temperature conditions. Regulatory and management guidelines include:

- San Miguel County Flood Damage Prevention Ordinance – consider adding riparian buffers and BMPs.
- San Miguel County Road Ordinances and practices - include road specifications with adequately sized culverts, drainage, road crossings or bridges that do not affect riparian vegetation or streambanks, and include vegetated stream buffers and drainage that is directed through areas with vegetated filter zones. Ensure road maintenance operations occur in accordance with above guidelines.
- Instream flow regulations established by the Interstate Stream Commission, NM Office of State Engineer and the Gallinas Water Master to ensure adequate flows for temperature maintenance.
- County Subdivision Ordinances to include protection of floodplains and riparian vegetation and encourage low impact development and green infrastructure.
- USFS Grazing Permit 10 year review of permits and annual operating plans to ensure that requirements for riparian areas are adequate and in practice.
- New Mexico Forest Practices Guidelines (NM State Forestry, 2008) as they relate to riparian areas.
- New Mexico Environment Department - Reevaluate the state standards for the section of river from Trout Springs to the Las Vegas Diversion (normal temperatures may not meet high quality coldwater standards due to natural stream type).

Table 5- Priority Management Measures (aka Best Management Practices) that have the most likelihood of reducing temperature. See Appendix B for ranking scheme and all identified MMs.

MANAGEMENT MEASURES	RATIONALE
LAND MANAGEMENT EFFORTS	
Livestock Management:	
Riparian Sensitive Grazing Plans customized for each project	Unmanaged livestock use can severely degrade riparian vegetation, streambanks, stream channels and uplands. While livestock have free range, no other work is likely to be effective.
Domestic and Recreation Management:	
Guided vegetation management and landscaping for domestic and recreational areas	Misconceptions regarding importance of riparian vegetation abound which have resulted in removal of riparian vegetation. Customized, creative solutions to meet multiple landowner objectives are needed that may include shade produced by non-riparian species (e.g. fruit trees, ornamentals).
Manage Recreation Use	Public recreation areas need further evaluation to determine the extent of riparian and stream bank degradation. Improvements in management and any needed restoration work would then be planned.
Encourage relocating infrastructure out of riparian areas	Buildings, etc. can severely affect riparian vegetation, streambank stability, access to the floodplain, and soil compaction. Risk of flood damage is high. While relocation is often not feasible it should be evaluated as an option.
RESTORATION EFFORTS	
Riparian Area	
Plant riparian vegetation	After management issues are solved, planting woody vegetation is the cheapest, easiest, fastest and perhaps most effective recovery tool available.
Stream Channel	
Reduce width/depth and bank stabilization	Treatment reduces solar exposure, hence cooling, improves overall stream function and water storage in adjacent soils. Also reduces stream sedimentation and improves support of riparian vegetation.
Reduce entrenchment/increase floodplain access	Entrenched streams can have very dry streambanks not able to support riparian vegetation. Furthermore, entrenched channels cannot attenuate flood events and further erosion is likely. Lack of floodwater access to floodplains reduces long-term flow and limits riparian vegetation. Presence of floodplain access attenuates flow and increases bank and groundwater storage and water cooling.
Increase sinuosity	Treatment improves overall stream function and water storage (hence some cooling

MANAGEMENT MEASURES	RATIONALE
	and support of riparian vegetation) in adjacent soils. Reduces entrenchment and further erosion from flooding with increased stream length and greater access to floodplain.
Reconnect channel with historic channel	Treatment improves overall stream function and water storage (hence some cooling and support of riparian vegetation) in adjacent soils. Reduces entrenchment and further erosion from flooding with increased stream length and greater access to floodplain.
Create/Enhance wetlands	Occurrence of wetlands is limited in the Gallinas Watershed. Creating or enhancing wetlands improves overall stream function and water storage (hence some cooling and support of riparian vegetation) in adjacent soils, including sediment retention, improves long-term flow conditions through slow release of stored water and aquifer recharge. Wetlands Mitigation Banking offers an incentive.
Reduce beaver/human conflicts	Beaver can be one of the least expensive and most beneficial techniques for restoring overall stream system function, especially water storage & subsequent cooling and reducing entrenchment. While human conflicts with beaver are common, they can often be mitigated with structures like Beaver Deceivers or fencing.
Roads	
Narrow and modify existing low water crossings	Can reduce solar exposure hence reduce temp., also stabilizes streambanks, and reduces upstream migration of erosion/entrenchment. Also beneficial to landowners.
Road drainage improvements	Road drainage through underground vegetated filter areas is important to cool water heated from road surfaces. Can reduce flood damage to streambanks and riparian vegetation. Reduces road impacts and damage to personal property.
Riparian buffers	Vegetated riparian buffers are critical when roads are located next to and parallel to streams to offer an area to cool stormwater runoff from heated road surfaces, anchor streambanks and filter sediments and impurities.
Uplands	
Arrest upland erosion	Reduces stream sedimentation and flooding into stream channels that can damage streambanks and riparian vegetation. Improves upland vitality. Easy, inexpensive projects good for volunteers and landowners.
CONSERVATION/PLANNING/ REGULATORY TOOLS	

MANAGEMENT MEASURES	RATIONALE
Conservation	
Leverage other funding sources: e.g. WHIP, EQUIP, Partners for Fish & Wildlife	Technical assistance and funding available to private landowners can augment federal funding.
Conservation Easements/Land Trusts	Financial incentives to protect natural areas from future developments.
Wetland Mitigation Banking	Financial incentives to protect/create/enhance wetlands
Planning	
Establish Riparian buffer widths and BMPs	Provide guidance on management of riparian areas for public and private entities.
Encourage low impact developments/green infrastructure	These developments are less likely to influence riparian vegetation and overall stream condition.
Regulatory	
Work with SM County on Floodplain Development Ordinances – add Riparian BMPs	Developments in floodplains can degrade riparian and stream conditions and necessitate construction of flood control devices that influence riparian vegetation and stream condition.
Work with SM County to improve road related ordinances and practices	Improperly designed roads can destabilize streambanks, increase direct runoff to streams including heated water and increase sedimentation.
Review instream flow regulations	Low flows are perhaps greatest factor influencing warm stream temperatures.
Work with SM County on Subdivision Ordinances	Developments in floodplains and riparian areas encourage construction of flood control devices that influence riparian vegetation & stream condition.
Work with USFS to review grazing permits and operating plans regarding riparian areas	Unmanaged livestock grazing in riparian areas can cause significant damage to riparian vegetation and streambanks and channels.
Work with USFS and State Forestry to review BMPs related to riparian areas	Forest practices, particularly use of heavy equipment, in riparian areas can cause erosion, compaction, and understory vegetation degradation.
Work with New Mexico Environment Department to explore reevaluating the state standards for the section of river from Trout Springs to the Las Vegas Diversion	Normal temperatures of this section may never meet high quality coldwater standards due to natural stream type, geology and topography.

Management Measure Priorities and Associated Load Reductions

A comprehensive list of MMs that can enhance riparian vegetation, hence improve stream shading, is provided in Appendix B. There, they are ranked with Management Measure Efficiency estimates (Estimated Load Reduction percentages). Those rankings form the basis of anticipated Actual Load Reductions listed in Table 6. Each priority stream segment (previously listed in Table 3) was evaluated using field assessments, consultant input (Hermit's Peak Watershed Alliance, 2011) and with information gleaned from landowner interviews (Hermit's Peak Watershed Alliance, 2012e) to determine the most effective and most applicable Management Measures needed for each segment.

Table 6 will drive work that occurs during implementation of this plan and projects will be pursued in that order of priority. However, in order to begin engaging a number of landowners early on, projects may be spread out over numerous stream segments to some extent. Furthermore, the feasibility (cost/benefit analysis, landowner willingness, practicality) of doing each Management Measure on specific sites along priority stream segments was not evaluated in detail in this planning phase and would occur on a project by project basis during implementation.

Table 6 - MMs/BMPS to Achieve Load Reductions on Priority Stream Segments.

PRIORITY	RECOMMENDED STREAM SHADE INCREASE %	TOTAL LOAD REDUCTION $J/M^2/S$	MANAGEMENT MEASURES (MM)	MM EFFICIENCY	ACTUAL LOAD REDUCTION $J/M^2/S$	ACTUAL % STREAM SHADE INCREASE
1	27.52	69.89932	Riparian Sensitive Grazing Plan*	80	55.919456	22.02
			Guided vegetation management	65	45.434558	17.89
			Plant riparian vegetation	50	34.94966	13.76
			Stream Channel Restoration*	30	20.969796	8.26
			Narrow and modify existing low water crossings	15	10.484898	4.13
			Management Measures Total:	**240**	**167.758368**	**66.05**
2	21.78	55.33057	Riparian Sensitive Grazing Plan*	80	44.264456	17.43
			Relocate infrastructure	10	5.533057	2.18
			Plant riparian vegetation	50	27.665285	10.89
			Stream Channel Restoration*	30	16.599171	6.54
			Narrow and modify existing low water crossings	15	8.2995855	3.27

PRIORITY	RECOMMENDED STREAM SHADE INCREASE %	TOTAL LOAD REDUCTION $J/M^2/S$	MANAGEMENT MEASURES (MM)	MM EFFICIENCY	ACTUAL LOAD REDUCTION $J/M^2/S$	ACTUAL % STREAM SHADE INCREASE
			Reduce beaver/human conflicts	25	13.8326425	5.44
			Management Measures Total:	**210**	**116.194197**	**45.75**
			Riparian Sensitive Grazing Plan*	80	40.301336	15.87
			Guided vegetation management	65	32.7448355	12.89
			Relocate Infrastructure	10	5.037667	1.98
			Plant riparian vegetation	50	25.188335	9.92
			Stream Channel Restoration*	30	15.113001	5.95
			Narrow and modify existing low water crossings	15	7.5565005	2.98
			Road drainage improvements	25	12.5941675	4.96
3	19.83	50.37667	**Management Measures Total:**	**275**	**138.5358425**	**54.54**
			Plant riparian vegetation	50	22.746025	8.96
			Manage recreation use	40	18.19682	7.16
			Stream Channel Restoration*	30	13.647615	5.37
			Arrest upland erosion	10	4.549205	1.79
4	17.91	45.49205	**Management Measures Total:**	**130**	**59.139665**	**23.28**
5	12.61	32.03222	Riparian Sensitive Grazing Plans	80	25.625776	10.09

PRIORITY	RECOMMENDED STREAM SHADE INCREASE %	TOTAL LOAD REDUCTION $J/M^2/S$	MANAGEMENT MEASURES (MM)	MM EFFICIENCY	ACTUAL LOAD REDUCTION $J/M^2/S$	ACTUAL % STREAM SHADE INCREASE
			Guided vegetation management and landscaping for domestic and recreational access and aesthetics	65	20.820943	8.20
			Relocate infrastructure out of riparian areas	10	3.203222	1.26
			Plant riparian vegetation	50	16.01611	6.31
			Stream Channel Restoration*	30	9.609666	3.78
			Narrow and modify existing low water crossings – Road crossing rehabilitation	15	4.804833	1.89
			Road drainage improvements	25	8.008055	3.15
			Riparian buffers adjacent to roads	50	16.01611	6.31
			Arrest Upland Erosion	10	3.203222	1.26
			Management Measures Total:	**335**	**107.307937**	**42.25**
			Riparian Sensitive Grazing Plans*	80	22.48452	8.85
			Guided vegetation management and landscaping for domestic and recreational access and aesthetics	65	18.2686725	7.19
			Relocate infrastructure out of riparian areas	10	2.810565	1.11
6	11.06	28.10565	Manage recreational use with trails, signs, access points	40	11.24226	4.43

PRIORITY	RECOMMENDED STREAM SHADE INCREASE %	TOTAL LOAD REDUCTION $J/M^2/S$	MANAGEMENT MEASURES (MM)	MM EFFICIENCY	ACTUAL LOAD REDUCTION $J/M^2/S$	ACTUAL % STREAM SHADE INCREASE
			Plant riparian vegetation	50	14.052825	5.53
			Stream Channel Restoration*	30	8.431695	3.32
			Narrow and modify existing low water crossings – Road crossing rehabilitation	15	4.2158475	1.66
			Create Wetlands	35	9.8369775	3.87
			Reduce beaver/human conflicts	25	7.0264125	2.77
			Road drainage improvements	25	7.0264125	2.77
			Riparian buffers adjacent to roads	50	14.052825	5.53
			Management Measures Total:	**425**	**119.4490125**	**47.03**
			Riparian Sensitive Grazing Plans*	80	19.981336	7.87
			Guided vegetation management and landscaping for domestic and recreational access and aesthetics	65	16.2348355	6.39
			Relocate infrastructure out of riparian areas	10	2.497667	0.98
			Plant riparian vegetation	50	12.488335	4.92
			Stream Channel Restoration*	30	7.493001	2.95
			Narrow and modify existing low water crossings – Road crossing rehabilitation	15	3.7465005	1.48
7	9.83	24.97667	Road drainage	25	6.2441675	3.12

PRIORITY	RECOMMENDED STREAM SHADE INCREASE %	TOTAL LOAD REDUCTION $J/M^2/S$	MANAGEMENT MEASURES (MM)	MM EFFICIENCY	ACTUAL LOAD REDUCTION $J/M^2/S$	ACTUAL % STREAM SHADE INCREASE
			improvements			
			Riparian buffers adjacent to roads	50	12.488335	4.92
			Management Measures Total:	**275**	**68.6858425**	**27.04**
			Riparian Sensitive Grazing Plans *	80	14.13164	5.56
			Plant riparian vegetation	50	8.832275	3.48
			Stream Channel Restoration*	30	5.299365	2.09
			Road drainage improvements	25	4.4161375	1.74
			Riparian buffers adjacent to roads	50	8.832275	3.48
8	6.95	17.66455	**Management Measures Total:**	**235**	**41.5116925**	**16.34**
			Plant riparian vegetation	50	6.874565	2.71
			Stream Channel Restoration*	30	4.124739	1.62
			Narrow and modify existing low water crossings – Road crossing rehabilitation	15	2.0623695	0.81
			Create Wetlands	35	4.8121955	1.89
			Reduce beaver/human conflicts	25	3.4272825	1.35
9	5.41	13.74913	**Management Measures Total:**	**155**	**21.3111515**	**8.39**
10	2.59	6.593562	Riparian Sensitive Grazing Plans *	80	5.2748496	2.08

PRIORITY	RECOMMENDED STREAM SHADE INCREASE %	TOTAL LOAD REDUCTION $J/M^2/S$	MANAGEMENT MEASURES (MM)	MM EFFICIENCY	ACTUAL LOAD REDUCTION $J/M^2/S$	ACTUAL % STREAM SHADE INCREASE
			Guided vegetation management and landscaping for domestic and recreational access and aesthetics	65	4.2858153	1.69
			Plant riparian vegetation	50	3.296781	1.30
			Stream Channel Restoration*	30	1.9780686	0.78
			Narrow and modify existing low water crossings – Road crossing rehabilitation	15	0.9890343	0.39
			Create Wetlands	35	2.3077467	.91
			Reduce beaver/human conflicts	25	1.6483905	.65
			Road drainage improvements	25	**1.6483905**	**.65**
			Riparian buffers adjacent to roads	50	3.296781	1.30
			Management Measures Total:	**375**	**24.7258575**	**9.73**
			Riparian Sensitive Grazing Plans*	80	1.0655608	0.42
			Guided vegetation management and landscaping for domestic and recreational access and aesthetics	65	0.86576815	0.34
			Relocate infrastructure out of riparian areas	10	0.1331951	0.05
			Plant riparian vegetation	50	0.6659755	0.26
11	0.52	1.331951	Stream Channel Restoration*	30	0.3995853	0.16

PRIORITY	RECOMMENDED STREAM SHADE INCREASE %	TOTAL LOAD REDUCTION $J/M^2/S$	MANAGEMENT MEASURES (MM)	MM EFFICIENCY	ACTUAL LOAD REDUCTION $J/M^2/S$	ACTUAL % STREAM SHADE INCREASE
			Narrow and modify existing low water crossings – Road crossing rehabilitation	15	0.19979265	0.08
			Road drainage improvements	25	.33298775	.13
			Riparian buffers adjacent to roads	50	0.6659755	0.26
			Management Measures Total:	**325**	**4.32884075**	**1.70**

*- All livestock related tools (e.g. fencing, water development) are combined into a Riparian Sensitive Grazing Plan category. All Stream Channel related tools (e.g. reduce width/depth and reduce entrenchment) are also combined. Conservation Programs/Planning/Regulatory tools are not listed here because they are not on-the-ground treatments that result in direct load reductions.

TECHNICAL AND FINANCIAL ASSISTANCE NEEDED

Technical and financial assistance needed to support the priority projects identified in Table 6 and Education and Outreach projects identified in Table 10 are listed in the below table. Technical assistance required by consultants, agencies or other collaborators are listed in Table 9. Costs for those entities are included in the budget in Table 7. The total budget of $1,691,600 is based on the three phased Implementation Schedule (a total of eight years) described in a subsequent section. While 319 funds will be pursued to implement this work, we recognize that other sources of funding will be necessary. Those funds will be sought from various sources including private foundations, local, state and federal grants (e.g. Water Trust Board, NRCS) and further support by private landowners and community volunteers. A description of additional funding sources that should be pursued to compliment 319 funds is included in Table 8.

Regulatory clearances needed to implement these projects will normally consist of US Army Corps of Engineers 404 Permit, and NM Environment Department 401 Water Quality Certification. NM Historic Preservation Division Section 106 Consultation under the National Historic Preservation Act may be required for some ground disturbing projects. Where Threatened and Endangered Species (Endangered Species Act, ESA) are potential, USFWS clearances may also be required. If needed, both NHPA and ESA clearances will occur as part of the 404 Permit. Because 96% of priority stream segments occur on private land, NEPA clearance will not normally be required. While no known local ordinances should affect on-the-ground projects, any applicable local clearances will be investigated and occur. Work to obtain necessary permits will be done by HPWA together with the landowner and with assistance from hired contractors. The costs for contractor assistance is included in the below budget.

Table 7- Financial resources needed to support Management Measures and Education and Outreach activities

DESCRIPTION	NUMBER OF years[1]/ projects[2] /miles[3]	TOTAL COST	COST PER year[1]/ project[2]/ mile[3]
Project Management and Coordination			
Management	8[1]	240,000	30,000[1]
Coordination	8[1]	240,000	30,000[1]
Administration	8[1]	80,000	10,000[1]
OSM/VISTA	3[1]	21,000	7,000[1]
Supplies	8[1]	9,600	1,200[1]
Equipment	8[1]	8,000	1,000[1]
Travel	8[1]	8,000	1,000[1]
Subtotal		**$606,600**	**$80,200**[1]
Project Implementation			
Riparian Sensitive Grazing Plans (includes consultants, materials, equipment)	7[3]	210,000	30,000[3]
Guided vegetation management and landscaping	5[3]	25,000	5,000[3]
Plant riparian vegetation	8[3]	32,000	4,000[3]
Relocate Infrastructure	3[2]	15,000	5,000[2]
Stream Channel Restoration (includes contractors to design, obtain necessary permits, and implement the project):			
Reduce entrenchment/improve floodplain access	10[3]	100,000	10,000[3]
Increase sinuosity	2[3]	10,000	5,000[3]
Reduce width/depth, bank stabilization	10[2]	25,000	2,500[2]
Reconnect channel with historic channel	2[2]	30,000	15,000[2]
Reduce beaver/human conflicts	4[3]	8,000	2,000[3]
Create/Enhance wetlands (includes consultants, permits, and implementation)	4[2]	100,000	25,000[2]
Narrow and modify existing low water road crossings (includes contractors to design, obtain necessary permits, and implement the project):	15[2]	75,000	5,000[2]
Road drainage improvements	7[2]	35,000	5,000[2]
Arrest upland erosion	20[2]	10,000	500[2]
Leverage with other funding sources	5[2]	5,000	1,000*[2]
Conservation Easements/Land Trusts	3[2]	3,000	1,000*[2]
Wetland Mitigation Banking	3[2]	3,000	1,000*[2]
Subtotal		**$686,000**	
Conservation, Planning and Regulatory Coordination			
Establish Riparian Buffers and BMPs	1[2]	15,000	15,000[2]

DESCRIPTION	NUMBER OF years[1]/ projects[2] /miles[3]	TOTAL COST	COST PER year[1]/ project[2]/ mile[3]
Encourage low impact developments/green infrastructure	1[2]	1,000	1,000[2]
Floodplain development ordinances	1[2]	5,000	5,000[2]
Instream flow regulations	1[2]	1,000	1,000[2]
County Road ordinances and practices	1[2]	5,000	5,000[2]
County Subdivision Ordinances	1[2]	3,000	3,000[2]
USFS Grazing permit review and annual operations	1[2]	3,000	3,000[2]
Riparian BMPs in NM Forest Practices guidelines	1[2]	3,000	3,000[2]
Subtotal		**$36,000**	
Education and Outreach			
Education Staff	8[1]	240,000	30,000 [1]
Specialist Contractors	8[1]	8,000	1,000[1]
Educational materials	8[1]	16,000	2,000[1]
Watershed Resource Center	8[1]	48,000	6,000[1]
Staff Training	8[1]	8,000	1,000[1]
Promotion	8[1]	4,000	500[1]
Tools & equipment for Community Watershed Restoration and Monitoring Team	8[1]	5,000	625[1]
Subtotal		**$329,000**	**$41,125**
Monitoring			
Program Development and Oversight – Covers consultation with monitoring experts to develop and refine monitoring program. Actual monitoring work done by Project Coordinator, Education Coordinator, VISTA, & volunteers	8[1]	26,000	10,000 first year, 2,000 subsequent years
Supplies and Equipment	8[1]	8,000	1,000[1]
Subtotal		**$34,000**	
TOTAL		**$1,691,600**	

* - involves facilitated work with other agencies

Table 8- Potential complimentary funding sources to CWA 319 Funds

FUNDING SOURCE	DESCRIPTION OF POTENTIAL EFFORTS	ESTIMATED/REQUESTED AMOUNT
Water Trust Board	River restoration projects	400,000
San Miguel County	Road assessment, road drainage improvements	10,000
City of Las Vegas	Wetland creation and enhancement	5,000
Tierra y Montes SWCD	River restoration projects	10,000
Natural Resources Conservation Service, NWQI, EQUIP, Wetlands	River restoration projects	25,000
EPA Wetlands Grants CWA Section 106	Wetland creation and restoration	50,000
Private Foundations (e.g. McCune, NM Community Foundation, National Fish and Wildlife Foundation, Trout Unlimited)	Education Efforts, Operating support	50,000
Bureau of Reclamation (Expanding Watershed Groups)	Operating support, educational, Watershed Resource Center	50,000
HPWA Fundraising	Watershed Resource Center, operating support ($5,000/yr. for 8 years)	40,000
OSM/VISTA	Full-time staff for 3 years ($15,000/yr for)	45,000
NM Highlands University	Staff (ARMAS Interns - $10,560/yr), monitoring equipment and expertise ($2,000/yr) – for 8 years	100,480
USFWS North American Wetlands Conservation Act (NACA)	Wetland creation/protection/ enhancement	10,000
USFWS Partners for Fish and Wildlife	Wetland creation/enhancement, river restoration	25,000
TOTAL		**$820,480**

Table 9- Technical assistance needed from collaborating organizations

TASK	COLLABORATOR
General assistance and coordination Education and Outreach programs and the Community Watershed Restoration and Monitoring Team provided by OSM/VISTA	Western Hardrock Watershed Team
Specialist Instructors for landowner workshops	Quivira Coalition Tierra y Montes Soil and Water Conservation District Michael Bain Kirk Gadzia Steve Carson Craig Sponholtz Bill Zeedyk
Simple Restoration Project Training and Oversight	Tierra y Montes Soil and Water Conservation District Craig Sponholtz Steve Carson Bill Zeedyk
Complex Restoration Project contracting	Craig Sponholtz Steve Carson Bill Zeedyk Tierra y Montes Soil and Water Conservation
Livestock management consultants	Quivira Coalition, Michael Bain, Kirk Gadzia
Wetlands creation/enhancement consultant	NMED, design and implementation consultants
Structures and consultation to reduce beaver/human conflicts	David Blagg
NEPA Requirements, Wetlands Mitigation Banking	EPA, NMED
404 permits, Wetland Mitigation Banking	Army Corps of Engineers, NMED
Floodplain Ordinances	San Miguel County – Land Development Specialist & Floodplain Coordinator - Mike Garcia
Road related guidelines	San Miguel County Road Department
Subdivision and related development Ordinances	San Miguel County – Land Development Specialist - Mike Garcia
Monitoring assistance	NMHU, ARMAS internships, OSM/VISTA, CWRMT
Education Programs in schools	NMHU, UWC, WLV Schools, LV City Schools

EDUCATION AND OUTREACH

For planned Management Measures to be effective, the fundamental social reasons that have lead to impaired conditions must be addressed through education and outreach. The importance of maintaining high water quality that meets state standards must be clearly understood by all stakeholders. Furthermore, the relationship between water quality and land management must also be better understood. Finally the tools need to be in place to provide land managers with resources to make and maintain improvements to their land management.

A strong education and outreach effort is also a critical foundation upon which to put EPAs Healthy Watershed Initiative (HWI) into place in the future. HWI recognizes "that our waters and aquatic ecosystems are dynamic systems that are interconnected in the landscape". A key part of that interconnected system is the people that live in and affect our watersheds. For local residents to contribute to restoration and management improvements and support Conservation Programs, Planning and Regulatory Measures (described in a previous section) their understanding and commitment to the holistic care of the Gallinas Watershed is essential.

To the best of our ability, we believe the fundamental social issues related to past watershed degradation are:

> **Ecological Knowledge** – There is an incomplete understanding of the ecological functions of rivers, riparian areas and watersheds, and the consequences of a lack of function, particularly on meeting water quality standards. In fact, some serious misconceptions are commonly held that have resulted in degraded conditions. For example, there is a common belief that streams and their riparian areas need to be "cleaned up" to be healthy; by this, most people often mean removing the willows, other woody vegetation, and dead wood from stream channels and riparian areas. Riparian vegetation, especially dense willow stands, is "unsightly" and hinders access to a desirable "park-like" river environment. Another commonly held misunderstanding is that riparian vegetation "steals all the water" leaving little for human use. There is a general lack of understanding of the role riparian vegetation plays in preventing evaporation through a cooler microclimate and helping to store water in soils.
>
> **Values** – While a deep love of the land and desire to keep it healthy is apparent in our area, maintaining the health of the land is often seen as a "nice thing to do" after other needs are met, rather than an integral part of our own long-term livelihoods. Building an understanding of the diverse ecological services, particularly high water quality, provided by a healthy watershed is needed. Fostering community support for watershed management and restoration will help drive a reprioritization of the importance of land stewardship in our watershed.
>
> **Economics** – Our economically depressed area in the past and present has resulted in our use of the land in excess of its ability to regenerate. Financial resources to adequately care for the land with a long-term vision that balances human and ecological needs are lacking.

Without addressing these fundamental misconceptions, elevating the importance of watershed stewardship to our community and providing community and financial support, restoration efforts described in this plan may be in vain especially while landowners and managers deal with the pressures

to increase water yield, reduce risks of catastrophic wildfire, develop recreational pursuits and "eke" out a living in our sparse and fragile landscape.

While there is a need for basic educational materials, actively engaging the community in restoration and monitoring efforts is the most likely means of deepening an understanding of watershed health and empowering people to take action to improve and maintain it.

Strategy

An effective Education and Outreach strategy (summarized in Table 10) must focus on the people that have the most direct control over watershed condition, the private landowners and public land managers. However, for those people to be effective, they need incentives and tools, community support, encouragement by public officials and technical and financial assistance. So, education and outreach programs must also address those needs. Furthermore, so the next generation of landowners, public officials and community members support long-term stewardship, young people need to be included in educational efforts.

Our strategy is based on numerous conversations with private landowners, public land managers, agency representatives, educators and community members. We conducted over 40 interviews with these stakeholders, held three public meetings, and attended numerous meetings of other groups. Knowledge gained in those discussions lead to the development of this strategy. A planned educational strategy (listed in order of priority) is below.

Private Landowners in the Upper Gallinas

The highest priority for Education and Outreach efforts is directed at private and municipal landowners and managers of river segments that need stream shade enhancement. Most areas that require land management and restoration work related to reducing stream temperatures and other impaired conditions occur on private and municipal lands in the Gallinas Watershed. Stream condition on US Forest Service land is typically acceptable and resources to do restoration and management work are in place.

In order to deepen an understanding, engage community support, and help connect landowners with available financial and technical assistance, a number of educational strategies need to be pursued. Landowners in the Gallinas are an extremely diverse group; delivery methods must therefore be equally diverse. Because every situation is somewhat different and a personal touch conveys deeper support, a direct, one-on-one means of delivering information and assistance to private and public landowners and managers is expected to be the most effective. That approach needs to be accompanied with printed materials in the form of brochures, fact sheets, and pamphlets (most people in the Gallinas are not connected to the web), addressing topics like:

- What is a Healthy Watershed?
- The Value and Management of Riparian Areas and Wetlands.
- Managing your Land for Watershed Health and Water Quality.

While similar informational documents likely exist, they need to be adapted to our local area and community.

Specific workshops and educational presentations, offered in the local area and pertinent to local issues, will provide another means of delivering information to landowners that is in their backyard and is done along with neighbors. Workshops and presentations would include:

- Livestock management for watershed health, including sending selected landowners to applicable intensive trainings (e.g. Holistic Management in Practice)
- Fence building, water development and other specific skills needed for livestock management
- Landscaping for watershed health
- Stream restoration techniques
- Upland erosion control techniques

Workshops will outline specific Management Measures needed to improve water quality standards and river and watershed condition. Adequately detailed information and tools will be offered to help landowners understand their importance and enable the implementation and long-term maintenance of suggested Management Measures in this plan.

As an alternative to personally delivering education programs, we plan to establish a Watershed Resource Center to provide a centralized location for landowners to find both technical and financial assistance. It would also provide a central location for public agencies to disseminate information about their programs. The Center would maintain a Directory of Financial and Technical Assistance available to help with watershed stewardship endeavors. Beyond providing information, this Center would offer a gathering place to foster community involvement and engagement.

Other means of delivering information to this group (e.g. presentations, trainings) are included in the below efforts.

Community Support and Engagement

In order to further engage our local community in caring for their watershed and to demonstrate community support to upper watershed landowners and managers, we recommend building a volunteer Community Watershed Restoration and Monitoring Team. This team should have a particular emphasis on recruiting area youth. We believe that the most effective approach to educating and engaging our community is to facilitate people working together to solve problems, in this case restoring the health of our watershed. This Watershed Based Planning effort made considerable progress in identifying numerous stream and watershed wide restoration efforts that could be done to improve stream temperatures and overall watershed health. Dependence on government funding (while it provides important seed money) alone will not build a community based effort that has a greater chance of occurring in the long run. The development of a Community Watershed Restoration and Monitoring Team is an effort that could encompass many educational objectives and simultaneously accomplish work on the ground. Such a restoration corps would not only engage the community, but also further watershed restoration dollars so we can accomplish more work.

Decision Makers

Educational programs for local policy makers, planners and regulators in the City, County, State and Federal branches of our government are needed as a third order of priority. Printed materials developed for landowners and managers can be provided to this audience. Also, presentations

appropriate to each group may be more effective. Web-based information, derived from printed materials would also be important for this group of busy people. Decision makers also need to be aware of community based efforts (e.g. the Community Watershed Restoration and Monitoring Team) that are in place and could be available to help them address restoration needs.

Schools

Offering programs for students through local area schools should occur to ensure that future generations are exposed to watershed stewardship concepts. Providing opportunities for students to be involved in hands-on, experiential programs that engage students in "real-life" monitoring and restoration activities, through the Community Watershed Restoration and Monitoring Team is important. Also, developing educational trunks, curriculum, and popular media to provide easy-to-use educational packages for schools is an effective approach to involve local schools.

Supporting higher education in watershed management and providing job training should also occur by continuing work with NM Highlands University through their ARMAS internship program. Working with the Western Hardrock Watershed Team to acquire OSM/VISTA staff is another mutually beneficial avenue for encouraging a competent future watershed management workforce.

General Community

All of the above tools (brochures, fact sheets, web information, presentations, Community Watershed Restoration and Monitoring Team) should be made available to the general public. Additional means of delivery to our local community should include our participation and hosting of public events (e.g. Synergy Fest, People's Faire, and HPWA's Gallinas Watershed Olympics).

Table 10- Summary of planned Education and Outreach efforts. Delivery of educational materials and programs to private landowners will occur as the highest priority.

EDUCATION AND OUTREACH TOOLS	AUDIENCE
Pamphlet/factsheet: What is a Healthy Watershed?	Private landowners Decision Makers Young People General Community
Pamphlet/factsheet: The Value and Management of Riparian Areas and Wetlands.	Private landowners General Community
Pamphlet/factsheet: Managing your Land for Watershed Health and Water Quality.	Private landowners
Workshop: Livestock management held in Gallinas canyon	Private landowners
Workshop: Fence building, water development and other livestock management skills	Private landowners General Community
Workshop: Send selected ranchers to Holistic Management in Practice (Kirk Gadzia)	Private landowners
Workshop: Landscaping for watershed health	Private landowners General Community
Workshop: Stream restoration techniques	Private landowners General Community
Workshop: Upland erosion control	Private landowners General Community
Directory of Financial and Technical Assistance	Private landowners Government Agencies
Watershed Resource Center	Private landowners Decision Makers Young People General Community
Community Watershed Restoration and Monitoring Team	Private landowners Young People General Community
Watershed Health, Riparian Habitat and Wetlands presentations	Decision Makers General Community
Watershed Trunk and curricula for schools	Young People
Popular and social media to distribute educational materials produced above. Use social media to recruit young people for the Community Watershed Restoration and Monitoring Team.	Decision Makers Young People General Community

IMPLEMENTATION SCHEDULE

Implementation of priority projects, education and outreach efforts and conservation, planning and regulatory measures is planned to occur in three phases over a period of eight years, hopefully to begin in 2013. This plan is dependent on uninterrupted and adequate funding levels. It is important for progress to continually occur in order to maintain community and landowner support. Momentum and cooperation gathered would likely suffer if work has significant gaps.

The three phases of implementation are described below and are also detailed in Table 11.

Phase 1 – Demonstration Projects and Education and Outreach – (2013 – 2014). The first phase focuses on beginning land management and restoration projects and an aggressive Education and Outreach effort. Project implementation will begin along high priority stream segments but will also strive to work on a few highly visible, easily achievable and likely effective projects that engage multiple landowners to serve as demonstrations in order to garner support from other landowners for future work. These projects will consist of: Riparian Sensitive Grazing Plans on two miles of river, Guided Vegetation Management on two miles of river, one effort to investigate relocating infrastructure, riparian plantings on two miles of river, stream channel enhancements on two miles of river, two road crossing modifications, five upland erosion control projects and one pursuit of a Conservation/Planning/ Regulatory tool. Simple demonstration projects (e.g. riparian planting, upland erosion control, fence building) will provide an opportunity to engage our new Community Watershed Restoration and Monitoring Team. We will use and refine the below described monitoring approach to track project effectiveness. Projects for Phase 2 will also be selected. Education and Outreach work will include: developing and delivering educational materials and presentations focused on private landowners, building a volunteer Community Watershed Restoration and Monitoring Team, and establishing a Watershed Resource Center with educational materials. Continued contact and coordination with all stakeholders will also occur.

Phase 2 - Project Implementation – (2015-2017). The second phase focuses on implementation with less emphasis on education and outreach, although it will continue with a focus on private landowners. Simple projects (e.g. riparian planting, erosion control structures, fencing) will be done by our Community Watershed Restoration and Monitoring Team. More complex projects (e.g. Riparian Sensitive Grazing Plans, Stream Channel Enhancements, road crossing modifications) will be accomplished with staff and contractors. Project monitoring methods will be refined and initiated on all projects. See Table 11 for the number of projects.

Phase 3 – Project Wrap-up – (2018-2020). Phase 3 will be a wrap up with an emphasis again on engaging the public so our community can support continued efforts beyond 319 funding. The remaining priority projects will be implemented and accompanied by long-term monitoring for new and past projects. Financial support for long-term education and outreach and private landowner assistance will be sought from other than 319 sources. See Table 11 for number of projects.

Table 11- Implementation Schedule

MANAGEMENT MEASURE	TOT. NUMBER OF STREAM miles[1]/ projects[2]	PHASE 1 (number stream miles[1]/ projects[2])	PHASE 2 (number stream miles[1]/ projects[2])	PHASE 3 (number stream miles[1]/ projects[2])
Land Management and Restoration Projects				
Riparian Sensitive Grazing Plans	7[1]	2[1]	5[1]	
Guided vegetation management	5[1]	2[1]	3[1]	
Plant riparian vegetation	10[1]	2[1]	6[1]	2[1]
Relocate Infrastructure	5[1]	1[1]	3[1]	1[1]
Stream Channel Enhancements	10[1]	2[1]	6[1]	2[1]
Narrow and modify existing low water crossings	10[2]	2[2]	6[2]	2[2]
Road drainage improvements*	7[2]		5[2]	2[2]
Arrest upland erosion*	20[2]	5[2]	10[2]	5[2]
Create/Enhance wetlands	4[2]		2[2]	2[2]
Reduce beaver/human conflicts	4[1]	1[1]	2[1]	1[1]
Riparian buffers adjacent to roads	6[2]	2[2]	3[2]	1[2]
Manage Recreation Use	2[2]		1[2]	1[2]
Conservation/Planning/Pursuits	8[2]	1[2]	5[2]	2[2]
Education and Outreach				
Watershed Health pamphlet/factsheet		X		
Riparian habitat & wetlands pamphlet/factsheet		X		
Managing your land for watershed health pamphlet/factsheet		X		
Short course on ranch management held in Gallinas canyon		X	X	
Fence Building and other skills workshops		X	X	
Landscaping for watershed health		X	X	
Stream restoration techniques workshop		X	X	
Send ranchers to Kirk Gadzia's workshop on Holistic Management in Practice		X	X	
Watershed Resource Center		X	X	X
Directory of Financial and Technical Assistance		X		
Community Watershed Restoration and Monitoring Team		X	X	X
Presentations of above topics			X	X
Watershed Trunk and curricula for schools			X	X
Popular and social media		X	X	X

* - Further assessment is needed to clarify the exact number of these projects.
X – Activity will occur in this phase of implementation

MEASURABLE MILESTONES OF IMPLEMENTATION

Following are quantitative and qualitative measurable milestones that will be used to gauge progress on implementing planned activities. Measures include the effectiveness of MMs in meeting stream shade goals as well as the ability of this effort to carry out the planned projects. Qualitative assessments will help to explain the reasons for meeting or not meeting targeted goals. While this planning effort has been very helpful in identifying local needs, attitudes, and interests, and developing strategies that are most likely to work, the planned activities have not been thoroughly tested to determine their effectiveness and feasibility. For that reason the following measurable milestones will be used to make adjustments in implementation efforts, focusing on efforts that work well to accomplish desired goals and eliminating those that do not. This continual adaptive management is expected to occur for on-the-ground projects, education and outreach programs, and in pursuing conservation, planning and regulatory measures.

Quantitative Measurable Milestones

- **Assessment of Standards Attainment** – Project specific and watershed wide monitoring will be regularly done (see Monitoring section) to determine progress toward meeting load reduction targets. Those data will be analyzed at the end of each project phase (2014, 2017, 2020) in order to assess progress toward Standards Attainment.
- **Length of Stream or the Number of Projects Completed** – The length of stream or the number of on-the-ground projects completed in each project category (e.g. grazing management plans, stream channel enhancements) will be compared with target numbers. Actual stream shade (measured with percent canopy) increases will also be compared to targets. This evaluation will occur at the end of each project phase (2014, 2017, 2020). See Table 12.
- **Number of Conservation Programs/Planning/ Regulatory Efforts –** The number of facilitated pursuits of Conservation Programs and progress on planning and regulatory input will be tracked and evaluated relative to targets at the end of each project phase (2014, 2017, 2020). See Table 12.
- **Number of Education Efforts** – At the end of each phase (2014, 2017, 2020), the number of education efforts undertaken and/or accomplished to include: landowner consultations, educational materials, workshops, training, presentations. Use of the Watershed Resource Center will be tracked once it is in place as well as the number of participants in our Community Watershed Restoration and Monitoring Team. See Table 12 for targets.

Modifications to targets and necessary adaptive management will be based on qualitative assessments of effectiveness and will occur as needed.

Table 12- Measureable Milestones

MANAGEMENT MEASURE	PHASE 1 (number stream miles[1]/ projects[2])		PHASE 2 (number stream miles[1]/ projects[2])		PHASE 3 (number stream miles[1]/ projects[2])		TOT. NUMBER OF STREAM miles[1]/ projects[2]	
Land Management and Restoration Projects	Project Targets	Percent Canopy Increase*	Project Targets	Percent Canopy Increase*	Project Targets	Percent Canopy Increase*	Project Targets	Total Canopy Increase**
Riparian Sensitive Grazing Plans	2[1]	15	5[1]	30		55	7[1]	10
Guided vegetation management	2[1]	15	3[1]	30		55	5[1]	8
Plant riparian vegetation	2[1]	20	6[1]	25	2[1]	55	10[1]	6
Relocate Infrastructure	1[1]	0	3[1]	30	1[1]	70	5[1]	1.5
Stream Channel Enhancements	2[1]	10	6[1]	30	2[1]	60	10[1]	4
Narrow and modify existing low water crossings	2[2]	25	6[2]	25	2[2]	50	10[2]	1.5
Road drainage improvements		0	5[2]	25	2[2]	75	7[2]	2.5
Arrest upland erosion	5[2]	10	10[2]	40	5[2]	50	20[2]	1.5
Create/Enhance wetlands		0	2[2]	45	2[2]	45	4[2]	2
Reduce beaver/human conflicts	1[2]	20	2[1]	30	1[1]	50	4[1]	2.5
Riparian buffers adjacent to roads	2[2]	20	3[2]	25	1[2]	55	6[2]	3.5
Manage Recreation Use		0	1[2]	40	1[2]	60	2[2]	6
Conservation/Planning/Pursuits	1[1]	0	5[2]	0	2[2]	0	8[2]	0
Education and Outreach								
Watershed Health pamphlet/factsheet	X							
Riparian habitat & wetlands pamphlet/factsheet	X							
Managing your land for watershed health pamphlet/factsheet	X							
Short course on ranch management held in Gallinas canyon	X		X					
Fence Building and other skills workshops	X		X					

MANAGEMENT MEASURE	PHASE 1 (number stream miles[1]/ projects[2])	PHASE 2 (number stream miles[1]/ projects[2])	PHASE 3 (number stream miles[1]/ projects[2])	TOT. NUMBER OF STREAM miles[1]/ projects[2]	
Landscaping for watershed health	X	X			
Stream restoration techniques workshop	X	X			
Send ranchers to Kirk Gadzia's workshop on Holistic Management in Practice	X	X			
Watershed Resource Center	X	X	X		
Directory of Financial and Technical Assistance	X				
Community Watershed Restoration and Monitoring Team	X	X	X		
Presentations of above topics		X	X		
Watershed Trunk and curricula for schools		X	X		
Popular and social media	X	X	X		

*- Percent Canopy Increase- the percent of the Total Canopy Increase** of stream shade that will be increased during each Phase.

**- Total Canopy Increase at the end of the implementation period. While some restoration projects will show results during the implementation phases, many stream shade efforts, especially regarding overstory canopy, may not show their full stream shade potential until after the implementation period has been completed. Total Canopy increase is based on the average of canopy increase for individual Management Measures (See Table 6).

X – Task will be completed in this phase of implementation

Qualitative Measureable Milestones

- **General Effectiveness** – To accompany the quantitative tracking, a narrative evaluation of project successes will occur. This evaluation will occur at the completion of each Phase and will be incorporated into final reports to granting agencies. It should include: effective techniques for obtaining landowner agreements to do projects, description of effective management and restoration efforts in terms of correcting degraded conditions, practicality of implementing the various planned activities, and evaluations from landowners or other participants in our programs. General Effectiveness milestones include:
    - Landowners are willing to embark on improved management and restoration projects on their lands.
    - Projects selected are appropriate for the landowner and location and are technically and financially feasible.
    - Projects can be maintained by landowners in the future.
- **General Conflicts/Issues** – A narrative evaluation of conflicts and issues that have arisen that prevent progress on specific efforts, including descriptions of adaptive management measures undertaken or planned should be included.

In the event that the WBP is fully implemented and the TMDL shade targets and temperature standards still exceed water quality standards, HPWA may need to reevaluate the TMDL and surface groundwater interaction. If measureable milestones are not being attained HPWA will reevaluate flow, width to depth and finally may need to reevaluate use attainability standards.

CRITERIA FOR EVALUATING LOAD REDUCTION ACHIEVEMENTS

NMED/EPA standards for desirable temperature conditions will be used as a basis for evaluating load reductions. Stream temperatures in the Gallinas River should not exceed 68 F (or 20 C). Additionally, canopy cover should reach at least 61.5 percent shade. If this plan has been implemented and the Gallinas River (Las Vegas diversion to headwaters) is found to meet its water quality standards for temperature, then the plan will have accomplished its goals. Assessment of standards attainment is expected to take place in 2014 (before significant implementation), in 2017 (during significant implementation), and finally, in 2020 (after implementation is complete). The assessment of standards attainment are some of the measureable milestones listed in the above section.

If in 2021 this plan has been implemented in full and the Gallinas River does not meet its water quality standards for temperature and effectiveness monitoring data show less improvement in water quality than expected given the level of effort of implementation, or if there is no significant improvement in water quality, then this plan will be modified using expert guidance and new management measures yet to be determined. Conversely, if the Gallinas River is found to meet temperature standards in 2021 or prior to 2021, this plan will be modified to focus on protecting water quality. However, unless this plan is revised under one of the circumstances above, this plan will be considered valid for the reach of the upper Gallinas River (AU NM-2212_00). This statement applies as long as a recognized temperature impairment and temperature TMDL are in effect.

MONITORING PROGRAM

A monitoring program will be instated to evaluate the effectiveness of the implementation efforts based on the criteria outlined in the above section (see Table 13). Continuous stream temperature monitoring will occur every year during summer months throughout the eight years covered in this plan. Sampling locations will include the 12 baseline sites and additional sites as necessary. At the end of each Phase, a repeat of field measured stream shade and width/depth on 50 random sites will occur watershed wide. Air photo interpretation of stream shade will occur once per Phase if new air photos become available. Effectiveness monitoring of each project site will include field stream shade, width/depth, and Rosgen Level II Geomorphology at each project site before treatment. After treatment, field stream shade, width/depth and geomorphology monitoring will occur at each project site in the final year of each Phase.

At the end of each Phase (in 2014, 2017, and 2020), an assessment of the monitoring data will occur in order to determine whether progress is being made in reducing load. The monitoring will be completed under a new approved Quality Assurance Project Plan (QAPP) which will be written and submitted to EPA at the beginning of Phase I of implementation. Reporting of monitoring progress and methodology will be conducted through standard NMED quarterly reports.

The above targeted monitoring will be completed in order to assess standards attainment, however, other monitoring efforts will also take place to look at the general watershed condition and identify any other areas (besides stream temperature) that may be of concern. Monitoring will be used as an educational tool, when possible, through the development and work of the Community Watershed Restoration and Monitoring Team.

Table 13- Effectiveness Monitoring Schedule

PHASE OF IMPLEMENTATION	YEAR	MONITORING EFFORT	SAMPLING SITES
Phase 1	2013	Write, submit and get approval for monitoring QAPP	
		Stream temperature (continuous May-Sept)	12 (baseline sites). May add new sites if necessary.
		Pre-treatment Field Stream Shade‡ (summer)	Sites at location of stream shade implementation projects
		Pre-treatment Width/Depth‡ (summer)	Sites at location of width/depth implementation projects
		Pre-treatment Rosgen Level II Geomorphology (summer)	Sites at location of river restoration implementation projects
	2014	Stream Temperature (continuous May-Sept)	12 (baseline sites). May add new sites if necessary.
		Field Stream shade‡ (summer), both Pre & Post Treatment	Sites at location of stream shade implementation projects
		Width to Depth† (summer), both Pre & Post Treatment	Sites at location of width to depth implementation projects

PHASE OF IMPLEMENTATION	YEAR	MONITORING EFFORT	SAMPLING SITES
		Rosgen Level II Geomorphology (summer), Pre & Post Treatment	Sites at location of river restoration implementation projects
		Air Photo Interpretation Stream Shade*	75 ft sampling density along entire length of river.
		Field Stream Shade & Width/Depth	Random sampling of 50 transects throughout watershed
		Phase 1 Assessment of Standards Attainment	Review of all monitoring data
Phase 2	2015	Stream temperature (continuous May-Sept)	12 (baseline sites). May add new sites if necessary.
		Field Stream Shade‡ (summer) Pre-treatment	Sites at location of stream shade implementation projects
		Width to Depth† (summer) Pre-treatment	Sites at location of width to depth implementation projects
		Rosgen Level II Geomorphology (summer) Pre-treatment	Sites at location of river restoration implementation projects
	2016	Stream temperature (continuous May-Sept)	12 (baseline sites). May add new sites if necessary.
		Field Stream Shade‡ (summer) Pre-treatment	Sites at location of stream shade implementation projects
		Width to Depth† (summer) Pre-treatment	Sites at location of width to depth implementation projects
		Rosgen Level II Geomorphology (summer), Pre-treatment	Sites at location of river restoration implementation projects
	2017	Stream Temperature (continuous May-Sept)	12 (baseline sites). May add new sites if necessary.
		Field Stream Shade‡ (summer), both Pre & Post Treatment	Sites at location of stream shade implementation projects
		Width to Depth† (summer), both Pre & Post Treatment	Sites at location of width to depth implementation projects
		Rosgen Level II Geomorphology (summer), both Pre & Post Treatment	Sites at location of river restoration implementation projects
		Air Photo Interpretation Stream shade*	75 ft sampling density along entire length of river.
		Field Stream Shade & Width/Depth	Random sampling of 50 transects throughout watershed
		Phase 2 Assessment of Standards Attainment	Review of all monitoring data
Phase 3	2018	Stream temperature (continuous May-Sept)	12 (baseline sites). May add new sites if necessary.
		Field Stream Shade‡ (summer) Pre-	Sites at location of stream shade

PHASE OF IMPLEMENTATION	YEAR	MONITORING EFFORT	SAMPLING SITES
		treatment	implementation projects
		Width to Depth† (summer) Pre-treatment	Sites at location of width to depth implementation projects
		Rosgen Level II Geomorphology (summer), Pre-treatment	Sites at location of river restoration implementation projects
	2019	Stream temperature (continuous May-Sept)	12 (baseline sites). May add new sites if necessary.
		Field Stream Shade‡ (summer) Pre-treatment	Sites at location of stream shade implementation projects
		Width to Depth† (summer) Pre-treatment	Sites at location of width to depth implementation projects
		Rosgen Level II Geomorphology (summer) Pre-treatment	Sites at location of river restoration implementation projects
	2020	Stream Temperature (continuous May-Sept)	12 (baseline sites). May add new sites if necessary.
		Field Stream Shade‡ (summer), both Pre & Post Treatment	Sites at location of stream shade implementation projects
		Width to Depth† (summer), both Pre & Post Treatment	Sites at location of width to depth implementation projects
		Rosgen Level II Geomorphology (summer), both Pre & Post Treatment	Sites at location of river restoration implementation projects
		Air Photo Interpretation Stream shade*	75 ft sampling density along entire length of river.
		Phase 3 Assessment of Standards Attainment	Review of all monitoring data

*or when data becomes available

‡ will be collected at least once a year, prior to or after a project has been implemented

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Appendix A: Load Reduction Methods

The TMDL for temperature impairment is calculated as: **WLA (0) + LA (99.30) + MOS (11.03) = 110.33 j/m^2/sec/day** (SWQB, 2005).

The following formula is used to calculate actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition- Load Allocation = 153.95 joules/m^2/s – 99.30 joules/m^2/s = 54.65 joules/m^2/s (SWQB, 2005)

Based on the recommended stream shade, the stream shade in 2003, and the above formula it was possible to calculate:

Recommended Stream shade (61.5%) - Actual Stream shade (40%) = Recommended Increase in Stream shade (21.5%)

Reduction in Solar Radiation Necessary to meet surface WQS (54.65 j/m^2/s)/Recommended Increase in Stream shade (21.5%) = 2.54 j/m^2/s.

In other words, every 1% increase in stream shade is equal to a reduction of 2.54 joules/m^2/s.

Based on this calculation it is possible to determine the load reduction achieved if all reaches and individual sites that under recommended stream shade standard are increased to 61.5%.

Recommended Stream shade (61.5%) - Existing Stream shade = Recommended Increase in Stream shade (%)

Recommended Increase in Stream shade x 2.4 j/m^2/s = Load Reduction (j/m^2/s).

After calculating load reductions in j/m^2/s for each low stream shade site, SSTEMP was then used to confirm the load reductions calculated.

Appendix B: Ranking of Management Measures.

This table identifies Management Measures/BMPs that will reduce temperature loading because they improve riparian vegetation shading. It also provides estimated temperature load reductions for each management measure based on each activity done in isolation. By combining management measures, the estimated load reduction would increase.

MANAGEMENT MEASURES (MM)	MM EFFICIENCY (ESTIMATED LOAD REDUCTION (%))
LAND MANAGEMENT EFFORTS	
Livestock Management:	
Riparian Sensitive Grazing Plans with following customized tools:	80*
Riparian Fencing (total livestock exclusion)	80
Discourage Livestock use – half fences, other structures	10
Livestock herding	50
On River Water Management (fencing)	60
Off River Water Development	25
Salting	10
Enhance non-riparian pastures (seeding, irrigation systems) - must be used in combination with riparian fencing.	30
Payments to defer grazing (rest)	30
Establish/Use Grass Banks	30
Convert grazed areas to recreational fishing, or eco-tourism use areas	60
Domestic and Recreation Management:	
Guided vegetation management and landscaping for domestic and recreational access and aesthetics	65
Relocate infrastructure out of riparian areas	10
Manage recreational use with trails, signs, access points	40
RESTORATION EFFORTS	

MANAGEMENT MEASURES (MM)	MM EFFICIENCY (ESTIMATED LOAD REDUCTION (%))
Riparian Area	
Plant riparian vegetation – focus on tall woody plants	50
Stream Channel	30*
Reduce entrenchment/floodplain access	40
Reduce beaver/human conflicts	25
Increase sinuosity	25
Bank stabilization	20
Reduce width/depth (e.g. vanes & baffles)	25
Reconnect channel with historic channel	25
Create/Enhance wetlands	35
Removal of levees and old stream structures (e.g. one log dam fish structures)	10
Roads	
Narrow and modify existing low water crossings – Road crossing rehabilitation	15
Road drainage improvements	25
Riparian buffers adjacent to roads	50
Road obliteration/relocation	50
Uplands	
Arrest upland erosion	10

* - This percentage is the combination of all livestock management or stream channel enhancement activities identified and accomplished in an area through a Riparian Sensitive Grazing Plan or Stream Channel enhancement activities.