Group A. Project Management

A.1 Title and Approval Sheet

Quality Assurance Project Plan

Rincon Arroyo Watershed Stabilization Project to Reduce E. coli loading to the Rio Grande

Submitted by:

Alexander (Sam) Fernald, Project Manager, and Connie Maxwell, Project Coordinator and Project Leader

New Mexico Environment Department

Surface Water Quality Bureau

APPROVAL SIGNATURES

Davena Crosley Digitally signed by Davena Crosley Date: 2023.12.08 13:26:47 -07'00'

Davena Crosley
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A2. Table of Contents

Acronyms

DQO	Data Quality Objectives
EPA	United States Environmental Protection Agency
NMED	New Mexico Environment Department
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedures
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
WPS	Surface Water Quality Bureau Watershed Protection Section
WDAS	U.S EPA Water Division Assistance Branch State and Tribal Programs Section

A3. Distribution List

Table 1. below contains the distribution list, project roles and responsibilities for this project. The QA Officer will ensure that copies of this QAPP and any subsequent revisions are distributed to members who have signature authority to approve this QAPP. The SWQB Project Officer will ensure that copies of the approved QAPP and any subsequent revisions are distributed to all other project personnel listed in Table 1. All NMWRRI staff identified of the distribution list will review the QAPP and sign the Acknowledgment Statement prior to initiating any work for this project. The signed Acknowledgement Statements will be collected by the SWQB Project Officer and will be given to the QA Officer for filing with the original approved QAPP.

Table 1 Distribution list, Project Roles, and Responsibilities

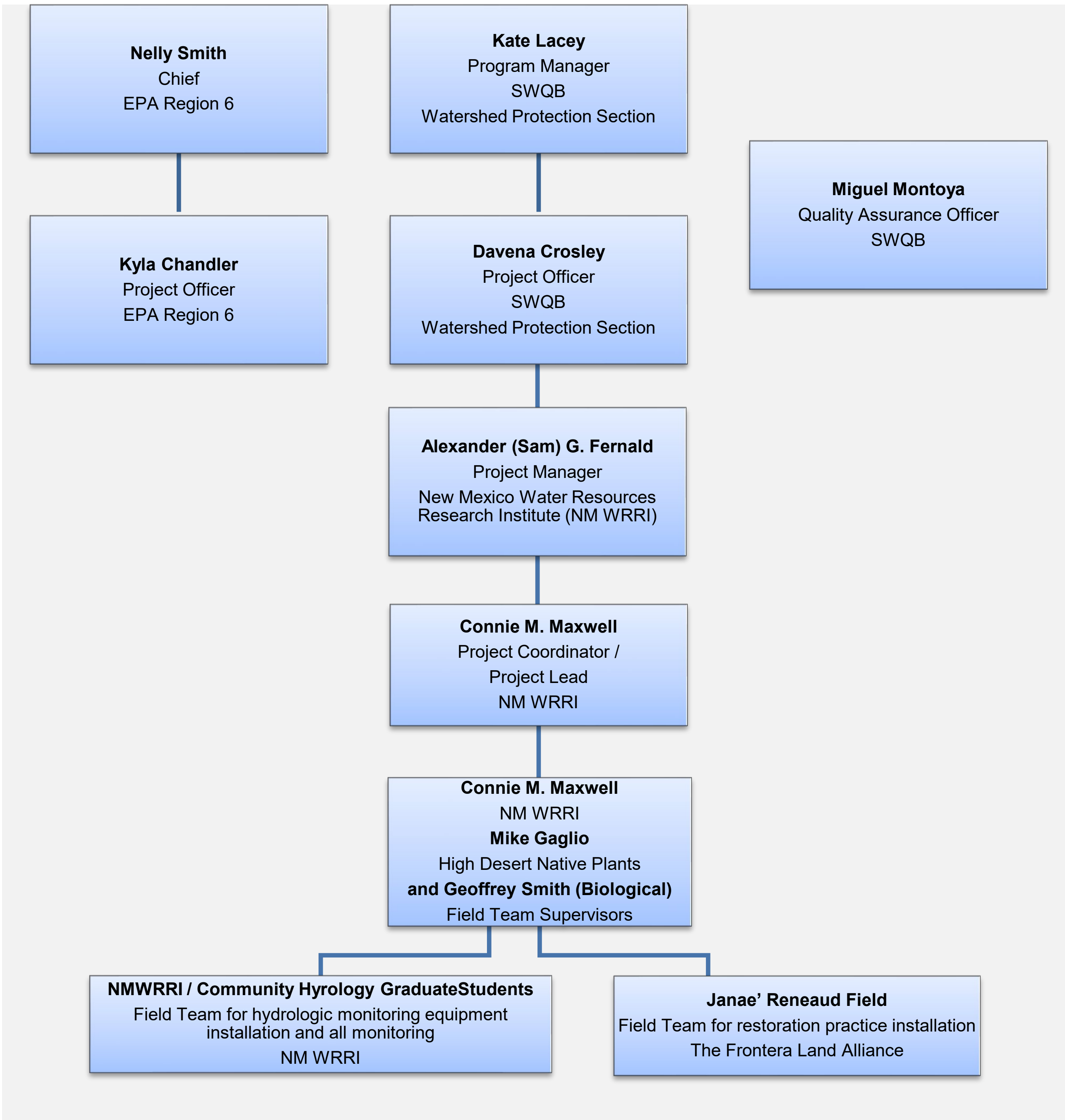
Name	Organization	Title/Role	Responsibility	Contact Information
Kate Lacey	SWQB	Program Manager	Reviewing and approving QAPP, managing project personnel and resources	505-946-8863 kathryn.lacey@env.nm.gov
Miguel Montoya	SWQB	QA Officer	Reviewing and approving QAPP	505-819-9882 miguel.montoya@env.nm.gov
Davena Crosley	SWQB	Project Officer	Preparing and revising QAPP, distribution of QAPP, project reporting, coordinating with contractors, oversight of data collection, and EPA reporting	575-636-3425 davena.crosley@env.nm.gov
Alexander (Sam) G. Fernald	New Mexico Water Resources Research Institute (NMWRRI)	Project Manager	Project oversight, data management, and submittal of quarterly reports	575-646-4337 afernald@nmsu.edu
Connie M. Maxwell	NMWRRI	Project Coordinator and Project Leader	Project design and implementation, construction oversight	575-740-1099 alamosa@nmsu.edu
Connie M. Maxwell	NMWRRI	Field Team Supervisor #1	Field training and supervision, monitoring, data collection, record keeping, and submitting reports	575-740-1099 alamosa@nmsu.edu
NMWRRI / Community Hydrology Graduate Students	NMWRRI	Field Team for hydrologic monitoring equipment installation and all monitoring	Field monitoring, data collection	
Mike Gaglio	High Desert Native Plants	Field Team for restoration practice installation	Restoration installation coordination, field training, and supervision	915-490-8601 mike@highdesertnativeplants.com
Janae' Reneaud Field	The Frontera Land Alliance	Field team human resources coordinator	Restoration team coordination	517-927-5250 janae@fronteralandalliance.org

Kyla Chandler	EPA	Environmental Protection Specialist WQPD, Region 6	Reviewing and approving QAPP	214-665-2166 chandler.kyla@epa.gov
Nelly Smith	EPA	Chief, State and Tribal Programs Section WQPD, Region 6	Reviewing and approving QAPP	214-665-7109 smith.nelly@epa.gov

A.4 Project Organization

The SWQB Quality Management Plan (NMED/SWQB 2021) documents the independence of the Quality Assurance Officer (QAO) from this project. The QAO is responsible for maintaining the official approved QAPP. Figure 1 presents the organizational structure for the “Rincon Arroyo Watershed Stabilization Project to Reduce *E. coli* loading to the Rio Grande,” referred to in this document as the “Project.”

Figure 1. Organization Chart



A.5 Problem Definition /Background

The purpose of this Quality Assurance Project Plan (QAPP) is to reduce *E. coli* loading to the Rio Grande through watershed restoration and reduction of *E. coli* transport. This QAPP refers to this project, "Rincon Arroyo Watershed Stabilization Project to Reduce *E. coli* loading to the Rio Grande," as the "Project". The Project is being managed by the New Mexico Water Resources Research Institute (NMWRRI).

Background

The 2018 - 2020 State of New Mexico Clean Water Act §303(d)/§305(b) Integrated Report and the included Integrated List for assessment unit NM-2101_10 shows the Rio Grande (Leasburg Dam to one mile below Percha Dam) is non supporting for Primary Contact for *E. coli* (NMED/SWQB, 2018, p242), by exceeding the standard requirement of the monthly geometric mean of *E. coli* bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less. A TMDL was calculated for the main stem of the Rio Grande in New Mexico below Elephant Butte Dam. The resulting document, Total Maximum Daily Load (TMDL) for the Main Stem of the Lower Rio Grande (from The International Boundary with Mexico to Elephant Butte Dam) was completed in 2007 (PdNWC WBP 2014, page 2). The following sections 1 through 5 detail the impairment scope and the conditions for impairment

--1) Impairment: The largest source of *E. coli* pollutant to the impaired stretches of the Rio Grande in the Hatch and Mesilla Valley is from watershed range sources, as 41% is from livestock and wildlife sources (other than waterfowl) as measured from four representative sites in the region (PdNWC WBP 2014, p. 19). Most relevant to this project, the Rincon Arroyo watershed, 32% is from watershed range sources at the Leasburg Dam observation site on the Rio Grande, which is approximately 14 miles downstream from the Rincon Arroyo outlet to the Rio Grande. The Rincon Arroyo watershed has been identified by the land manager stakeholders as the highest priority watershed for this impaired reach, and the sediment transport is estimated to be the highest for the Hatch and Mesilla Valley, at a rate of 36.2 acre-feet per year (AFY) (TTI and DSS, 2015

--2) "Watershed natural structure" – "vegetation cover" conditions contributing to impairment: The condition of the watershed natural structure, particularly vegetation cover (as measured by % natural cover), influences nonpoint source pollution (NPS) as good vegetation cover conditions result in "decreased sheet flow, increased infiltration, decreased runoff and associated contaminants, reduced erosion and development of a healthier biotic community in the watershed" (PdNWC WBP 2014, p. 35), and thus an increase in vegetation cover is a goal to address the impairment. This area has a high percentage of bare ground (quantitative analysis using NDVI to be provided in this study), including roads that do not have the infrastructure to manage the flow, increase flow energy, and result in significant transport and erosion, as communicated by stakeholders in the region, including the three main ranchers of the watershed and BLM managers. They have shared that vegetation cover has decreased in the region generally due to their perceived growing aridity, occurrences of drought, and potentially land management grazing practices out of coordination with the climatic conditions. (Also note the discussion in the management measures section that the historical vegetation cover on floodplains as measured by NDVI will be correlated to flows and restoration results and adjusted by a control region).

--3) "Flow and channel dynamics" conditions contributing to impairment – high energy "flashy" flood dynamics, which also result in sediment transport and low "soil stability": High hydrologic energy transports contaminants and sediment that harbors *E. coli* contaminants (Fluke et al. 2019). Hydrologic energy increases as vegetation density declines, as surface roughness exerts strong control over infiltration in dryland (arid and semi-arid regions) (Wilcox et al. 2003). The WBP states that "pollutant loading in the watershed upstream from Leasburg Dam is primarily related to storm related runoff that can best be described as flash flooding" (PdNWC WBP 2014, p. 37). Thus, mitigation of hydrologic energy is a goal to address the impairment. Stakeholders in the Stormwater Coalition, including the Doña Ana Flood Commission, have shared that flooding and the intensity of flood events have been increasing, and that watershed restoration is a critical priority to address the source of the problem.

--4) "Ecological history" and disturbance conditions contributing to impairment – drought and reduction of upland water soil moisture: the increased occurrence of drought in the region contributes to vegetation loss and increases in hydrologic energy and sediment and NPS transport.

--5) "Social context" conditions contributing to impairment – "level of information, certainty and planning to achieve large watershed management potential": Quantification of the benefits of watershed restoration practices that slow and spread the flow for this region are critical to be able to achieve the targeted goals of reducing sediment and bacterial contaminant transport on the scale of the Rincon Arroyo watershed and then across the Hatch and Mesilla Valleys. Predictive modeling approaches that quantitatively link structure to processes that achieve ecological and social benefits are needed to increase the rate of restoration success in drylands (James et al. 2013). This project will serve as a Phase I to one or more larger projects, and will provide information critically needed by the stakeholders as to the efficacy and benefits of the practices.

Further introduction background to problem description

Throughout the Hatch and Mesilla Valleys, as is common across the Southwest, vegetation loss in upland watersheds is leading to floods that scour soils and transport sediment and the non-point source pollution (NPS) of E. coli bacterial. Higher flow energies and decreased infiltration are diminishing water storage across the landscape, negatively impacting the ecosystems and vegetation cover which is critical for catching and absorbing this NPS. The largest source of E. coli pollution to the impaired stretches of the Rio Grande in the Hatch and Mesilla Valley is from watershed range sources, as 41% is from livestock and wildlife sources (other than waterfowl) as measured from four representative sites in the region (PdNWC WBP 2014, p. 19). A large group of stakeholders, the South Central New Mexico Stormwater Management Coalition (Stormwater Coalition – see description of stakeholders in Management Measures section J), has identified that watershed restoration is a critical priority throughout the Hatch and Mesilla Valleys, as the sediment transport leads to clogging of downstream riparian areas and agricultural infrastructure, and increasing the occurrence of flooding (See Addendum I overall perspective and approach, p. 2). The Stormwater Coalition has chosen the Rincon Arroyo Watershed (HUC 1303010203, 134 sq. miles, 85,770 acres) as its high and first priority project. The restoration of this watershed will establish the approach, expected benefits, and extent of watershed restoration to achieve these benefits throughout the rest of the region. The group has been working with the USDA Natural Resource Conservation Service (NRCS) to submit a proposal to their Small Watershed Projects Program for a Watershed Protection and Flood Prevention project, with funding without a match requirement of up to $25m (before congressional approval is required) for the planning and implementation of restoration through small-scale flood protection measures. This project would serve as a Phase I to the larger project, and would provide information critically needed by the stakeholders as to the efficacy and benefits of the practices. The restoration approach proposed here is to slow and spread “flashy” flood flow, to both settle out bacterial and sediment transport (which then serves as a source of E. coli to the overlying water Fluke et al. 2019) and support increased vegetation cover to further increase infiltration and decrease hydrologic energy. This phase I project will test and validate the design and provide quantifiable indicators, allowing for prediction of the extent of restoration needed for the remainder of the Rincon Arroyo watershed and subsequently other watersheds in the region.

References:

Fluke, J., R. González, Pinzón, and B. Thomson. 2019. Riverbed sediments control the spatiotemporal variability of *E. coli* in a highly managed, arid river. Front. Water 1.

James, J. J., R. L. Sheley, T. Erickson, K. S. Rollins, M. H. Taylor, and K. W. Dixon. 2013. A systems approach to restoring degraded drylands. Journal of Applied Ecology 50:730-739.

New Mexico Environment Department/Surface Water Quality Bureau (NMED/SWQB). 2018a. 2018 2020 State of New Mexico Clean Water Act Section 303(d)/ Section 305(b) Integrated Report. 64 pp.

New Mexico Environment Department/Surface Water Quality Bureau (NMED/SWQB). 2018b. 2018 2020 State of New Mexico Clean Water Act Section 303(d)/ Section 305(b) Integrated Report. Appendix A 303(d)/305(b) List. 369 pp.

Tetra Tech Inc. (TTI), and Del Sur Surveying LLC (DSS). 2015. Surveyor’s Report IBWC Channel Maintenance Alternatives and Sediment Transport Studies for the Rio Grande Canalization Project; Contract No. IBM09D0006. USIBWC.

Wilcox, B. P., D. D. Breshears, and C. D. Allen. 2003. Ecohydrology of a Resource Conserving Semiarid Woodland: Effects of Scale and Disturbance. Ecological Monographs 73:223-239

Goals and Objectives

Here we provide more information about the impairment goal, and then (briefly) more information about four additional interrelated hydrologic and social goals.

1) Impairment Goal: We estimate that the restoration approach conservatively will reduce the loading from this Phase I project by a minimum factor of 2. Based upon the 2007 NMED TMDL document (as summarized in the PdNWC WBP 2014) of the average load for a mid-point flow from this impaired reach of 4.0 x 10^13 CFU/day, our estimation of the load contribution from this Phase I project subbasin is 6.5 x 10^9 CFU/day. Our target is thus a load reduction of a minimum of 3.2 x 10^9 CFU/day (day of flow events). Our approach has been documented to be particularly effective. Use of vegetation and incorporation of vegetative strips have been used to reduce *E. coli* numbers from farm and landscape water flow. For example, in annual grasslands, Tate et al. (2006), reported *E. coli* load reductions up to 48% (the reductions ranged from log 0.3 to log 3), depending on the width of the strips used. Parajuli et al. installed vegetative strips at the landscape level to reduce loading in a northern Kansas watershed. Installation of vegetative strips reduced approximately 60% of the *E. coli* load and 63% of sediments (Parajuli et al. 2008). Staddon et al. (2001) documented 100-fold higher retention of Gram-negative bacteria in vegetated strips compared to bare soil (*E. coli* is Gram-negative). Based on these estimates (and others such as Harmet et al. 2018), we conservatively predict that we can reduce the landscape-derived portion of the loading by a factor of 2. As to the mechanisms of *E. coli* retention in vegetative strips, the sorption of bacteria to plant material and soils and specific attachment to plant roots is well-documented in the literature (e.g., Marshall, 1969; Dennis et al. 2010). The retention and sorption capacity of soils and plant roots for bacteria are high, and the expectation is the cells are strongly retained. For example Bashan and Levanony (1988) found the adsorption of a Gram-negative bacterium

to soils was not reversible by water washing. This phase I project will establish indicators for *E. coli* load reduction that will be linked to key ecohydrologic indicators that are inputs to other landscape assessments, such as hydrologic modeling. This will produce *E. coli* indicators that will be generalizable to the region.

2) Vegetation cover conditions goal: Increase the vegetation cover indicators by a statistically and functionally significant extent (e.g. 10% from the additional water supply to floodplain intervention regions) by the end of 2024.

3) Flow and channel dynamics goal: Create a statistically and functionally significant reduction in flow in the restoration subbasins as compared to the control subbasins, e.g. reducing a 25-year 24-hour event to a 10-year 24 event, by the end of 2024 (demonstrated in the hydrograph as reductions to peak or flows in the rising or falling limbs and flow volumes and in reductions to *E. coli* and sediment transport).

4) Ecological history (decreasing soil moisture) conditions goal: Create a statistically and functionally significant increase the area of infiltration at interventions (e.g. connectivity of flood flow to floodplains) from estimated connectivity of base conditions (e.g. from 27% of the floodplain in a 10-year event to 90%).

5) Social context conditions goal – level of information, certainty and planning to achieve large watershed management potential: Produce a comprehensive quantitative indicator package (which synthesizes the results from goals 1-4) that estimate the extent of watershed restoration which can be generalizable for future planning of this region, particularly the Rincon Arroyo Watershed and other watersheds in the Hatch and Mesilla Valley.

References:

Bashan, Y. and H. Levanony. 1988. Adsorption of rhizosphere bacterium Azospirillum brasilense to soil, sand and peat particles. J. Gen. Microbiol. 134: 1811-1820.

Dennis, P.G., A.J. Miller and P.R. Hirsch. 2010. Are root exudates more important than other sources of rhizodeposits in structuring rhizosphere bacterial communities? FEMS Microbiology Ecology. 72:313-327

Harmet et al. 2018. Vegetated treatment area (VTAs) efficiencies for E. coli and nutrient removal on small-scale swine operations. Internat. Soil Water Conserv. Res. 6:153-164

Marshall, K.C. 1969. Studies by Microelectrophoretic and Microscopic Techniques of the Sorption of Illite and Montmorillonite to Rhizobia . J. Gen. Microbiol. 56:301-306.

P.B. Parajuli P., K.R. Mankin, P.Barnes, 2008. Applicability of targeting vegetative filter strips to abate fecal bacteria and sediment yield using SWAT Ag. Water Mange. 95:1189-1200.

Staddon, A.W., M.A. Locke and R. J. Zablotowicz. 2001. Microbiological characteristics of a vegetative buffer strip soil and degradation and sorption of Metalochlor. Soil Sci. Soc. Amer. 65:1136-1142.

USACE, H. E. C. HEC-HMS. http://www.hec.usace.army.mil/software/hec-hms/

USDA-NRCS. 2004. Part 630 Hydrology: Chapter 10 Estimation of Direct Runoff from Storm Rainfall. National Engineering Handbook. Washington, DC, USA: Natural Resources Conversation Services, US Department of Agriculture.

A.6 Project/Task Description

Description

The Project will implement watershed restoration to slow and spread "flashy" flood flow, to both settle out bacterial and sediment transport (which then serves as a source of E. coli to the overlying water Fluke et al. 2019), and support increased vegetation cover to further increase infiltration and decrease hydrologic energy. The study/project consists of vegetation, hydrologic, and bacterial monitoring to assess the efficacy of the restoration. This will be elaborated in more detail in Data Generation and Acquisition section B1.

Table 2 Description and Schedule

Task #	Task Title	Key Person	Planned Start and End Dates	Planned End Date	Completion Benchmark
1	Project management and reporting	Sam Fernald	7/1/2020 (Agreement began 9/2/2020)	4/30/2025	Final report submitted
Description from agreement: Time duration description: Assuming the project begins 7/1/2020 (acceptable to team if project is awarded later), this activity duration is over the course of the project. Task description: Oversight of the approved project including: administering contracts; ensuring technical viability of the project; ensuring funds expended are within the budget and in accordance with applicable law; and ensuring that quarterly fiscal and technical progress reports, and a final report, are submitted to NMED					
2	Steering Committee	Connie Maxwell	7/1/2020 (Agreement began 9/2/2020)	4/30/2025	Steering committee and stakeholders accept synthesis plan
Description from agreement: This task is over the duration of the project. Task description: meet quarterly, conduct field trips to assess the restoration implementation, results, and potential benefits and synthesize generalizable indicators that allow for estimation of extent of restoration required to achieve goals in the region. The stakeholder group will be assessing this in the context of a near-future planned project to restore the remaining Rincon Arroyo with NRCS funding.					
3	Bid survey work & restoration work	Sam Fernald	7/1/2020 (Agreement began 9/2/2020)	11/1/2022	Surveys contracted completed and restoration contract awarded
Description from agreement: The task duration is anticipated to be approximately 4 months. Surveys will bid and contracted first to provide the quantity counts and locations for the restoration work. This information will be supplied to the bidders for the restoration work.					

Task #	Task Title	Key Person	Planned Start and End Dates	Planned End Date	Completion Benchmark
4	BLM required clearances	Jessica Knopic	Currently underway	12/1/2022	BLM required clearances issued
Description from agreement: The task duration is anticipated to be complete to enable installation prior to the monsoon season. BLM will complete the Programmatic Environmental Assessment for the larger Rincon Watershed Stabilization Strategy, and this will facilitate site specific NEPA and Bureau policy requirements in this project area					
5	ACOE permits	Connie Maxwell	7/1/2020 (Agreement began 9/2/2020)	4/6/2023	ACOE issues either permit or determination of no permit required
Description from agreement: The task duration is anticipated to be approximately 4 months. The team will meet with the ACOE to present the project and secure any required Nationwide (404) permits					
6	QAPP for environmental monitoring and modeling	Connie Maxwell	8/1/2020 (Agreement began 9/2/2020)	4/22/2021	QAPP complete and monitoring and modeling plans updated
Description from agreement: The task duration is anticipated to be approximately 2 months.					
7	Vegetation cover data collection and analysis	Connie Maxwell with students	September of each year	Each year December 31st	Current vegetation cover conditions (NDVI and field cover) measures prior and after monsoon season
Description from agreement: The task duration is anticipated to be approximately 4 months each year with the vegetation monitoring itself conducted at the height of productivity, approximately each September.					
8.1	Installation of Management Measure: Stone Lines	Connie Maxwell working with contractors	4/15/2022	4/30/2025	Installation complete

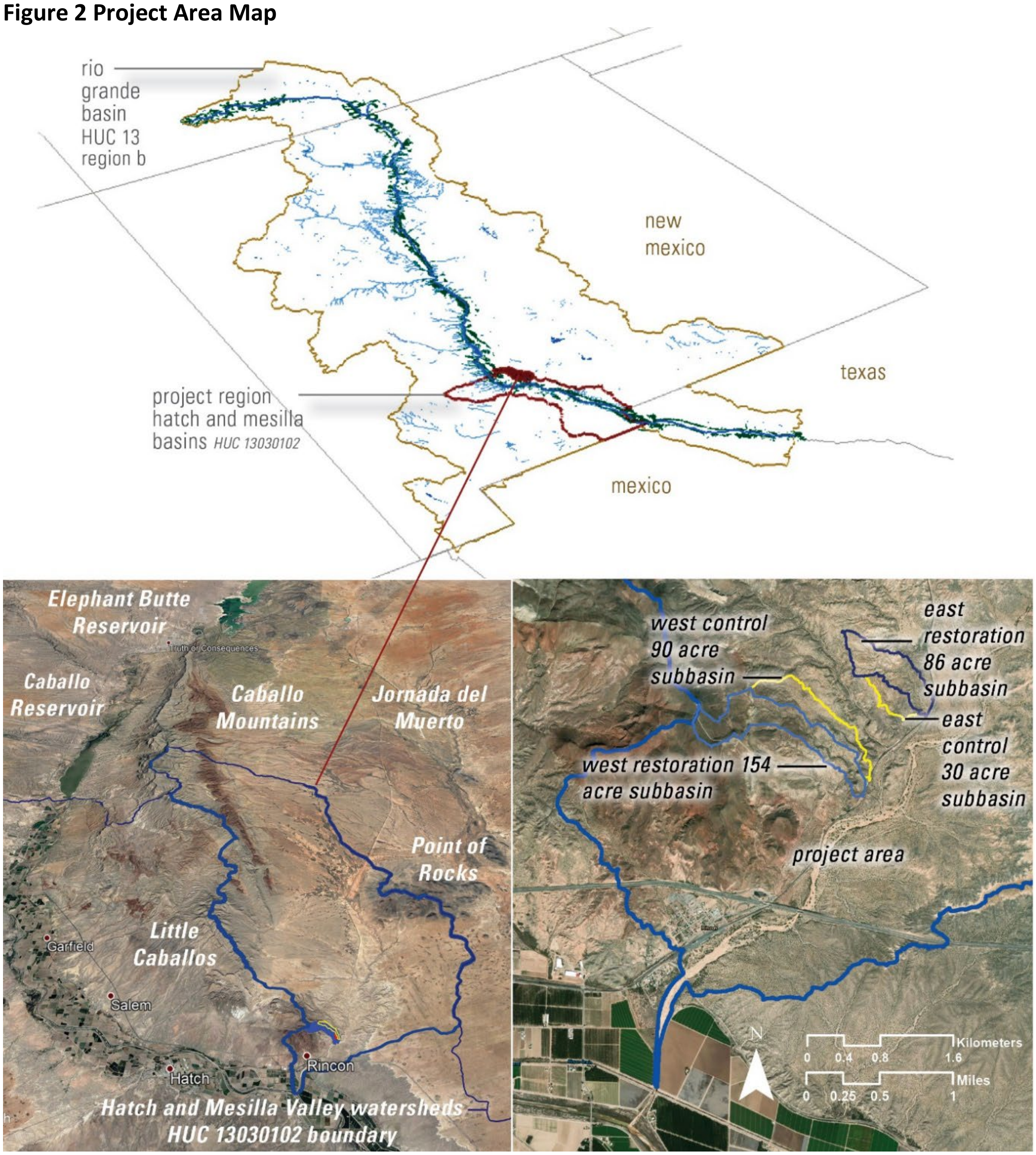
Task #	Task Title	Key Person	Planned Start and End Dates	Planned End Date	Completion Benchmark
8.2	Installation of Management Measure: Contour wire and brush lines	Connie Maxwell working with contractors	4/15/2022	4/30/2025	Initial installation complete; adjustment as needed in subsequent years
8.3	Installation of Management Measure: Microcatchments	Connie Maxwell working with contractors	4/15/2022	4/30/2025	Initial installation complete; adjustment as needed in subsequent years
8.4	Installation of Management Measure: Native grass seeding	Connie Maxwell working with contractors	4/15/2022	4/30/2025	Initial installation complete; adjustment as needed in subsequent years
8.5	Installation of Management Measure: One-rock dams	Connie Maxwell working with contractors	4/15/2022	4/30/2025	Initial installation complete; adjustment as needed in subsequent years
8.6	Installation of Management Measure: Protection of treated areas from grazing	Connie Maxwell working with contractors	4/15/2022	4/30/2025	Initial installation complete; adjustment as needed in subsequent years
8.7	Installation and completion of Management Measure: Education and Outreach, (including workshop that achieves road restoration)	Connie Maxwell working with contractors	4/15/2022	4/30/2025	Initial workshop installation complete with other measures; education conducted throughout project ending with Task 13
Description from agreement: The initial installation will be complete prior to the 2023 monsoon season. After the monsoon season is complete, the contractor will return for an adaptive management adjustment period.					

Task #	Task Title	Key Person	Planned Start and End Dates	Planned End Date	Completion Benchmark
9	Construction oversight (supervision of installation to set quality standards)	Mike Gaglio	4/15/2022	4/30/2025	Installation complete, tested, and installation standards documented, and contractor work approved
Description from agreement: 1st week of installation and review after monsoonal season runs.					
10	Installation of monitoring equipment (project and control arroyo)	Connie Maxwell with students	4/15/2021	12/31/2021	Installation complete, tested, and data standards documented
Description from agreement: NMWRRI with subject experts and students will install the equipment prior to the restoration completion date					
11	*E. coli* data collection and analysis (monsoon season of highest interest)	Geoffrey Smith with students	Each year 7/1	Each year 12/1	Data documented and correlated to indicators and analysis complete
Description from agreement: Dr. Geoffrey Smith and students to check equipment and process samples in conformance with QAPP.					
12	Hydrologic data collection and hydrologic and erosion analysis	J. Phillip King with Connie Maxwell	Each year 7/1 (Agreement began 9/2/2020)	Each year 12/1	Data documented and correlated to indicators and analysis complete
NMWRRI with subject experts and students					
13	Key findings recorded for future Rincon Arroyo restoration plan	Connie Maxwell	10/31/2021	4/30/2025	Results correlated between indicators and benefits
Description from agreement: Co-production between team and stakeholders of synthesis report generalizable for the region					

Project Area

The project is located in southern New Mexico, in a watershed that has its outlet near the town of Rincon, NM. The restoration addresses a 154-acre subbasin with practices on 10.2 acres and a 126-acre subbasin with practices on 9.5 acres of an 86-acre subbasin and a 30-acre control subbasin. Effect of the watershed site is to approximately 14 miles of the Rio Grande reach (Leasburg Dam to one mile below Percha Dam, NM-2101_10), including the impaired reach from Rincon Arroyo outlet (at the location of water quality station: RIO GRANDE NEAR RINCON AT NM 140 - 42RGrand126.9) to Leasburg.

Figure 2 Project Area Map



Monitoring Location Selection Criteria
Monitoring will occur to measure and quantify the indicators of our goals to achieve effects upon: 1) Impairment, 2) Vegetation cover, 3) Flow and channel dynamics, 4) Decreasing soil moisture (in areas of potential flow), and 5) Level of information, certainty and planning to achieve large watershed management.

1) Impairment monitoring location selection criteria: Measuring the E. coli load in flood flow at the location of the outlets of the restoration and control subbasins (Figure 3b) will help us understand the transport dynamics of the identifiable and total area of the subbasin upstream of the outlet. Turbidity analyses will be done in parallel to complement the E. coli data.

2) Vegetation cover monitoring location selection criteria: Measuring vegetation cover and density at the fenced and non-fenced at the locations of both near the outlet and in the upper subbasin locations in each subbasin will allow us to assess the accuracy of the remotely-sensed vegetation data throughout the major diversity of conditions in the subbasin (Figure 3a). The first measure at all the locations will provide an initial assessment; selected areas will then be monitored throughout the project to provide temporal diversity for assessment. The selection will be based upon the assessed accuracy of the remotely-sensed data, if accuracy appears low, all sites will be measured over time. If the accuracy appears high, one location near the outlet and one in the upper subbasin will be chosen to verify if the accuracy holds over time through the end of 2023. For additional ground truthing, we will use photographs captured from aerial imagery or drone images, which will have better-than-submeter resolution. All restoration locations will then be assessed for changes in and effects of vegetation cover and density over time using the remotely-sensed data.

3) Flow and channel dynamics monitoring location selection criteria: Measuring flow of the arroyos at the location of the outlets will help us understand the flow dynamics of the identifiable and total area of the subbasin upstream of the outlet. This will include measuring stage (height) and extent of infiltration (Figure 3b).

4) Decreasing soil moisture (in areas of potential flow) monitoring selection criteria: To understand infiltration changes at the locations of the specific practices, we will measure the extent of inundation onto the floodplains, infiltration, and soil moisture changes (Figure 3a).

5) Level of information, certainty and planning to achieve large watershed management monitoring location selection criteria: To understand the information needed to inform management, we will share our data with our steering committee approximately quarterly to both identify triggers for management responses or changes and identify needs for formulating and visualizing the data.

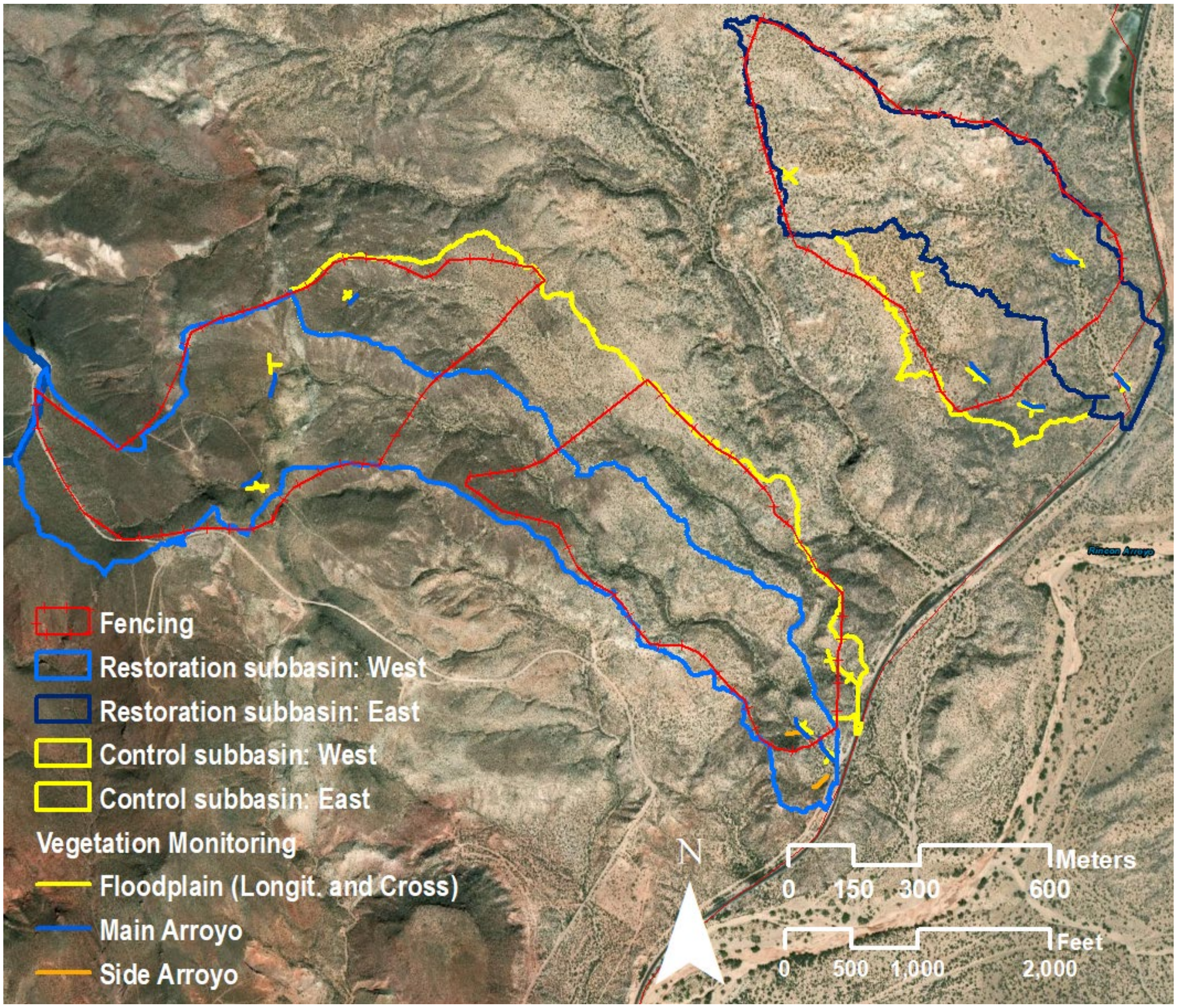


Figure 3a Project Area with Monitoring Locations

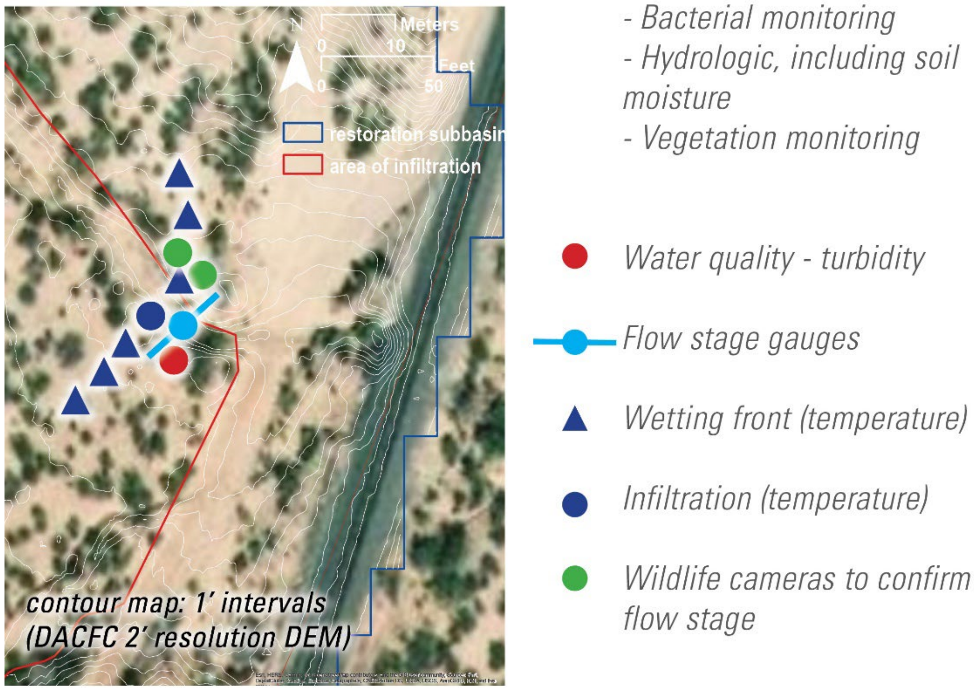


Figure 3b. Monitoring Locations at Outlets of Subbasins

Restoration Activities

Management Measure #1: Contour stone lines
Management Measure #1 Description: Approximately 18 (including approx. 2,700 lineal feet) contour stone lines are planned for installation, to be confirmed upon onsite surveys. Contour stone lines (Mekdaschi and Liniger, 2013) are surface runoff water management, soil conservation, and erosion mitigation measures in the flatter upland flow areas that have access for stone delivery. The function is to spread, not impound, water upstream before it enters arroyo flow, through increasing infiltration, recruiting vegetation, trapping soil and sediment behind structure, and increasing productivity for managed grazing. A stone line is typically 10' (25 cm) high and has a base width of 14"-16" (35-40 cm). It is constructed of a mixture of small and large stones along the contour and across a field. Smaller stones are placed upslope and the larger ones are placed underneath to slow down runoff, trap fertile soil sediment and enhance water infiltration. The distance between the lines depends on the slope and how many stones are available if locally sourced. The recommended spacing between lines for higher slopes is up to 100' apart, and for lower slopes, 65' (20m) for slopes less than 1%, and 50' (15m) for slopes of 1-2%. Stones would likely be brought in from an offsite quarry despite the availability of stone in the locations anticipated due to the quantity required for each line. Thus these lines are in locations that have adequate access. References: Mekdaschi, R., and H. Liniger. 2013. Water harvesting: guidelines to good practice. Centre for Development and Environment (CDE), Bern; Rainwater Harvesting Implementation Network (RAIN), Amsterdam; MetaMeta, Wageningen; The International Fund for Agricultural Development (IFAD), Rome.
Management Measure #2: Contour wire and brush lines

Management Measure #2 Description: Approximately 40 (including approx. 7,100 lineal feet) contour wire and/or brush lines are planned for installation, to be confirmed upon onsite surveys. Contour wire and/or brush lines, or net wire diversions (USDA NRCS, 2016) are surface runoff water management, soil conservation, and erosion mitigation measures in the flat upland flow areas. The practice objective is to control or protect range land from gully and/or sheet erosion, and head cuts caused by runoff with excess volume or energy by diverting it to protected areas, spreading and/or reducing the velocity of flow. The function is to spread not impound water upstream before it enters arroyo flow, through increasing infiltration, recruiting vegetation, trapping soil and sediment behind structure, and increasing productivity for managed grazing. A wire and/or brush contour line, or net wire diversion is a low profile 10'-12" galvanized mesh wire and/or brush as a continuous horizontal porous obstruction to flow held by posts 10' maximum on center. Brush is locally collected if available or brought to the site. The structures are intended to be permanent, and will build up sediment and vegetation on the upstream side of the structure. BLM requires that structures on the landscape blend in and not be painted a contrasting color, however, the vertical presence of the structure will be apparent enough to prevent injuries to cattle or wildlife.

References:

USDA NRCS. 2016. NRCS Field Office Technical Guide (FOTG) Arizona: Conservation Practice Standard Diversion Code 362. https://efotg.sc.egov.usda.gov/references/public/AZ/161001_362_DiversionStandard.pdf

Management Measure #3: Microcatchments

Management Measure #3 Description: Approximately 1,000 microcatchment systems are planned for installation. Microcatchment systems (Mekdaschi and Liniger, 2013) use various small stone bunds, including curved and semi-circular, or small brush weirs placed on and maintain contours for surface runoff water management, soil conservation, and erosion mitigation measures for runoff from relatively small catchment areas (up to 2 acres). Areas for treatment are upstream from defined drainage areas (arroyos) that exhibit erosion and entrenchment. In this project, practices planned to be installed in the headwaters above arroyos are eyebrow stone bunds (approx. 910) and in upland areas are media lunas (Maestas et al 2018) or demi-lunes (approx. 90). The practice objective is to control or protect range land from gully and/or sheet erosion, and head cuts caused by runoff with excess volume or energy. The function is to slow flow, capture sediment and nutrients to support revegetation and increased infiltration, and spread or maintain spread flow by maintaining a relatively consistent top surface on the contour. Note that these are not dams and are not intended to impound water, but are porous catchments. Eyebrow stone bunds are small structures intended to slow flow in the upland rills above arroyos to create a low profile terracing effect. The structures are permeable, and overflow is intended to overtop the structures, requiring the height to remain shallow to prevent the flood flow from increasing energy through waterfalling, similar in function to a one-rock dam. The materials are to be commonly collected onsite if this does not compromise the site ecological integrity. Rock, including sizes between cobbles (2.5") and boulders (10"), and/or brush debris is collected and used. When using brush for headwater rills above arroyos, the approach of brush weirs is modified to be smaller and span the rill to maintain the contour of the rill bank. Media lunas (or demi-lunes) are stone bunds that create a depositional area upstream of the structure and either spread or maintain spread sheet flow.

References:

Maestas, J., S. Conner, B. Zeedyk, B. Neeley, R. Rondeau, N. Seward, T. Chapman, and R. Murph. 2018. Hand-built structures for restoring degraded meadows in sagebrush rangelands: examples and lessons learned from the Upper Gunnison River Basin, Colorado. Range technical note; No. 40. Mekdaschi and Liniger, 2013 (see Measure 2 for reference).
Management Measure #4: Native grass seeding
Management Measure #4 Description: All of the management measures have objectives to increase vegetation to support functions of reducing runoff and in Management Measures 1-3, contour stone lines, contour wire and brush lines, and microcatchments, we will introduce grass seed to a minimum of 5% of the structures in the first year across a range of conditions, and if successful in areas of flow, application to the successful conditions in the subsequent years. Seed will be applied in order to reduce loss by wind and animals and encourage germination collaborating with current research (Dr. Faist, Rutter, 2019) and team input and placed on the soil upstream of the structure where flow will accumulate. References: Rutter, M. R. 2019. NMSU researcher, collaborators work to create best tools to help restore landscapes with native seeds.). New Mexico State University News Center. Las Cruces, NM. https://newscenter.nmsu.edu/Articles/view/13781/nmsu-researcher-collaborators-work-to-create-best-tools-to-help-restore-landscapes-with-native-seeds
Management Measure #5: One-rock dams
Management Measure #5 Description: Approximately 7 one-rock dams are planned for installation. One rock dams are runoff water management, soil conservation, and erosion mitigation measures in arroyos that exhibit downstream erosion and entrenchment and have enough width to establish in-channel bars. The practice objective is to control or protect range land from gully erosion, and head cuts caused by runoff with excess volume or energy. The function is to slow flow, capture sediment and nutrients to support revegetation and increased infiltration. The structure has a low profile on the landscape. Per Maestas et al. (2018), placement of one rock dams vary with channel type and morphology, with key features that they are a) built to only one rock high (generally no more than a third the height of the bankfull channel), and b) built with a footer for splash apron on the downstream end that extends far enough (2x the height of the structure) to intercept water. References: Maestas et al., 2018 (See Measure 3 for reference)
Management Measure #6: Protection of treated areas from grazing
Management Measure #6 Description: Fencing for cattle exclosure shall be placed around the majority of the restoration treatment and control subbasin (over 80%) with a section left unprotected to compare project performance under typical Southwest and regional range conditions. Approximately 39,000 lineal feet of fencing are planned for installation.
Management Measure #7: Education and Outreach, (including workshop that achieves road restoration)
Management Measure #7 Description: Restoration of 3,000 feet of roads is planned to be in collaboration with and training of road maintenance crews from the County and BLM using rolling dips (on the county road) and water bars (on the rarely used/abandoned power line access road) (Zeedyk, 2006) that maintain the road velocity through the areas to not result in erosion by diverting a portion of the flow from the road through gravity. To achieve our education and outreach / social context conditions goal – the level of information, certainty and planning to achieve large watershed management potential – we will have a

steering committee of stakeholders, meet quarterly, and conduct field trips to assess the restoration implementation, results, and potential benefits. This assessment will be conducted collaboratively with the steering committee and other stakeholders. The team will work with the group to confirm, further develop, and refine how these findings establish generalizable indicators that allow for estimation of extent of restoration required to achieve goals in the region. The final indicators (with data and methods to arrive at these indicators) will be captured in a final report for this project that will include the relevant estimation methods to predict the effect of each restoration practice.

References: Zeedyk, B. 2006. Water harvesting from low-standard rural roads. Santa Fe, NM: Quivira Coalition.

A7. Quality Objectives and Criteria for Measurements

Question/Decision

The baseline data collection and monitoring components of the Project are intended to answer the following questions and measure the success of the goals:

The overall question is whether the slowing and spreading of flood flow in upland watersheds can support revegetation to the extent that it filters sediment and nutrients, in particular E. coli. The main supporting question is if the revegetation can be supported to the extent that it increases infiltration and reduces flow energy, which would then support the main question.

1) How Project Data Will Be Used To Determine or Prove Project Goals

We have developed evaluation criteria for each of the goals listed in the Goals section (Section A.5) above.

i) Indicators for impairment Goal Load minimum reduction by factor of 2: We will estimate E. coli load transport and turbidity, and produce quantitative links to vegetative cover (see measure 2) and hydrologic flow (see measure 3) to predict extent of treatment required to achieve goals. We will measure E. coli load from the restoration subbasins and a control arroyo subbasin directly adjacent, using EPA method 1603 for E. coli with data of critical interest from the summer monsoonal seasons of2022, and 2023, and 2024. We will use a Teledyne Glacier Portable Refrigerated Sampler (collects 20 liters of flood flow and refrigerates them for up to 48 hours).

ii) Indicators for vegetation cover conditions goal of statistical and functional increases at intervention locations by 2024: To assess what percent vegetation cover change occurs due to the restoration measures, we will monitor the vegetation cover conditions with both remote sensing (NDVI on a 3m resolution (Planet Team, 2017)) and field transect measures used by BLM for their AIM program for ground-truthing (Herrick 2017), calibrated per the control subbasin conditions. To correlate the vegetation cover effect on hydrologic energy, specifically runoff peaks and volume, we will rerun our models and calibrate to the new runoff measures (see measure 3) to assess the changes to the Curve Number. This then provides indicator measures for i) the response of vegetation cover to restoration, ii) effect of vegetation on runoff, and iii) effect of vegetation on E. coli transport.

iii) Indicators for flow and channel dynamics goal of hydrologic peak and volume statistical and functional: Note that tying *E. coli* transport to hydrologic peaks and flow volume is more practical than trying to tie it to sediment transport for two reasons: i) reliable sediment transport measures directly from water sampling are difficult to get, and ii) hydrologic dynamics are important to land managers and modeling is common. We will directly measure flow stage (height) and volume using a protected pressure transducer to derive runoff peaks and volume through model calibration at both the restoration subbasin and the control subbasin. Additionally we will directly measure infiltration rate using a submerged Alpha Mach iButton Temperature Rod, which uses temperature as a proxy to derive the infiltration rate (Moore 2007). This provides i) the effect of restoration on hydrologic energy, and ii) the ability to tie the other vegetation cover and E. coli load indicator measures to the hydrologic energy. We also predict that the reduction in hydrologic energy will statistically and functionally reduce the site erosion as measured by the high resolution DEM's and LiDar provided by the Dona Ana Flood Commission (DACFC), and compared over preceding and upcoming periods. DACFC is contributing high resolution aerial photography and LiDAR that meets the USGS QL2 standard for the 134 square mile Rincon Arroyo watershed. The DACFC has been developing a comprehensive collection of data sets using aerial photography and LiDAR since 2004. Each data set provides a snapshot of this area that will be compared to other data sets to see erosional changes that will be tied to previously-modeled hydrologic events of different energies. We can also evaluate migrating arroyos and flow paths, and changes in vegetation density. We have gauge data for the watershed outlet and have completed hydrologic modeling calibrated to that data for 2008- 2013, the data from this project will be analyzed in comparison to those events to establish robust correlations between hydrologic energy, erosion, and E. coli NPS transport. We will compare the historic data sets to the hydrologic modeling, and the results of this project (2010, 2014, 2018, and planned 2022-23

iv) Indicators for ecological history (decreasing soil moisture) conditions goal - statistically and functionally increasing the connectivity of flood flow to the floodplain at areas of interventions (e.g. in a 10-year event from 27% to 90%: We will install iButton Thermistor temperature sensors along the surface from the channel into the floodplain to verify the extent of inundation at different flow stages. This provides i) the effect of restoration on connectivity of flood flow to the floodplain and thus area of infiltration, and ii) the ability to confirm the effect of the area of infiltration on hydrologic energy

v) Social context conditions goal measures – level of information, certainty and planning to achieve large watershed management potential: The data and results of the quantitative indicators will be documented to provide standards that can be used as generalizable indicators for this region synthesized in the final report. The success measure will be the approval of the final Rincon Arroyo restoration plan by the steering committee, followed by collaborating stakeholders predicting benefits of further implementation in this region.

References:
Herrick, J. E., J. W. Van Zee, S. E. McCord, E. M. Courtright, J. W. Karl, and L. M. Burkett. 2017. Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Quick Start. Volume II: Design, supplementary methods and interpretation. 0975555200. USDA - ARS Jornada Experimental Range: Las Cruces, New Mexico.

Moore, S. J. 2007. Streamflow, infiltration, and recharge in Arroyo Hondo, New Mexico: Chapter F in Ground-water recharge in the arid and semiarid southwestern United States (Professional Paper 1703). 2330-7102. US Geological Survey.

Planet Team. 2017. Planet Application Program Interface.). Space for Life on Earth. San Francisco, CA, USA: Planet Team.

Data Quality Objectives
The quality of the data will be adequate to provide a high level of confidence in determining the efficacy of slowing and spreading flow to support revegetation that can filter sediment, nutrients, and thus mitigate *E. coli* transport in the Project.

Data Quality Indicators
The measurement quality objectives will be sufficient to achieve the DQO and will be in conformance with those listed in the SWQB's QAPP. The Data Quality Indicators listed in the SWQB's QAPP and applicable to the data collected for this project are precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity.

DQI	Determination Methodologies
Precision	1) Impairment monitoring data: At least 9 liters (and up to 20 liters) of flood flow will be collected by the Isco Glacier Sampler for each flood flow and refrigerated until the sample is collected. A signal that the arroyo ran and thus samples collected will be given via the weather station in real time. The sample will be kept refrigerated by the Isco Sampler for up to 48 hours, after which it will be transported on ice and will be analyzed within 72 hours for E. coli and turbidity by lab personnel. Regarding the precision of the EPA Method 1603, the following applies to the medium used (mTEC) to test for E. coli presence: The modified mTEC method precision was found to be fairly representative of what would be expected from counts with a Poisson distribution. 2) Vegetation cover monitoring data: Remotely-sensed vegetation cover and density will be compared to field-measured cover and density to identify precision and guide the remotely-sensed data calibration. 3 & 4) Flow and channel dynamics monitoring data: To understand the flow dynamics of the subbasin, we seek to identify the flow volume and the peak flow energy (flow rate) of the flow at the outlet, and will ensure precision by comparing values estimated by hydrologic models to the directly measured values in the field. To ensure precision, we will measure several parameters of the flow to allow several calculations of volume. Stage (flow height) is measured at a location where we have measured the cross-section using both a pressure transducer, as well as a stage gauge (a large ruler) and a wildlife cameras. Extent of inundation is also measured, which will provide a third measure of volume. A hydrologic model will identify peak flow energy, which will input the flow volumes that are recorded and estimate the peak flow rates taking into account slope and surface roughness.

	5) Level of information, certainty and planning to achieve large watershed management potential: quality issues addressed in above indicators.
Bias	1) Impairment monitoring data: regarding method E. coli 1603, the bias of the modified mTEC method has been reported to be -2% of the true value. 2) Vegetation cover monitoring data: We will compare our results to other sites within the same watershed sampled by BLM (additional AIM sites). 3 & 4) Flow and channel dynamics monitoring data: The direct flow measures will allow us to calibrate the hydrologic modeling and minimize common biases of input values that are averages for landscape-scale arid conditions, and use values that are more representative of the area. 5) Level of information, certainty and planning to achieve large watershed management potential: quality issues addressed in above indicators.
Accuracy	1) Impairment monitoring data: Accuracy of results of Method 1603 is typically reported in percent false positives and negatives reported. The false positive rate reported for modified mTEC medium averaged 6% for marine and fresh water samples. Five percent of the *E. coli* colonies observed gave a false negative reaction. 2) Vegetation cover monitoring data: The field measures are direct measures of the field conditions and will serve to validate the accuracy of the remotely-sensed data and provide a means of calibration. 3 & 4) Flow and channel dynamics monitoring data: The field measures are more direct measures of the field conditions and will serve to validate the accuracy of the models and provide means of calibration. To ensure accuracy of the field measures, we employ redundancies, and calibrate the equipment. For flow volume measures, we will remeasure the cross-section where stage will be measures each year to determine changes. 5) Level of information, certainty and planning to achieve large watershed management potential: quality issues addressed in above indicators.
Representative	1) Impairment monitoring data: Quality control measures for chain of custody, maintenance of the water samples at refrigeration and confirmation of rainfall by weather station data are three of the ways we will ensure the water samples are representative of that date's water flow on the landscapes. The E. coli should thus be representative of that day's sampling event.

	2) Vegetation cover monitoring data: Sampling the full diversity of the different site conditions will maximize our ability to represent the site. As well, the fine scale of the remotely-sensed data (3m resolution) will allow greater representation of the diversity of the site conditions. 3 & 4) Flow and channel dynamics monitoring data: The measure of the flow at the outlet of each subbasin allows us to measure the flow dynamics of the full subbasins. 5) Level of information, certainty and planning to achieve large watershed management potential: quality issues addressed in above indicators.
Comparability	1) Impairment monitoring data: To test for sample site variability, eight volunteer laboratories, an *E. coli* verification laboratory, and a research laboratory participated in the U.S. Environmental Protection Agency's (EPA's) interlaboratory validation study of EPA Method 1603. A detailed description of the study and results are provided in the validation study report (referenced in the 1603 Method). 2) Vegetation cover monitoring data: Initial training and supervision and quality control checks on the data collection of the field measures will minimize any sampling errors and ensure accuracy and thus comparability. 3 & 4) Flow and channel dynamics monitoring data: The redundancy of the wildlife camera confirming the stage (flow height) measures will allow for calibrations of any distortions due to sediment in the flows and ensure comparability. 5) Level of information, certainty and planning to achieve large watershed management potential: quality issues addressed in above indicators.
Completeness	1) Impairment monitoring data: We aim to complete replicate analyses for *E. coli* on all samples taken (estimated to be 10 – 20 samples / year). 2) Vegetation cover monitoring data: Annual maximum remotely-sensed vegetation measures as controlled by precipitation and flow connectivity will provide the ability to assess the efficacy of the restoration practices. For ground-truthing, the first measure at all the locations will provide an initial assessment; selected areas will then be monitored over the course of the project to provide temporal diversity for assessment. The selection will be based upon the assessed accuracy of the remotely-sensed data, if accuracy appears low, all sites will be measured over time. If the accuracy appears high, one location near the outlet and one in the upper subbasin will be chosen to verify if the accuracy holds over time. All restoration locations will

	then be assessed for changes in and effects of vegetation cover and density over time using the remotely-sensed data. 3 & 4) Flow and channel dynamics monitoring data: Hydrographs from approximately 3-6 events would likely supply enough variability of flows to determine representative flow dynamics and calibrate our hydrologic models. The continuous monitoring of the flows is very likely to capture significantly more events. 5) Level of information, certainty and planning to achieve large watershed management potential: quality issues addressed in above indicators.
Sensitivity	1) Impairment monitoring data: Method 1603 for E. coli testing has a detection limit of 1 culturable E. coli colony forming unit per 100 mL of sample. If samples are highly turbid, detection limits will rise, and lower volume samples will be tested, giving an approximate detection limit of 100 E. coli per 100 mL This higher detection limit is still well within the recreational water limit for e. coli (126 E. coli/100 mL). 2) Vegetation cover monitoring data: We will test differing measures of vegetation to test the sensitivity of each measure to the mitigation of flow energy, and thus *E. coli* transport: percent vegetation cover, species type, species density, and vegetation patch sizes. 3 & 4) Flow and channel dynamics monitoring data: The hydrologic modeling will also test differing measures of vegetation to test the sensitivity of each measure to the mitigation of flow energy, and thus *E. coli* transport: percent vegetation cover, species type, species density, and vegetation patch sizes. 5) Level of information, certainty and planning to achieve large watershed management potential: quality issues addressed in above indicators.

A.8 Special Training/Certification

This project will be primarily implemented by NMWRRI and its subcontractors, including the successful bidding restoration contractor. The restoration contractor’s field team will be trained by NMWRRI and its subcontractor, in the placement and methods of the restoration practices in accordance with procedures identified in SOPs referenced in this QAPP. The training will be documented to ensure there is a record that individual had been trained in the appropriate field by experienced staff. Data collection and monitoring for this project will be implemented by NMWRRI with technical assistance and oversight from the SWQB Project Officer. Volunteers will be trained by NMWRRI and its subcontractor, and supervised at all times by a supervisor from the successful bidding restoration contractor in the field for restoration work and NMWRRI for data collection efforts. Any individual supervising work, training workers or volunteers, or conducting monitoring work for the project will review this QAPP and sign the acknowledgment statement prior to initiating any work for this project. The signed acknowledgment statements will be kept on file with original QAPP by the QAO.

A.9 Documents and Records

The SWQB Project Officer will make copies of this approved QAPP and any subsequent revisions available to all individuals on the distribution list who do not have signature authority for approving the QAPP.

When changes affect the scope, implementation, or assessment of the outcome, this QAPP will be revised to keep project information current. The SWQB Project Officer, with the assistance of the QAO, will determine the effects of any changes to the scope, implementation, or assessment of the outcome on the technical and quality objectives of the project. This Project Plan will be reviewed annually by the SWQB Project Officer to determine the need for revision.

Project documents include this QAPP, field notebooks, calibration records, validation and verification records, recorded field data, records of analytical data in hard copy or in electronic form, and QC records. Also included are project interim and final reports. Data captured on a global positioning system (GPS), camera, smart phone, tablet, or laptop will be downloaded to a NMWRRI computer or an external hard drive at the end of each day. Copies will be made of all data and stored separately from the original data.

For project reports, all digital project data will be kept in a project file on the NMWRRI server computer (Location E.1) and on a separate external backup hard drive at the NMWRRI office (Location E.2). Hard copy project documents will be kept in a project folder in a file folder at the NMWRRI office (Location H.1). All hard copy documents will be digitized and stored on the NMWRRI Project Coordinator's computer and backup hard drive (see Table 3). The SWQB Project Officer shall serve as the State Records Administrator, and approval of this agreement serves as the written approval that the project data may be transferred to NMED and thus the state archives. Copies of the data will be distributed by NMWRRI to NMED SWQB Project Officer after each field season, typically at the end of November.
For vegetation, hydrologic, and *E. coli* load monitoring, all digital project data will be kept in a project file on the NMWRRI Project Coordinator's computer (Location E.11) and on a separate external backup hard drive at the NMWRRI Project Coordinator's office (Location E.12), as well as an online backup copy to which the NMWRRI office and Project Manager have access (Location E.13). Hard copy project documents will be kept in a project folder in a file folder at the NMWRRI Project Coordinator's office (Location H.11) and at the time of data distribution to NMED SWQB, an additional copy will be distributed to the NMWRRI main office (Location H.1). All hard copy documents will be digitized and stored on the NMWRRI Project Coordinator's computer and backup hard drive (see Table 3). Copies of the data will be distributed by NMWRRI to NMED SWQB Project Officer after each field season, typically at the end of November. The SWQB WPS will retain project documents in accordance with applicable sections of New Mexico's Disposition of Public Records and Non-Records regulation, codified at 1.13.30 Administrative Code (NMAC) and Retention and Disposition of Public Records regulations, codified at 1.21.2 NMAC. The distribution of the data to NMED then allows NMWRRI to retain or destroy the records according to their own retention policies and in accordance with the regulations specified herein.

Table 3 Data Records for the Project

Document	Type of Form	Storage Location (see previous paragraph)	Field Sheet Used
QAPP	Electronic (.doc) & Hard Copy	Locations E.1, E.2, E.13, H.1	EPA Requirements for Quality Assurance Project Plan. EPA QA/R-5. Located at: https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf
Calibration Records	Electronic (.doc) & Hard Copy	Locations E.11, E.12, E.13, H.1, and H.11	NA (file downloaded to laptop)
Flow stage (height) data	Electronic Excel Files and HOBOware files	Locations E.11, E.12, E.13, H.1, and H.11	NA (file downloaded to laptop)
Infiltration data	Electronic Excel Files and WeeButton files	Locations E.11, E.12, E.13, H.1, and H.11	NA (file downloaded to laptop)
***E. coli* load**	Electronic Excel Macro files	Locations E.11, E.12, E.13, H.1, and H.11	EPA method 1603 for E. coli
Vegetation and soil monitoring Field sheets	Electronic (.xls) & Hard Copy	Locations E.11, E.12, E.13, H.1, and H.11	Field sheets. Located at: https://jornada.nmsu.edu/monit-assess/manuals/monitoring
Photos	Electronic (.jpg)	Locations E.11, E.12, E.13, H.1, and H.11	Photo transection sheet. Located at https://jornada.nmsu.edu/monit-assess/manuals/monitoring
Interim and Final Reports	Electronic (.doc) & Hard Copy	Locations E.1, E.2, E.13, H.1	NA

Group B: Data Generation and Acquisition

B1. Sampling Plan

Our sampling and monitoring design is intended to measure the efficacy of slowing and spreading flow to support revegetation that can filter sediment, nutrients, and thus mitigate *E. coli* transport. Our monitoring will compare the effects of the restoration efforts, which consist of small-scale erosion/flood-control structures, to control areas with no structures. The intended effects are to decrease flow energy, increase water infiltration, and support revegetation in areas of ephemeral flood flow. Two forms of control will be provided, no interventions, and non-fenced areas unprotected from grazing, e.g. interventions to no interventions in fenced areas, as well as interventions to no interventions in non-fenced areas. Sample locations are determined by the locations of preexisting flow paths and arroyos and are placed in the locations which can illustrate the difference in conditions from areas with high water flow to areas with low water flow. Another factor which determines the sampling locations is the topography of the watershed, samples will be taken at both the higher and the lower end of the range of elevations. The frequency of sampling is annually between the months of July and December.

1) Sampling design for indicators for impairment Goal (*E. coli)*: We will measure *E. coli* load from the restoration subbasins and a control arroyo subbasin directly adjacent, using EPA method 1603 for *E. coli* with data of critical interest from the summer monsoonal seasons of 2022, 2023, and 2024. We will use a Teledyne Glacier Portable Refrigerated Sampler (collects 20 liters of flood flow and refrigerates them for up to 48 hours). Additionally, we will measure turbidity, and produce quantitative links to vegetative cover (see measure ii) and hydrologic flow (see measure iii) to predict extent of treatment required to achieve goals.

2) Sampling design for indicators for vegetation cover conditions - field data: For our first method to ground-truth the remotely sensed procedure described following, we will measure to primarily assess percent vegetation cover, but secondarily, species type, species density, and vegetation patch sizes. The additional measures will help us assess the sensitivity of the relationship of these indicators to vegetation cover and if the types and patterns of vegetation are associated with differing infiltration and filtering functions. We will measure during or after the height of the vegetation season typically between September and December (the period of time through which annuals are still present and can be accounted for even if dead, per the local BLM methodology). These assessments will quantify the amount of vegetation, the types of vegetation, and how the vegetation is arranged on the landscape. Student assistants under the supervision of the Project Coordinator/Project Lead will be conducting these assessments. The assessment methods will be Line Point Intercept Transects, Gap Intercept Transects, Rapid Rangeland Health Assessments customized to the conditions assessed, and listings of all the types of vegetation and the types of plant-plant interactions that exist in the area (with photographic records). Each subbasin is broken up into two sections, an upper and lower section due to elevation differences (Figure 3a), and is listed following: West Restoration Uplands, West Restoration Lowlands, West Control Uplands, West Control Lowlands, East Restoration Uplands, East Restoration Lowlands, East Control Uplands, and East Control Lowlands. Transects are chosen to best represent the area, with randomness incorporated into the methodology.

A 25 meter transect will be done in the floodplain along an arroyo in each section, and a 25 meter transect will provide a cross-section of the arroyo up to the floodplain. The 25m transect will cross the 25 m at the center mark, creating an approximate right-angle cross. An additional transect will be done up into a side arroyo to compare vegetation along water flow in the floodplains. The Line Point Intercept will be performed along the transects, which measures the amount and type of vegetation, litter, and ground cover along the transects. The Gap Intercept will also be performed on the transects, which measures the amount and size of gaps in vegetation cover along the transects. We then aim to assess what characterizes vegetation patches of different infiltration functions.

For additional ground-truthing of the remote sensing monitoring approach, we will use photographs captured from aerial imagery or drone images, which will have better-than-submeter resolution. Our objective is to validate the accuracy of images captured during the peak of vegetation during the growing season, typically September.

Remotely-sensed vegetation data: We will monitor the vegetation cover conditions by deriving the normalized difference vegetation index (NDVI) using remote sensing data from Planet Labs, Inc. (3m resolution data that is both atmospherically calibrated (scaled Top of Atmosphere radiance (at sensor) image product and orthorectified suitable for analytic and visual applications (Planet Labs Inc., 2020; Planet Team, 2017)). To calibrate the NDVI data and assess the changes over time, we will use accepted change detection techniques (Jensen, 2005) to: i) conduct any needed relative radiometric correction using Empirical Line Calibration (ELC) and pseudo-invariant features (PIFs) to ensure that the data files are comparable to each other, ii) conduct a vegetation index differencing approach, which subtracts the second-date vegetation index from the first (Lu et al., 2004; Lyon et al., 1998), and iii) assess and conduct if ELC calibration of the data to the field data will be necessary. We will further assess and conduct if principal component analysis will be helpful to distinguish vegetation pattern changes over time.

3) Sampling design for indicators for flow and channel dynamics goal of hydrologic peak and volume: The sampling design for flood flow intends to measure the peaks and volumes of the flows. This will allow us to calibrate hydrologic modeling of the subbasins, particularly the effect of the landscape on runoff as defined by curve numbers (USDA NRCS, 2004). The student assistants will collect the samples under the supervision of the Project Coordinator/Project Lead. We will measure stage using a HOBO 30-Foot depth water level data logger, which is a pressure transducer that is then calibrated by another logger out of the flow. The pressure transducer will be protected by a ground water well casing modified to be above ground. The location of the samples is in the outlet of the subbasin. The frequency of sampling will be dependent upon flood flow, and historically is shown to be an average of 2-3 times per year between 2008-2013.

4) Sampling design for indicators for ecological history (decreasing soil moisture) conditions goal - increasing the connectivity of flood flow to the floodplain. We will measure infiltration rates of the channel bed using temperature as a tracer for the movement of the water (Blasch et al., 2007; Moore, 2007; Stonestrom and Constantz, 2003). We may replace this method with soil moisture probes and data loggers, as we may be given access to this equipment for this project. If we have this opportunity, we will then additionally measure the extent of soil moisture in following differing conditions: varying degrees of concentrated flood flow and vegetated states compared to infiltration rates at areas of restoration practices, which will each be compared to areas out of flow. To ensure accuracy in our calculations and understandings of the water infiltration potential in each area of the watershed, we will also determine the soil textures in a 70cm soil pit profile and assessment of the soil stability in relation to flow (Herrick et al., 2017), and bulk density, porosity, and a common range of soil moisture levels using the Core Method (Dane and Topp, 2002). Student Assistants under the supervision of the Project Coordinator are the personnel who will be collecting the samples. In the Soil Stability Test, the 18 randomly selected small topsoil samples are taken along the same transect used for both Gap and Line-point. This test is used to determine how the soil retains its structure and composition under extreme moisture.

5) Sampling design for social context conditions goal measures – level of information, certainty and planning to achieve large watershed management potential: sampling designs are addressed in other indicators above, as this goal is related to the synthesis of information.

Table 4 Project Monitoring Specifics

Responsible Party	Monitoring	Location	Frequency

NM WRRI / NMSU Biology Department	*E. coli*, and turbidity	Outlets of subbasins (Figure 3b)	Each flow event, primarily in monsoon season
NM WRRI	Vegetation cover	At the zones of high and low elevations of the subbasins (Figure 3a)	Annually
NM WRRI	Flow and infiltration	Outlets of subbasins (Figure 3b)	Each flow event, primarily in monsoon season
NM WRRI	Soil types	At the zones of high and low elevations of the subbasins (Figure 3a)	Annually, except soil pits, which will be done once in advance of analysis

B2. Sampling Methods

1) Sampling methods for indicators for impairment Goal (*E. coli)*: We will measure *E. coli* load and turbidity from the restoration subbasins and a control arroyo subbasin directly adjacent, using EPA method 1603 for *E. coli* with data of critical interest from the summer monsoonal seasons of2022, 2023, and 2024. We will use a Teledyne Glacier Portable Refrigerated Sampler (collects 20 liters of flood flow and refrigerates them for up to 48 hours).

2) Sampling methods for indicators for vegetation cover conditions – field measures. Vegetation monitoring will be in accordance with *Volume 1: Core Methods Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems* (Herrick et al., 2017). Line Point Intercept assessments will be done as a cross section of 25 meters by 25 meters (two separate transects) in accordance with the section Line Point Intercept on pg. 27, at 50cm intervals. Gap Intercept assessments will measure the gap or lack of vegetation between areas along the transect which consist of 20cm or more of consistent cover and be done along the same two transects which have been set up for line-point intercept, so that the sample area is the same. The method is done in accordance with the section Gap Intercept on pg. 41. Vegetation monitoring methods will compare remotely-sensed data to the field measured vegetation coverage. The remote-sensing methods will be done in accordance to *Introductory digital image processing: a remote sensing perspective (3rd edition)* (Jensen, 2005). To identify GPS locations for the transects, we will use a Trimble Geo 7X handheld.

Photographic documentation will be conducted using the protocols identified in *Volume 1: Core Methods Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems* (Herrick et al., 2017) in the Photo Point section on pg. 25.

To perform vegetation cover condition, we will create a 12x12 meter image quadrant as a reference. Within this quadrant, we will simulate point sampling to determine the vegetation cover percentage of the aerial imagery. It is important to ensure that the sample area is sufficiently large for accurate assessment. To achieve this, we will use the formula $A = P(1 + 2L)$, where A represents the minimum sample site dimension, P denotes the image pixel dimension, and L represents the estimated locational accuracy measured in terms of the number of pixels (Justice and Townshend, 1981), and here the spatial resolution of the Planet image is 3 meters, and a one-pixel shift is expected during image processing. Based on this information, the minimal size of an internally homogeneous sampling area would be 3 * (1 + 2 * 1) = 9 meters × 9 meters. Therefore, we have considered a 12 meters × 12 meters quadrat for our sampling. To ensure accurate registration and alignment between the sample quadrats of aerial imagery and Planet images, we will utilize Ground Control Points (GCPs). GCPs will be created and placed in both the aerial imagery and the Planet images. This will allow us to establish a reliable co-registration between the two image sources. Next, we will derive transformation functions for converting NDVI values to vegetation cover percentages using linear regression analysis. These functions will be developed based on the analysis of aerial imagery and the corresponding NDVI values derived from Planet data. By calibrating the NDVI data and assessing the changes over time, we can accurately monitor and quantify the vegetation cover changes.

Our objective is to validate the accuracy of images captured during the peak of vegetation during the growing season, typically September. To ensure consistency, we select images acquired on the same day and time, with a maximum time difference of one week. We aim to produce two key outputs. Firstly, we perform change detection of NDVI over a specific time period. This involves utilizing a vegetation index differencing approach, where we subtract the NDVI value of the second-date image from that of the first-date image. This allows us to identify and quantify the changes in vegetation over time (Lu *et al.*, 2004; Lyon *et al.*, 1998). Student assistants under the supervision of the Project Coordinator/Project Leaders will be conducting these assessments.

The calibration methodology and techniques employed for NDVI to percent vegetation transformation will follow accepted industry standards and best practices per published literature (Figure 4).

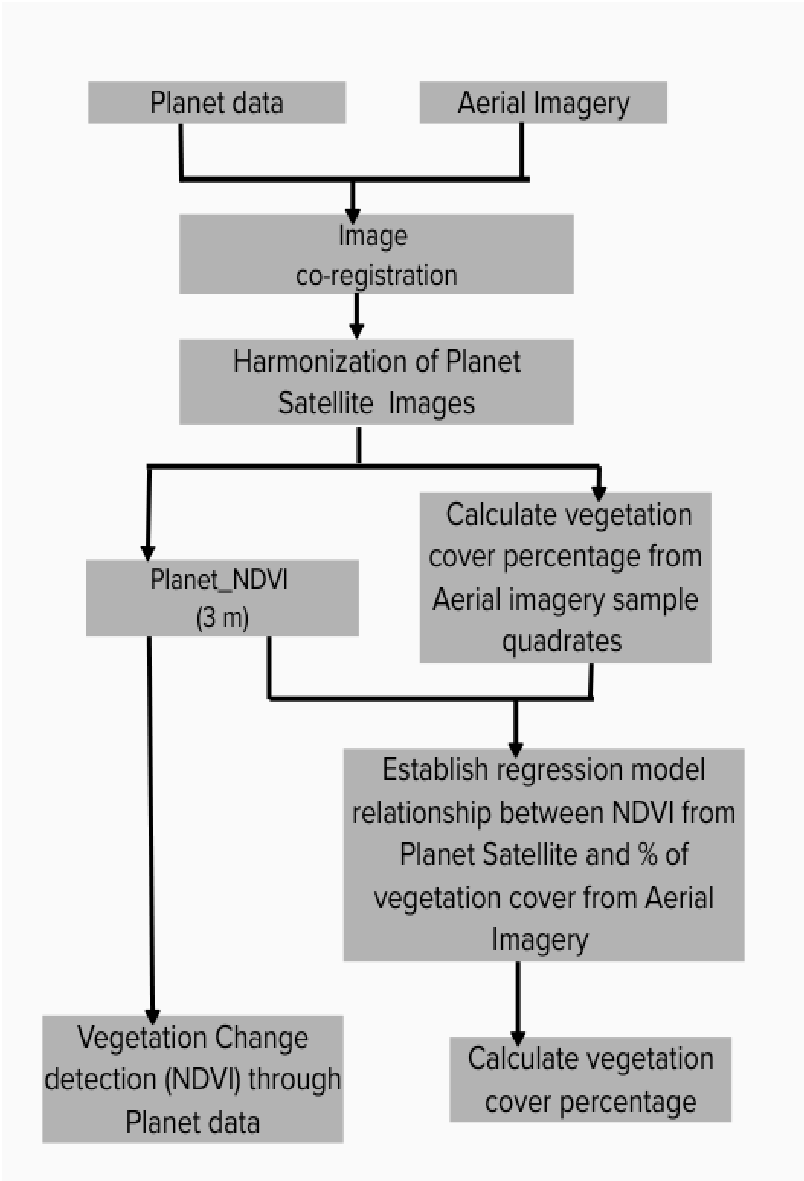


Figure 4. Workflow Diagram for use of Remote Sensing for Monitoring Vegetation Cover

3) Sampling methods for indicators for flow and channel dynamics goal of hydrologic peak and volume: Flow stage will be measured using a HOBO 30-Foot depth water level data logger and protected by a ground water well casing modified to be above ground, in accordance with *Design and installation of monitoring wells* (Striggow et al., 2013). Hydrologic data input modeling methods will be in accordance with Geo-HMS, Geo-RAS, HEC-HMS, and HEC-RAS methodologies (US Army Corps of Engineers (USACE), 2020) and SCS curve number methodologies defined in the National Engineering Handbook (USDA NRCS, 2004). Soil data for the hydrologic modeling will be per SSURGO (USDA NRCS Soil Survey Staff), and compared to the data collected for indicators #4 following.

4) Sampling methods for indicators for ecological history (decreasing soil moisture) conditions goal - increasing the connectivity of flood flow to the floodplain: A rapid rangeland health assessment will be adapted to assess connectivity in xeric riparian areas per *User's Guide for the Rapid Assessment of the Functional Condition of Stream-Riparian Ecosystems in the American Southwest* (Stacey et al., 2006), and in accordance with two methods: i) *Volume 1: Core Methods Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems (Herrick et al., 2017)* Plot Observation section on pg. 23; and ii) *Interpreting indicators of rangeland health, version 3* (Pellant et al., 2005).

Infiltration rates at the channel near the outlet will be measured with a T.rod.X (Alpha Mach) in accordance with Naranjo and Turcotte (2015)). This method may be replaced by soil moisture probes, Campbell Scientific CS655 12cm soil moisture and temperature sensor, data logger, cabinet mounted on t-post, and solar panel mounted on cabinet in accordance with *Methods of soil analysis, Part 4: Physical methods* (Dane and Topp, 2002). Infiltration rates at selected practices will be measured with the soil moisture probes.

Extent of flow inundation at selected practices will be measured with iButtons (Alpha Mach) in accordance with Fawcett et al. (2019), and fixed on the soil surface along the cross section of the floodplain directly adjacent to the arroyo.

The soil profile assessment is done in accordance with *Volume 1: Core Methods Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems* (Herrick et al., 2017) on pg. 21.

The Soil Stability Test is done in accordance with *Volume 1: Core Methods Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems* (Herrick et al., 2017) on pg. 47.

5) Sampling methods for social context conditions goal measures – level of information, certainty and planning to achieve large watershed management potential: sampling methods are addressed in other indicators above, as this goal is related to the synthesis of information.

B3. Sample Handling Custody

1) Sampling handling and custody for indicators for impairment Goal (*E. coli)*: water samples will be kept refrigerated in the Teledyne sampler in the field for up to 48 hours, and samples will be transported on ice and analyzed within 72 hours of initial collection. Chain of custody forms will be signed in the field and then transferred and signed by the person in the Biology department doing the *E. coli* and turbidity analyses.

2) Sampling handling and custody for indicators for vegetation cover conditions - field data: Because there are no plans to collect samples for laboratory analysis, there are no handling requirements.

3) Sampling handling and custody for indicators for flow and channel dynamics goal of hydrologic peak and volume: Because there are no plans to collect samples for laboratory analysis, there are no handling requirements.

4) Sampling handling and custody for indicators for ecological history (decreasing soil moisture) conditions goal - increasing the connectivity of flood flow to the floodplain: Sampling of soil bulk density,

porosity, and a common range of soil moisture levels using the Core Method will be in accordance with *Methods of soil analysis, Part 4: Physical methods* (Dane and Topp, 2002). Because there are no plans for the remaining methods for this indicator to collect samples for laboratory analysis, there are no further handling requirements.

5) Sampling handling and custody for social context conditions goal measures – level of information, certainty and planning to achieve large watershed management potential: sampling handling and custody are addressed in other indicators above, as this goal is related to the synthesis of information.

B4. Analytical Methods

1) Sampling analysis for indicators for impairment Goal (*E. coli)*: EPA recommended QA/QC procedures will be used. Specific to EPA method 1603, initial precision and recovery analyses, ongoing demonstration of laboratory capability through performance of the ongoing precision and recovery will be carried out. Negative and positive controls for EPA method 1603 will use sterile water and E. coli K-12 cultures, respectively. Filter sterility checks (Section 9.8), method blanks (Section 9.9), and media sterility checks will be run routinely. On any given day, if any of these quality control parameters fail, the data will be rejected until the QC controls are corrected.

Turbidity standard curves will be run in order to calibrate the optical density turbidometer using protocols by Turner Designs, the manufacturer of the Aquafluor system we're using. This is a single sample turbidometer, if sample numbers become too high, we will use a 96-well spectrophotometer available in the Biology department that is routinely used to measure optical density. Personnel will be trained in biosafety procedures (NMSU Environmental Health and Safety,(https://safety.nmsu.edu/lab-safety/bio-safety/biosafety-related-training/), with particular emphasis on sterile technique.

2) Sampling analysis for indicators for vegetation cover conditions - field data:
We will derive transformation functions for converting NDVI values to vegetation cover percentages using linear regression analysis for each sample quadrat. For each quadrate, image captured by aerial/drone will be analyzed using sample point method as suggested by BLM Technical Note 454 on Ground –Based Image Collection and Analysis for Vegetation and Monitoring. These functions will be developed based on the analysis of aerial imagery and the corresponding NDVI values derived from Planet data. By calibrating the NDVI data and assessing the changes over time, we can accurately monitor and quantify the vegetation cover changes. The detailed workflow has been shown in Figure 4.

3) Sampling analysis for indicators for flow and channel dynamics goal of hydrologic peak and volume: Because there are no plans to collect samples for laboratory analysis, no analytical methods are needed.

4) Sampling analysis for indicators for ecological history (decreasing soil moisture) conditions goal - increasing the connectivity of flood flow to the floodplain: Sampling analysis of soil bulk density, porosity, and a common range of soil moisture levels using the Core Method will be in accordance with *Methods of soil analysis, Part 4: Physical methods* (Dane and Topp, 2002). Because there are no plans for the remaining methods for this indicator to collect samples for laboratory analysis, no further analytical methods are needed.

5) Sampling analysis for social context conditions goal measures – level of information, certainty and planning to achieve large watershed management potential: sampling analysis are addressed in other indicators above, as this goal is related to the synthesis of information.

B5. Quality Control

The quality Control activities for all indicators 1-5 are to be performed according to *Volume 1: Core Methods Monitoring Manual for Grassland, Shrubland, and Savannah Ecosystems* (Herrick et al., 2017)) on pg. 10 are to be as follows:

Frequency	Activity
Continuously	• Practice proper technique. • Maintain data organization. • Document errors. • Keep the ecological context in mind. • Solicit expert advice if needed. • Back up your data. Acceptance/rejection criteria: All indicators: if measures are found to be missing, unreadable, or deemed outside of the realm of the possible and thus likely to be a typographical error, this will constitute an error requiring returning to the plot. If a piece of equipment appears to stop working or returns data that is deemed outside of the realm of the possible, it will be replaced, or the data expected from the equipment will be omitted. 1) Indicators for impairment goal (*E. coli)*: per Section B4 Analytic Methods. Additionally: On any given day, if any of these quality control parameters fail, the data will be rejected until the QC controls are corrected. 2) Indicators for vegetation cover conditions - remote sensing measures: if measures are found to be more than 25% different than the field measures, calibration efforts will be made, and change analysis will be redone after calibration. If calibration cannot bring the measures to within 25% of the field measured change analysis, alternative remote sensing data sources (including Landsat) will be examined for compliance with these protocols, and if none found, field measures will govern for assessment. 3) Indicators for flow and channel dynamics goal of hydrologic peak and volume: the SSURGO soil data inputs into the hydrologic modeling shall be used unless they differ from the field data collected for indicators #4 by 25%, in which case we shall substitute the field collected data. 4) Indicators for ecological history (decreasing soil moisture) conditions goal: if the soil measures (pits and stability) differ to the SSURGO data by more than 25%, expert advice will be solicited (Project Manager and Dr. King). If the findings are deemed to be

	unlikely, additional pits and stability tests will be conducted near the region per the expert advice. 5) Social context conditions goal measures – level of information, certainty and planning to achieve large watershed management potential: if additional information or assessment will be required and is possible and realistic to obtain to facilitate planning, it will be conducted.
Daily	Review data sheets for completeness and correctness. • If quality control procedures are incomplete, they will be completed • If errors are found, return to the plot to collect the correct data. • Upload and name photos. • Identify unknown plant species. • Back up your data after corrections have been made.
Weekly	• Review data for completeness and errors with an ecosystem expert or team leader. • Identify any remaining unknown plant species. • Back up your data.
Monthly and upon change to a new ecosystem	• Calibrate data gatherers for each method in the protocol. • Review data for completeness and errors with an ecosystem expert or team leader. • Back up your data.

B6. Instrument/Equipment Testing, Inspection and Maintenance

The primary equipment which will be inspected, tested, and could potentially require maintenance are included in the below list. Student assistants under the supervision of the Project Coordinator/Project Lead or the Biological Field Team Supervisor will conduct the work.

1. Teledyne Glacier Portable Refrigerated Sampler, used to measure *E. coli* load and water quality-turbidity, with the capability to store refrigerated samples until collection: This equipment will be inspected and tested prior to placement in the field and maintained in accordance with the directions provided by the manufacturer.
2. Flow Stage Monitoring "well", includes a pressure transducer, using a HOBO 30-Foot depth water level data logger, hung in a protective well casing, and mounted at the level of channel bed. Also includes a pressure sensor outside the "well" for calculation of flow stage (height): This equipment will be inspected and tested prior to placement in the field and maintained in accordance with the directions provided by the manufacturer.
3. Wildlife camera as a check for stage: This equipment will be inspected and tested prior to placement in the field and maintained in accordance with the directions provided by the manufacturer.
4. Immersible Data Logger/ TROD, consists of a self-contained data logger and four thermistors located at multiple depths in a vertical profile. To measure inflation rate and the heat of the soil surface at the time of infiltration: This equipment will be inspected and tested prior to placement in the field and maintained in accordance with the directions provided by the manufacturer.

5. Soil moisture probes and data loggers: This equipment will be inspected and tested prior to placement in the field and maintained in accordance with the directions provided by the manufacturer.
6. Wildlife camera as a check for stage.
7. The Turner Designs Aquaflow turbidometer will be checked for uniform function at least monthly by running turbidity standards. If standards differ by more than 10%, the system will be re-calibrated.

The GPS location equipment will be inspected and tested prior to placement in the field and maintained in accordance with the directions provided by the manufacturer.

B7. Instrument/Equipment Calibration and Frequency

It should be possible to show that all data was collected with monitoring devices that can be shown to have been properly calibrated. For this project, specific calibration requirements apply to below list. Documentation of calibration and verification will be maintained by student assistants under the supervision of the Project Coordinator/Project Lead or the Biological Field Team Supervisor.

The primary equipment which will be inspected, tested, and could potentially require maintenance are included in the below list. Student assistants under the supervision of the Project Coordinator/Project Lead or the Biological Field Team Supervisor will conduct the work.

1. Teledyne Glacier Portable Refrigerated Sampler, used to measure *E. coli* load and water quality-turbidity with the capability to store refrigerated samples until collection: This equipment will be calibrated in accordance with the directions provided by the manufacturer before deployment and after retrieval, as described in this location: https://www.teledyneisco.com/en-us/waterandwastewater/Sampler%20Documents/Manuals/Glacier%20Refrigerated%20Sampler%20User%20Manual.pdf
2. Flow Stage Monitoring "well", includes a pressure transducer, using a HOBO 30-Foot depth water level data logger, hung in a protective well casing, and mounted at the level of channel bed. Also includes a pressure sensor outside the "well" for calculation of flow stage (height): This equipment will be calibrated in accordance with the directions provided by the manufacturer before deployment and after retrieval, as described in this location: https://www.onsetcomp.com/products/data-loggers/u20-001-01
3. Wildlife camera as a check for stage: This equipment will be inspected and tested before deployment and after retrieval and maintained in accordance with the directions provided by the manufacturer, as described in this location: https://www.manualslib.com/products/Day6-Plotwatcher-Pro-Game-Surveillance-System-3612470.html
4. Immersible Data Logger/ TROD, consists of a self-contained data logger and four thermistors located at multiple depths in a vertical profile. To measure inflation rate and the heat of the soil surface at the time of infiltration: This equipment will be calibrated in accordance with the directions provided by the manufacturer before deployment and after retrieval, as described in this location: https://alphamach.com/faq/
5. Soil moisture probes and data loggers: This equipment will be calibrated in accordance with the directions provided by the manufacturer before deployment and after retrieval, as described in this location: https://www.campbellsci.com/cs655

6. Turner Designs Aquaflow turbidometer will be calibrated to begin the work, then as needed or monthly, whichever comes first.
7. The GPS location equipment: This equipment will be calibrated in accordance with the directions provided by the manufacturer before deployment and after retrieval, as described in this location: https://geospatial.trimble.com/products-and-solutions/geo-7x#product-downloads

B8. Inspection/Acceptance for Supplies and Consumables

Reagents will only be used within their expiration dates, and in the microbiological analyses, the reagents ready for use will be refrigerated and made fresh as appropriate.

B9. Non-Direct Measurements

Data from a weather station that will be installed and maintained by the Doña Ana County Flood Commission (DACFC) at the site location will further allow us to calibrate our hydrologic modeling and assess the flow and infiltration dynamics. The installing, handling, maintenance, and calibration of the equipment undergoes an internal DACFC QAQC process, as well as the data is uploaded to an online location in real time, and that process undergoes a QAQC process by the online provider, OneRain. The data will be accessible at this location: https://weather.donaanacounty.org/.

For our hypothesis that the reduction in hydrologic energy will reduce the site erosion by 20%, our measures will utilize the high resolution Doña Ana County (DAC) DEMs and LiDAR provided by the Doña Ana County Flood Commission (DACFC), and compare preceding and upcoming periods. DACFC is contributing high resolution aerial photography and LiDAR that meets the USGS QL2 standard for the 134 square mile Rincon Arroyo watershed (herein called “DAC data”). The DACFC has been developing a comprehensive collection of data sets using aerial photography and LiDAR since 2004. Each data set provides a snapshot of this area that will be compared to other data sets to see erosional changes that will be tied to previously-modeled hydrologic events of different energies. We predict that the 0.5’ horizontal resolution of the DAC data will provide enough density to accurately predict the ground elevation (see specifications below from the metadata), and thus ground elevation changes over time. We will test the need for calibration and determine the confidence levels of the DAC LiDAR data by comparing areas unlikely to have been affected by flow with data from a DACFC PPK set-up on a drone platform, which is a higher resolution LiDAR system (herein called “DACFC PPK data”). The system uses a Quanergy M8 Ultra sensor, with the following specifications: Wavelength: 905 nm; Maximum range: 200 m; Range accuracy: < 3 cm; Returns 3; and Detection layers: 8. If the DAC data measures the ground level with 80% accuracy as compared to the DACFC PPK data, we will proceed with the DAC data for our analysis, if below 80% accuracy, we will use the finer-scale DACFC drone and capture base and annual changes in a representative selection of the practices.

B10. Data Management

New Mexico Water Resources Research Institute (NM WRRI) will be responsible for data management. All data will be converted to electronic format, stored and backed up by NMWRRI. Computer hard drives are backed up continuously to an online repository, and daily on external hard drives (for redundancy). Hard copies of field sheets will be maintained in a project binder organized by assessment and date and stored in a key protected filing cabinet in the office of NMWRRI. Data will be sent to the SWQB Project Officer by the end of each field season, which typically ends by the end of December, by NMWRRI, typically by the end of January. Upon receiving data, the SWQB Project will store data on SWQB network drive. The SWQB network drive is backed up daily and maintained by the NMED Office of Information Technology. Electronic data files will be stored on the SWQB network drive in accordance with 1.21.2 NMAC, *Retention and Disposition of Public Records.*

Group C: Assessment and Oversight

C1. Assessment and Response Actions

The Project Officer will provide project oversight by periodically assisting with and/or reviewing data collection efforts. A review of the baseline data collection and monitoring efforts by the SWQB Project Officer will take place at the end of each monitoring season. The SWQB Project Officer will assess project progress to ensure the QAPP is being implemented, including periodic audits by the QAO, as needed. Any problems encountered during the course of this project will be immediately reported to the SWQB Project Officer who will consult with appropriate individuals to determine appropriate action. Should the corrective action impact the project or data quality, the SWQB Project Officer will alert the QAO. If it is discovered that monitoring methodologies must deviate from the approved QAPP, a revised QAPP must be approved before work can be continued. All problems and adjustments to the project plan will be documented in the project file and included in the final report.

C2. Reports to Management

Annual reports will be submitted by the NMWRRI to the SWQB Project Officer and will include progress of project and any available data. Printouts, status reports or special reports for SWQB or EPA will be prepared upon request. The final report will be submitted to the SWQB Project Officer by the completion of the project, 4/30/2025. The SWQB Project Officer will be responsible for submitting the final project deliverables to EPA through their Grants Reporting Tracking System.

Group D: Data Validation and Usability

D1. Data Review, Verification and Validation

Data will be reviewed by the Field Team Supervisor for erroneous data, incomplete data and transcription errors prior to demobilization from the field site. Data will be considered usable if the requirements of this QAPP were followed and the data is within acceptable range limits as defined under this QAPP. Data that appears incomplete or questionable for the parameter will be flagged for review. Flagged data will be discussed with the Project Manager to determine the potential cause and usability, and if indicating an issue not previously anticipated, also discussed with the Steering Committee to determine management triggers and updated to the SWQB Project Officer. If a reasonable justification for use of the data cannot be attained, those data will be not used in analysis and implementation of activities listed under this QAPP unless the data can be recollected and assessed for usability.

D2. Validation and Verification Methods

The NMWRRI will ensure that valid and representative data are acquired by ensuring DQI methodologies identified in the Quality Objectives and Criteria for Measurements (Section A7) of this QAPP are followed. The sample collection procedures are utilized in accordance with the Sampling Method Section (Section B2) in conjunction with the Quality Control procedures and acceptance/rejection criteria as stated in the Quality Control Section (B5) for all data collected (direct or non-direct) and used in environmental decision making. The NMWRRI verification and validation (V&V) of data will occur after every field season by the Field Team Supervisor. The Field Team Supervisor will verify data by data type, sample date, and sample location. Data will be considered validated and usable if procedures in this QAPP were followed, with no questionable data found during the verification process. In the event questionable data are found, the Project Manager will be notified and will consult appropriate personnel to determine the validity of the data. Results of the verification and validation process will be included in the final reports.

D3. Reconciliation with User Requirements

The user requirement is a restatement of the data quality objective: The quality of the data will be adequate to provide a high level of confidence in determining whether the Rincon Arroyo Watershed Stabilization Project to Reduce E. coli loading to the Rio Grande is meeting the project goals, as stated in the approved scope of work. If the project's results do not meet this requirement, then additional monitoring may be necessary to fill in data, which may include an extension of the monitoring period to measure effects that were not apparent during the project period.

References:

Blasch, K.W., Constantz, J., Stonestrom, D.A., 2007. Thermal methods for investigating ground-water recharge. Professional Paper.

Dane, J.H., Topp, C.G., 2002. Methods of soil analysis, Part 4: Physical methods. Soil Science Society of America, Inc.

Elzinga, C., Salzer, D., Willoughbyh, J., 1998. Measuring and monitoring plant populations. Technical Reference 1730-1 BLM. RS/ST-98/005+ 1730 (5.1 MB), Bureau of Land Management. Denver, Colorado

Fawcett, S., Sistla, S., Dacosta-Calheiros, M., Kahraman, A., Reznicek, A.A., Rosenberg, R., von Wettberg, E.J., 2019. Tracking microhabitat temperature variation with iButton data loggers. Applications in plant sciences 7, e01237.

Herrick, J.E., Van Zee, J.W., McCord, S.E., Courtright, E.M., Karl, J.W., Burkett, L.M., 2017. Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Quick Start. Volume II: Design, supplementary methods and interpretation, Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Core Methods. Volume II: Design, supplementary methods and interpretation. USDA - ARS Jornada Experimental Range, Las Cruces, New Mexico.

Jensen, J.R., 2005. Introductory digital image processing: a remote sensing perspective (3rd edition). Prentice Hall, Upper Saddle River, NJ, USA.

Lu, D., Mausel, P., Brondizio, E., Moran, E., 2004. Change detection techniques. Int. J. Remote Sens. 25, 2365-2401.

Lyon, J.G., Yuan, D., Lunetta, R.S., Elvidge, C.D., 1998. A change detection experiment using vegetation indices. Photogramm. Eng. Remote Sensing 64, 143-150.

Moore, S.J., 2007. Streamflow, infiltration, and recharge in Arroyo Hondo, New Mexico: Chapter F in Ground-water recharge in the arid and semiarid southwestern United States (Professional Paper 1703). US Geological Survey.

Naranjo, R.C., Turcotte, R., 2015. A new temperature profiling probe for investigating groundwater-surface water interaction. Water Resoure. Res. 51, 7790-7797.

Pellant, M., Shaver, P., Pyke, D., Herrick, J., 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. US Department of the Interior, Bureau of Land Management, National Science and Technology Center,, Denver, CO, USA.

Planet Labs Inc., 2020. Planet Imagery Product Specifications. https://assets.planet.com/docs/Planet_Combined_Imagery_Product_Specs_letter_screen.pdf.

Planet Team, 2017. Planet Application Program Interface, Space for Life on Earth. Planet Team, San Francisco, CA, USA.

Stacey, P.B., Jones, A.L., Catlin, J.C., Duff, D.A., Stevens, L.E., Gourley, C., 2006. User's Guide for the Rapid Assessment of the Functional Condition of Stream-Riparian Ecosystems in the American Southwest. Wild Utah Project.

Stonestrom, D.A., Constantz, J., 2003. Heat as a tool for studying the movement of ground water near streams. US Department of the Interior, US Geological Survey.

Striggow, B., France, D., Lewis, B., 2013. Design and installation of monitoring wells. U. S. Environmental Protection Agency, Science and Ecosystem Support Division. Athens, Georgia.

US Army Corps of Engineers (USACE), 2020. Hydrologic Engineering Center. https://www.hec.usace.army.mil/software/default.aspx (accessed 10/19/2020).

USDA NRCS, 2004. Part 630 Hydrology: Chapter 10 Estimation of Direct Runoff from Storm Rainfall, National Engineering Handbook. Natural Resources Conversation Services, US Department of Agriculture, Washington, DC, USA.

USDA NRCS Soil Survey Staff. Web soil survey. https://websoilsurvey.nrcs.usda.gov/. Accessed 3/2/2018.

Acknowledgement Statement

New Mexico Environment Department Surface Water Quality Bureau

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Rincon Arroyo Watershed Stabilization Project to Reduce E. coli loading to the Rio Grande
Quality Assurance Project Plan Acknowledgement Statement

This is to acknowledge that I have received a copy (in hard copy or electronic format) of the Quality Assurance Project Plan for "Rincon Arroyo Watershed Stabilization Project to Reduce E. coli loading to the Rio Grande".

As indicated by my signature below, I understand and acknowledge that it is my responsibility to read, understand, become familiar with and comply with the information provided in the document to the best of my ability.

If I am in a supervisory or training role, I understand and acknowledge that it is my responsibility to ensure that those I supervise or train comply with the information provided in the document to the best of my ability.

____
Signature

____
Name (Please Print)

____
Date
Return to SWQB QAO Miguel Montoya