GROUP A. PROJECT MANAGEMENT

A.1 Title and Approval Sheet

Quality Assurance Project Plan

Managing watershed runoff into the Mesilla Valley

Submitted by:
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New Mexico Environment Department

Surface Water Quality Bureau

APPROVAL SIGNATURES

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A.2 Table of Contents

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Acronyms

AMT	Above mean terrain
AT	Aerial Triangulation
ATV	All-terrain vehicle
AU	Assessment Unit
BHI	Bohannan-Huston, Inc.
BLM	Bureau of Land Management
Blvd	Boulevard
C	Celsius degree
CFU	Colony Forming Units
CLC	City of Las Cruces
cm	centimeter
DAC	Dona Ana County
DACFC	Dona Ana County Flood Commission
DEM	Digital Elevation Model
DOC	document
Dr	Drive
DQO	Data Quality Objectives
EBID	Elephant Butte Irrigation District
EPA	Environmental Protection Agency
FNU	Formazin Nephelometric Units
GIS	Geographic Information System
GSD	Ground Sample Distance
EC	Electrical Conductivity
ESRI	Environmental Systems Research Institute
GI	Green Infrastructure
GCP	Ground Control Points
GPS	Global Positioning System
HDNP	High Desert Native Plants
HUC	Hydrologic Unit Code
IMU	Inertial Measurement Unit
LiDAR	Light Detection and Ranging
LRG	Lower Rio Grande
M	meter
mL	milliliter
mTEC	Modified membrane-Thermotolerant *Escherichia coli* Agar
MST	Mountain Standard Time
NAVD88	North American Datum of 1988
NDVI	Normalized Difference Vegetation Index
NEPA	National Environmental Policy Act
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMSU	New Mexico State University
NM WRRI	New Mexico Water Resources Research Institute
NPS	non-point source
NPS	Nominal Pulse Space

NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Units
ORD	One Rock Dams
PLSS	Public Land Survey System
PdNWC	Paseo Del Norte Watershed Council
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QPR	Quarterly Progress Report
RGBI	Red, Green, Blue, InfraRed Color
SOP	Standard Operating Procedures
SSURGO	Soil Survey Geographic Database
SUA	Special Use Airspace
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
UCE	UltraCam Eagle
US	United States
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UTV	Utility Task Vehicle
WBP	Watershed Based Plan

A.3 Distribution List

Table 1. 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 the Project Manager. The Project Manager will distribute to all other project personnel listed in Table 1. All members of the distribution list who do not have signature authority to approve this QAPP 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.

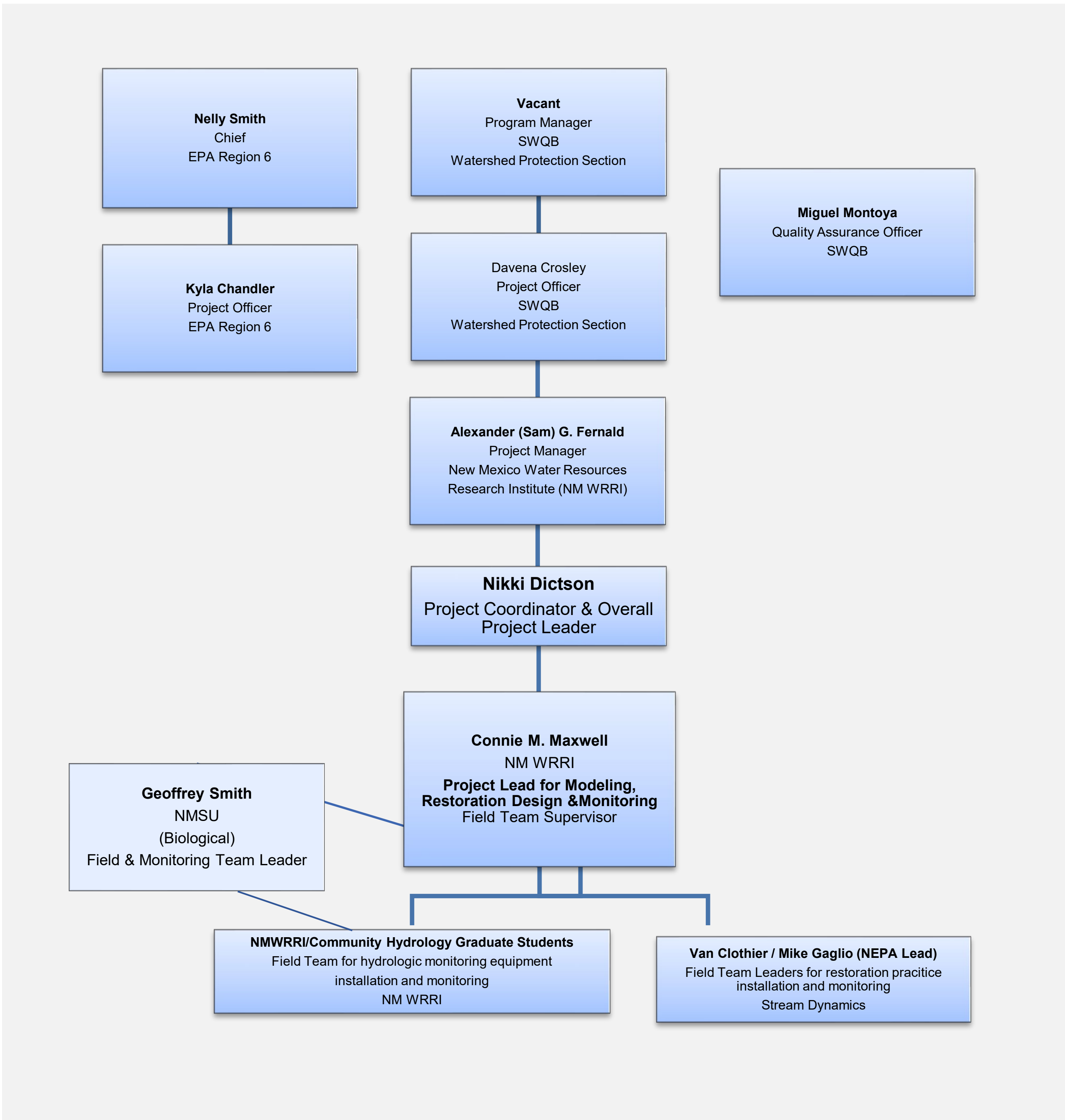
Table 1. Distribution list, Project Roles, and Responsibilities

Name	Organization	Title/Role	Responsibility	Contact Information
Vacant	SWQB	Program Manager	Reviewing and approving QAPP, managing project personnel and resources	
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	NM Water Resources Research Institute	NM WRRI Project Manager	Project oversight, data management, and submittal of quarterly reports	575-646-4337 afernald@nmsu.edu
Nikki Dictson	Contractor	Project Coordinator and Overall Project Leader	Project Coordinator, field supervision, data collection, reporting	979-575-4424 ndictson@gmail.com
Connie M. Maxwell	NMWRRI	Project Leader for Modeling, Restoration Design, & Monitoring	Restoration and monitoring design for paired watershed study, Field coordination, monitoring, data collection, record keeping, & reports	575-740-1099 alamosa@nmsu.edu
Mike Gaglio	Contractor	Field Team Lead for NEPA, Restoration & Monitoring	Field monitoring, data collection, Restoration design and installation, NEPA	915-490-8601 mike@highdesertnativeplants.com
Van Clothier	Contractor	Field Team Lead for Restoration & Monitoring	Restoration design and installation	575-590-0549 Van@streamdynamics.us
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 & 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 2019) 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 “Managing watershed runoff into the Mesilla Valley” referred to in this document as the “Project.”

Figure 1. Organization Chart



A.5 Problem Definition/Background

The purpose of this project is to reduce sediment and *Escherichia coli* (*E. coli*) bacteria loading to the Rio Grande through the implementation of watershed restoration practices. The project that this Quality Assurance Project Plan (QAPP) refers to is "Managing watershed runoff into the Mesilla Valley," also known as the "Mesilla Valley Project." The Mesilla Valley Project is being managed by the New Mexico Water Resources Research Institute (NM WRRI) at New Mexico State University.

Background

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 (NPS) pollutant *E. coli* bacteria. 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 pollutant. The Watershed Based Plan (WBP) by the Paso del Norte Watershed Council (PdNWC) states that the largest source of *E. coli* to the impaired stretches of the Rio Grande in the Hatch and Mesilla Valleys is from watershed range sources, with 41% from livestock and wildlife sources (other than waterfowl) measured from four representative sites in the region (PdNWC WBP 2014, p. 19). The New Mexico Water Quality Standard for E. coli in the El Paso-Las Cruces Watershed is 410 coliform forming units per 100 milliliters (cfu/100 mL) in a single sample while for multiple samples a monthly geometric mean of 126 cfu/100 mL is used (20.6.4 NMAC 2012) (PdNWC WBP 2014, page 2).

The 2022-2024 State of New Mexico Clean Water Act §303(d)/§305(b) Integrated Report and the included Integrated List for assessment unit NM-2101_01 Rio Grande (Anthony Bridge to NM192 bridge W of Mesquite) is non supporting for its Primary Contact designated use because of *E. coli* (NMED/SWQB, 2022, p245), by exceeding the attainment standards for *E. coli*. Assessment Unit NM-2101-03, Rio Grande (NM192 bridge W of Mesquite to Picacho Bridge) is Fully Supporting attainment for all designated uses and parameters (NMED/SWQB 2022, p246). But this change is only present in the most recent CWA Integrated Report, as previous CWA Integrated Reports all showed AU NM-2101_03 as non-supporting for E. coli (NMED/SWQB, 2018, p242). A Total Maximum Daily Load (TMDL) for *E. coli* in this river reach was approved in 2007. Furthermore, the WBP states: *All the data confirm that the reach of the Rio Grande from the international boundary with Mexico to Picacho Bridge is impaired although this appears confined to the bottom assessment unit (International Boundary with Mexico to Anthony Bridge)* (PdNWC 2014). Based upon the 2007 NMED TMDL document (as summarized in the PdNWC WBP 2014) the average load for a mid-range flow from this impaired reach was 6.29x10^12 cfu/day.

The following sections detail the impairment and the conditions that contribute to impairment:

1. Impairment: The largest source of *E. coli* 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).

2. Watershed natural structure – vegetation cover conditions contributing to impairment: The condition of the watershed natural structure, particularly percent vegetation cover influences nonpoint source pollution (NPS). A high percent of vegetation cover conditions results 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 (a quantitative analysis using normalized difference Vegetation Index (NDVI) will be provided in this study), including roads that do not have infrastructure to manage the flow, increase flow energy, and result in significant transport and erosion. Locals 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 for the paired watershed study location, "the Butler Cothern Subbasins".

3. Flow and channel dynamics conditions contributing to impairment – high energy "flashy" flood dynamics, which also result in erosion and sediment transport: 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 has 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 – The 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 across the Hatch and Mesilla Valleys. Predictive modeling approaches that quantitatively link structure to processes which achieve ecological and social benefits are needed to increase the rate of restoration success in drylands (James *et al.* 2013). This project will provide information critically needed by the stakeholders as to the efficacy and benefits of the practices to increase adoption of practices.

The South-Central New Mexico Stormwater Management Coalition is a large group of stakeholders interested in water quality concerns in the Project area. The Stormwater Coalition has identified that watershed restoration is a critical priority throughout the Hatch and Mesilla Valleys because sediment transport leads to clogging of downstream riparian areas and agricultural infrastructure and increasing the occurrence of flooding. Other stakeholders in the Mesilla Valley project include the City of Las Cruces, Elephant Butte Irrigation District (EBID), and the Master Watershed Conservationist Program.

For this project, stakeholder input yielded concerns and commitments to address watershed health conditions by implementing watershed restoration and green infrastructure practices at four separate sites within the Assessment Unit watersheds.

The Stormwater Coalition has chosen the Butler & Cothern & Subbasins as a priority project, and the City of Las Cruces has chosen the Sandhill Arroyo and Salopek Boulevard projects as priorities. Upstream from the Salopek Boulevard project, the Tortugas Emergency Dam Overflow restoration project was chosen as a priority because it will demonstrate the connectivity between two different land uses and provide an educational opportunity with the Master Watershed Conservationists Program.

The restoration approach to be used on each site involves the principle of slowing and spreading peak flood flows to settle out sediment which serves as a source of *E. coli* (Fluke et al. 2019). This, in turn, will support increased vegetation cover to further increase infiltration and decrease hydrologic energy. This 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 watershed and subsequently other watersheds in the region. Evaluating the effectiveness of the proposed restoration practices in these projects will help establish the expected benefits of watershed restoration in terms of a quantifiable goal, the reduction of *E. coli*, so that the appropriate restoration practices can be extended throughout the rest of the region.

Objective

The goal of this watershed restoration project is to reduce *E. coli* loads in the lower Rio Grande through the implementation of watershed restoration practices. By reducing the source of *E. coli*, sediment transport, secondary goals (referred to below as Conditions Goals) contributing to watershed health will be achieved. The outcomes to be achieved by the impairment and conditions goals are summarized below:

1) Impairment Goal: We estimate that the restoration approach will reduce the *E. coli* loading from the treated subwatersheds by a minimum factor of 2. 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 Harmel *et al.* 2018), we conservatively predict that we can reduce landscape-derived portion of the loading by a factor of 2.
2) Vegetation cover condition goal: Increase the vegetation cover by a range of 5-10% from the additional water supply to floodplain regions of the flows by the end of 2024.
3) Flow and channel dynamics conditions goal: Reduce peak flows from a 10-year 24-hour event by 5-10% by the end of 2024.
4) Ecological history conditions goal: Increase the area of infiltration at the installed interventions by a factor of 2-3.

5) Social context conditions goal: Synthesize the results from goals 1-4 to develop standards that can be used as general indicators for this region to promote widespread adoption of the restoration practices.

A.6 Project/Task Description

Description

The Project will implement watershed restoration practices at four unique sites within the AU watersheds as outlined above. These locations represent various areas of the watershed: uplands, arroyos, constructed flood control structures, and streets. The project consists of vegetation, hydrologic, and bacterial monitoring to assess the efficacy of the restoration in reducing NPS pollution. The characteristics of each site are different; therefore, the practices and monitoring strategies will differ for each site. These details will be outlined in the following sections. This is elaborated in more detail in Group B Data Generation and Acquisition, section B1.

Table 2. Description and Schedule

Task Number	Task Title	Key Person	Planned Start Date	Planned End Date	Completion Benchmark
1	Project Management and Reporting	Sam Fernald	2/3/2022	1/31/2025	QPRs and Final Report Submission
Task 1 Description: To effectively administer, coordinate, and monitor all work performed under this project including technical and financial supervision and preparation of status reports.					
2	Project QAPP Monitoring and Modeling	Maxwell & Dictson	3/1/2022	11/30/2023	Approved QAPP
Task 2 Description: To refine, document, and implement data quality objectives (DQOs) and quality assurance/quality control (QA/QC) activities that ensure data of known and acceptable quality are generated by this project.					
3	Field Assessment / Surveys to complete designs	Van Clothier	4/1/2022	02/31/2024	Survey Report
Task 3 Description: Surveys including Channel geomorphological characteristics will be measured prior to revegetation activities. Specifically, bankfull channel width, depth, cross sectional area, and thalweg and valley slopes will be measured. The geomorphological measurements will be repeated prior to the end of the study to evaluate the effectiveness of revegetation to stabilize the stream banks.					
4	Stakeholder Facilitation / Planning Committee	Nikki Dictson	2/2/2022	1/31/2025	Quarterly Planning Committee Meetings held
Task 4 Description: Coordinate, plan and conduct outreach events including 2 Green Infrastructure workshops and Quarterly Planning Committee Meetings or Field Trips. Conduct Community Meetings for neighbors and to sign up GI at up to 10 homes at Sandhill Arroyo Neighborhood.					

5	Obtain Required Clearances and Permits	Mike Gaglio	3/1/2022	9/30/2024	NEPA reports submitted and Permits and Clearances Received
Task 5 Description: Develop designs for review and approval by NMED, followed by local permitting and clearances to be completed and permits received prior to restoration proceeding.					
6.1	Restoration at EBID Tortugas Emergency Spillway	Van Clothier	5/1/2022	12/31/2023	Installation complete and mapped and contractor work approved by permitting agencies
Task 6.1 Description: Restoration Designs are complete, construction is complete, and data standards are documented at the EBID Emergency Spillway Site.					
6.2	Green Infrastructure Salopek Blvd. Project	Van Clothier	2/1/2023	12/31/2024	Installation complete, tested, and installation standards documented, and contractor work approved by permitting agencies
Task 6.2 Description: Restoration Designs are complete, construction is complete, tested and data standards are documented at the Salopek Blvd. Site.					
6.3	Restoration at Sandhill Arroyo at Lavender Crossing	Van Clothier	02/01/23	12/31/2024	Installation complete, tested, and installation standards documented, and contractor work approved by permitting agencies
Task 6.3 Description: Restoration Designs are complete, construction is complete, tested and data standards are documented at the Sandhill Arroyo above Lavender Crossing Site.					
6.4	Restoration at Butler and Cothern Watersheds	Van Clothier	2/1/2024	12/31/2024	Installation complete, tested, and installation standards documented, and contractor work approved by permitting agencies
Task 6.4 Description: Restoration Designs are complete, construction is complete, tested and data standards are documented at the Butler & Cothern Paired Watersheds.					

7	Monitoring and Assessment	Maxwell & Dictson	3/1/2022	12/31/2024	Equipment installed, tested, and data standards documented
Task 7 Description: Install Monitoring Equipment at all appropriate sites, maintain and download data, conduct Quarterly and Annual Surveys and assess all data for final report.					

Project Area

The project is in southern New Mexico, in the Mesilla Valley around Las Cruces and Doña Ana County. Watershed restoration practices will be implemented at four sites within the Mesilla Valley, all draining into the lower Rio Grande (Figure 2). The first two sites are within the Tortugas Arroyo watershed (HUC 130301020702), where restoration will occur at Elephant Butte Irrigation District's Tortugas Emergency Spillway and on Salopek Road at Salopek/Stull Park. Tortugas Arroyo drains to the Boggy Spur Drain and then into the Park Drain, which eventually drains into the Rio Grande below Highway 189 Bridge south of Vado in HUC 130301020803 and Assessment Unit NM2101-01 (Figure 3). The third restoration location is in Sandhill Arroyo between Lavendar Road and Interstate 25 (HUC 130301020602). This site ends up in a drain that discharges to the Rio Grande in (HUC 130301020704). The fourth location is on the West Mesa of the Mesilla Valley at the Butler and Cothern Watersheds (HUCs 130301020606 and 130301020608). All these locations are within Assessment Unit NM2101-03 Rio Grande (NM192 bridge west of Mesquite to Picacho Bridge).

Figure 2. Project Area Map of Restoration Sites.

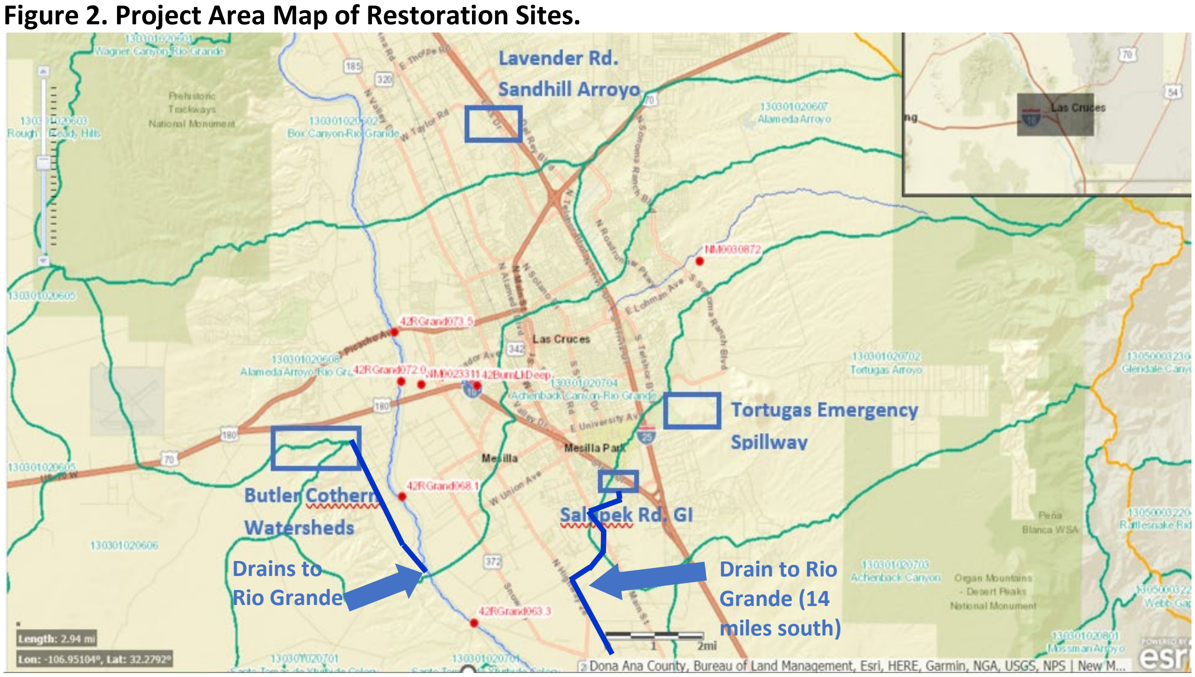
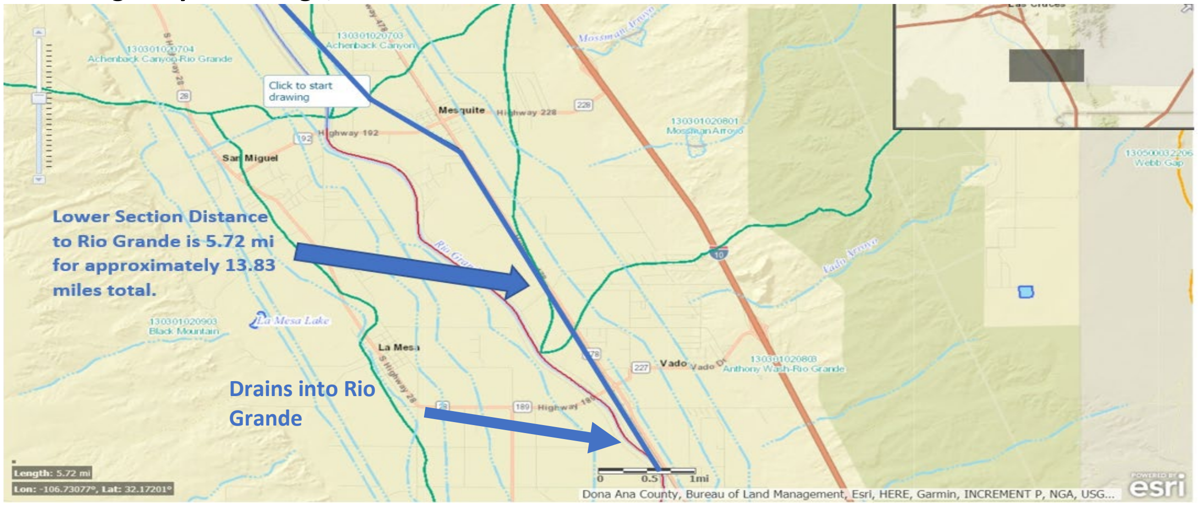


Figure 3. Tortugas Arroyo enters a drain and flows for almost 14 miles then drains into the Rio Grande below Highway 189 Bridge, south of Vado within assessment unit NM 2101-01.



Restoration Activities

Tortugas Arroyo Emergency Spillway Watershed Restoration

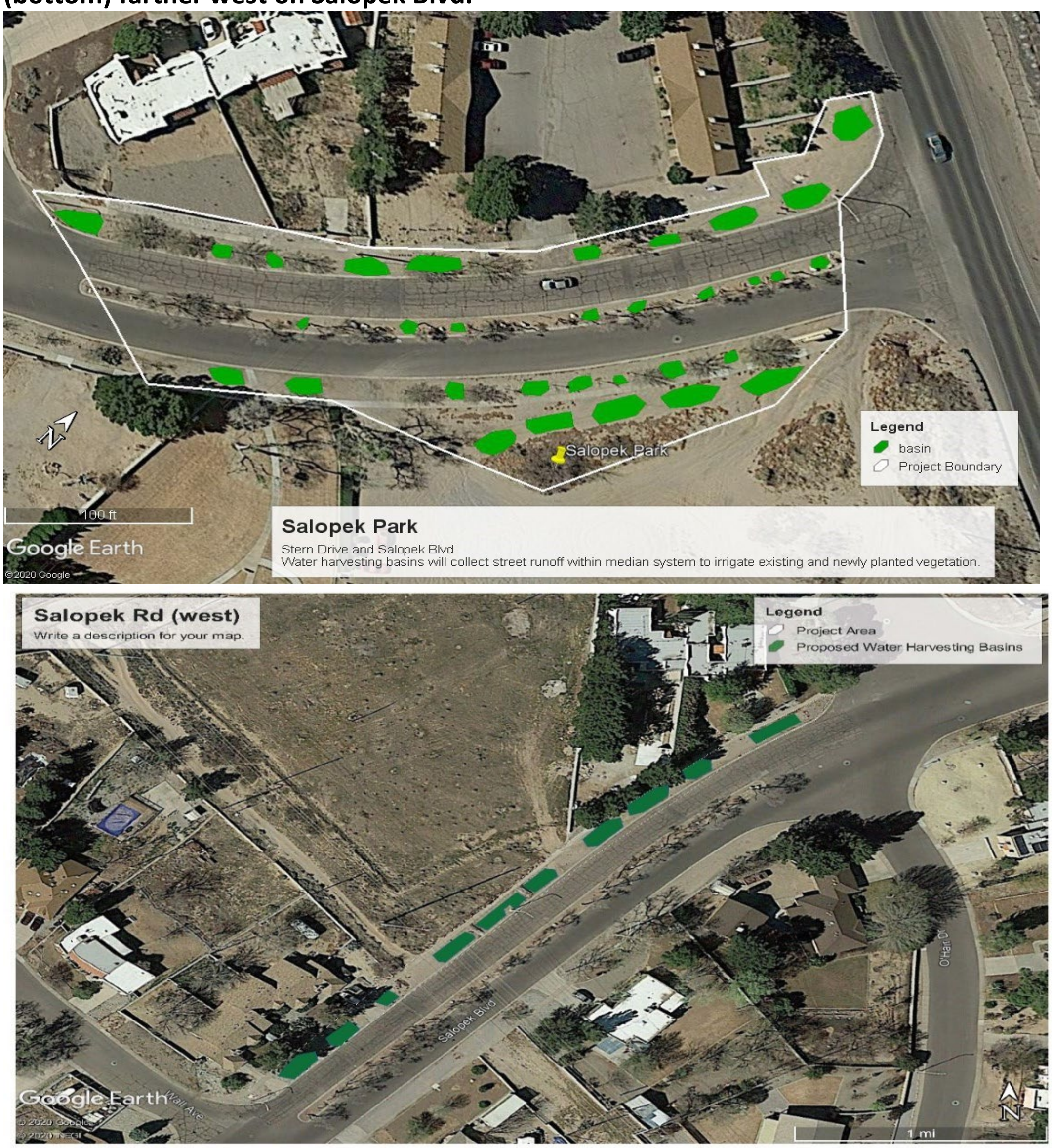
The Elephant Butte Irrigation District (EBID) owns and operates the Tortugas Arroyo Flood Control Structure and Emergency Spillway located just east of the New Mexico State University (NMSU) Golf Course Country Club (Figure 4). The land is owned and managed by EBID, there is a steep gradient and many erosion points along the emergency spillway that has been exacerbated by bicycles, motorcycles, and UTVs riding up and down the hillside. Near the top of the hillside the land is owned by NMSU. The restoration at this site will include practices to slow and spread the water as it moves downhill to reduce erosion in the high gradient drainage arroyos.

Figure 4. Google Earth View of EBID Tortugas Emergency Spillway and Restoration Sites.

Salopek Blvd. Green Infrastructure Project

The green infrastructure project is proposed on Salopek Blvd. at the intersection of Stern Drive, alongside the Tortugas Arroyo, to the intersection of Wall Avenue (Figure 5). The stormwater flows Southwest to the Pecan Orchards, Tortugas Arroyo, ditch, and finally discharges to the Rio Grande River. The green infrastructure and low impact development practices being proposed along Salopek Blvd. and the medians will slow down the stormwater The medians and areas will be revegetated with hearty native vegetation, increasing water capture will assist with watering the new native vegetation, allow more infiltration for aquifer recharge and slow and reduce flows to Tortugas Arroyo allowing sediment and bacteria to settle out. A portion of this water would also be directed into Salopek / Stull Park allowing the water to spread out over the large grassy area at the park, allowing water to slow down through the grass, and increasing infiltration and reducing flows and pollutants from entering Tortugas Arroyo.

Figure 5. Google Earth views of Salopek Blvd. proposed basins at entrance next to park (top) and (bottom) farther west on Salopek Blvd.



Sandhill Arroyo

The green infrastructure and arroyo restoration project is located in Sandhill Arroyo from Interstate 25 west to Lavender Drive (Figure 6). The goal is to reduce the low flow and medium flow events with induced meandering, bank stabilization, and water harvesting. Residential water harvesting will be installed in a few properties in the neighborhood to reduce stormwater run off from streets that act as tributaries to the arroyo. The Arroyo has recently been disturbed by a new sewer line replacement project, resulting in the arroyo widening and less vegetation than the google earth map shows. The vegetation had previously narrowed the creek, helped to stabilize the banks and create some sinuosity or bends in this reach. It now has a wide straight path with very little to slow it down resulting in increased velocity and erosion of this reach, which leads to the Lavender Road low water crossing having high sediment loads spread across it with every rainfall event.

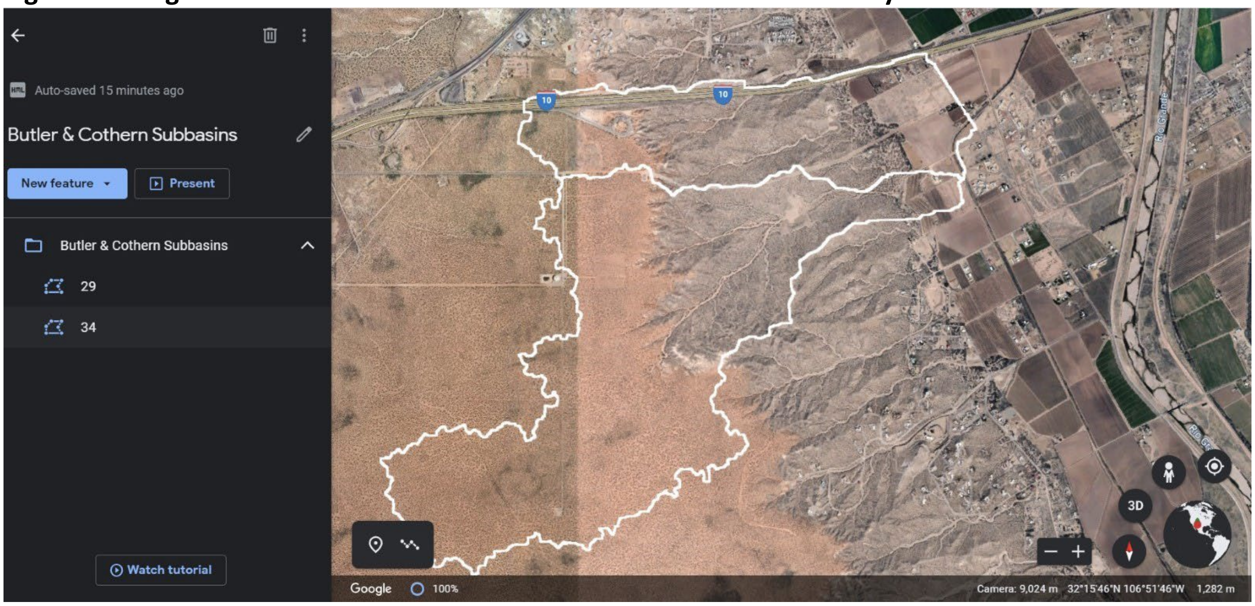
Figure 6. Google Earth view with proposed boundary of the restoration project at Sandhill Arroyo including GI with homeowners.

Butler & Cothern Paired Watershed Study

The Butler & Cothern paired Watersheds as throughout the Hatch and Mesilla Valleys is characterized by arroyos on steep slopes that are headcutting up into the flat mesa terrain (Figure 7). High energy storm water flows scour and transport significant sediment and *E. coli* pollutant sources into agricultural infrastructure, which then outfalls into the Rio Grande.

The paired watershed study involves measuring key parameters and installing watershed monitoring equipment within both sub-basins. Then watershed restoration practices using small-scale erosion control features constructed of natural materials will be installed on approximately 415 acres within the 1,136-acre Cothern sub-basin. The key performance criteria (such as sediment yield and *E. coli* concentrations) of the restoration practices in the Cothern sub-basin will be compared to a 514-acre control sub-basin, the Butler sub-basin. The project area is separated into two Butler sub-basins to be controls and two Cothern sub-basins that will have two restoration approaches. Cothern sub-basin 1 (north) will consist of brush/rock weirs and road restoration only. Cothern sub-basin 2 (south) will have additional contour stone lines and media lunas at the mesa top. Hydrological functions and vegetation changes would be monitored in the restoration and control sub-basins.

Figure 7. Google Earth view of Butler & Cothern Paired Watersheds Study



Restoration Practices and Management Measures

The watershed restoration strategies vary at each location. The following is a summary of the restoration practices or management measures that will be incorporated in the sites.

Management Measure #1: Grade Stabilization Structures, Contour Stone lines or bunds plus Critical Planting

Stone lines combine elements of macro-catchment and micro-catchment technologies depending on runoff collected either from an external catchment or in-field. A stone line is typically 25 cm high and has a base width of 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 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. The recommended spacing between lines is 65’ (20 m) for slopes less than1%, 50’ (15 m) for slopes of 1-2%, up to 100’apart. Where used as road water harvesting, the ends are to be turned upstream approximately 50 cm - 1m to promote slight pooling. The function of these includes vegetation recruitment, soil and sediment are trapped behind the structure, and increase in productivity for managed grazing. Allowing floodwaters to spread across the floodplain would dissipate energy and water from flood events and reduce the potential for structural damage downstream. In addition, water capture would recharge the water table. As a consequence, it would also capture sediments as the water spread out over the floodplain. This may be problematic if areas become filled with sediment, other areas would need to be constructed. Because of the variability associated with flood events, a pilot project was recommended to explore the feasibility of employing these techniques and development of wet meadows utilizing stormwater in the watershed as implementation of the Lower Rio Grande Wetlands Action Plan (2006).

Management Measure #2: Net Wire Diversion (NRCS Practice 362) or Wire and/or Brush Weir

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.

Management Measure #3: Rock or brush weirs / grade stabilization (NRCS Practice 410)

The application in this project is a method of slowing headwater rill flow upstream from arroyos that exhibit erosion and entrenchment, in the branches above the arroyo. The structures are not meant to retain or dam water, as they are permeable, and overflow from larger flows are intended to overtop the structure, requiring the height to remain shallow to prevent the flood flow from increasing energy through waterfalling, similar in function to a one-rock dam. For a range of slope from 0% to 50% (1:2 gradient, 26.57°), the height range is from 8" - 1'-0" on the downslope side. The system is replicated with a similar design, with greater numbers of structures placed with greater apparent downstream erosion. Placement should be from 20'-60' apart of arroyo length, with the closer distance used more frequently, and the longer distances for areas with higher numbers of rock or brush weirs to be placed, lower slopes, and more narrow, lower flow arroyos. The materials are to be commonly collected onsite if this does not compromise the site's ecological integrity. Rock, including sizes between cobbles (2.5") and boulders (10"), and/or debris is collected and used. This practice is also commonly used to capture surface runoff/sheet flow in agricultural applications. Functions include slowing flow, capture sediment and nutrients to support revegetation and increased infiltration. Many rills, cattle trails, small incised arroyos and other linear features that concentrate flow downslope and dry out the rangeland will be treated by hand. This phase of the hand work will be done close to where locally collected rocks are available to build one rock dams in arroyos that have incised. Stream Dynamics will also do minor earthwork with pick and shovel in these vicinities to restore sheet flow to old cattle trails, rills, and other erosional features that are appropriate to do by hand to minimize equipment tracks.

Management Measure #4: One Rock Dams / grade stabilization (NRCS Practice 410)

Low profile on landscape in drainage areas. Per Range Technical Note No. 40 (Maestas et al., 2018): Placement of a one rock dam varies with channel type and morphology. Some key features:• Build to only one rock high (generally no more than a third the height of the bankfull channel)• Build a footer for splash apron on the downstream end that extends far enough (2x the height of the ORD) to intercept water running quickly over the structure in a high flow event.• Fit rocks together tightly, all at the same height, to create a relatively uniform surface on top.• Extend the bankside edges of the structure up the bank a bit to facilitate water going over the structure and not around it. Function includes slowing flows, capture sediment, and supporting vegetation.

Management Measure #5: Rolling Dips and Flat Land Drains

Roads act as catchments for surface runoff. Draining unimproved (*i.e.,* natural surface) roads frequently prevents standing water from accumulating on the road which leads to rutting and erosion. Rolling Dip or Flat Land Drains (similar, variation is based upon slope) road drains will be installed where allowed on along access roads where work activities and topographic conditions allow roads to be drained. This will be done to protect the roads and adjacent areas from erosion during rainstorms that occur from ATV traffic or may occur during and after construction and to protect the roads from damage by our equipment. Rolling Dip Road drains are quickly becoming the standard practice for water harvesting from low standard dirt roads in the greater southwest. A shallow basin is excavated to the side of the roadway and this material is applied to the roadbed itself to create a short grade reversal. Vehicles going down a gradual hill must drive up and over the low and smooth berm to get on down the road. Water does not go uphill, so it is directed onto the basin where it soaks into the ground and grows grass uphill, so it is directed onto the basin where it soaks into the ground and grows grass.

Management Measure #6: Imprinting & Seeding

Areas deemed suitable would be imprinted and seeded with native species. The treatment zones include all surfaces disturbed by access and construction activities within the scope of this Project. Imprinting and seeding are achieved through a single pass with two implements, a Dixon Land Imprinter and a native seed spreader, mounted on an agricultural tractor. In areas not suitable for imprinting seed will be hand broadcast and raked or harrowed into the soil.

Management Measure #7: Cobble Channel Liner

A Cobble Channel Liner is a long, narrow One Rock Dam, much longer than it is wide, built in a recently incised rill or gully bottom and used to armor the bed and/or reconnect bankfull flow with the recently abandoned floodplain.

Management Measure #8: Media Lunas

Media Lunas are made of rock placed on the surface in a crescent shape to spread sheet flow across a broader area. Sheet flow encounters the rock structure, spreads out, slows down, deposits seed and debris, soaks into the soil (contributing to increased soil moisture under the structure), and, once the soil is saturated, sheet flow leaves the structure in a wide fan. Media Lunas and other rock structures are expected to capture soil, debris, and seed and subsequently exhibit increased vegetation from the pre-construction condition. This would be assessed through photo point monitoring. This is a qualitative measure.

Management Measure #9: Zuni Bowl

Bill Zeedyk observed Native American workers on the Zuni Pueblo building headcut control structures that used the principle of the natural cascade or step pool. Rather than spill the water directly over a high fall, the cascade was used to build a series of smaller steps and pools, keeping the velocity within manageable range.

Management Measure #10: Plug & Pond Headcut Control

Small, Hand Built Structures Plug and Pond Headcut control, If the plug is the proper height and it ponds water to an elevation approximately equal to the lip of a headcut, ponding will stop any further upstream migration of the headcut. The reason is that the erosive force of the water is eliminated when the drop-off is flooded. Retention of water in the pond will soak into the ground, growing vegetation is a zone that was previously erosive.

Management Measure #11: Post Vanes

Post Vanes are used in Induced Meandering to protect a bank from erosion, while allowing the opposite bank to erode and inducing the channel to meander, which decreases channel slope, decreases shear stress, increases width and path length, and generally helps the system to reach an equilibrium state quickly.

Management Measure #12: Outreach and Education Activities.

The Planning Committee will develop and deliver Education and Outreach including Community Meetings with neighbors of the four project sites, field trips, training Master Watershed Conservationist Volunteers, 2 GI Workshops, water quality issues and Pet Waste Management. This management measure includes outreach and education to Master Watershed Conservationist Volunteers to assist in installing structures, outreach, and monitoring, as well as outreach and education to the public to help engage stakeholders in understanding and supporting water quality issues and restoration implementation in the watershed. This will include green infrastructure workshops at both Salopek Blvd. and Lavendar Crossing of Sandhill Arroyo Implementation projects conducted by Van Clothier, Mike Gaglio, WRRI staff, and others. Outreach and Education will be targeted to the homeowners next to Sandhill Arroyo about pet waste and stormwater management and we expect to engage up to 10 homeowners to allow green infrastructure and vegetation in their yards to reduce runoff directly from the street to the arroyo.

Management Measure #13: Mulching (NRCS Practice 484)

Mulching means applying plant residues or other suitable materials to the land surface. The purpose is to cover the soil with readily available organic matter. The benefits of this strategy are reduced evaporation and increased soil moisture retention, creation of microhabitats that improve soil health and the soil food web, reduced wind erosion, and reduction of transportation of usable materials to the landfill, just to name a few. Mulch will be used judiciously in all water harvesting features where surface flows are such that transport of mulch is not possible. Mulch will be derived from on-site vegetation or imported from City of Las Cruces mulch supply (a free resource to the citizens of Las Cruces).

Monitoring Location Selection Criteria

Monitoring will be different at each location as the conditions and thus the restoration strategy varies for each location, with monitoring location selection criteria listed below. We choose our monitoring locations at a subset of the areas that will be affected by the practices. For the Butler & Cothern paired watersheds site, two control sub-basins which will not have any restoration practices will also have monitoring installed in order to track the benefits of the practices. At the Butler & Cothern paired Watersheds site, a subset of restoration sites will be chosen as a random sample of locations that are representative of the variability of the site and are reasonably accessible. Other sites will have monitoring installed in specific locations that will be affected by the restoration practices that will be determined as the practices are installed. Monitoring will occur to measure and quantify the indicators of our goals, considerations of monitoring method per location are as follows:

1) Impairment
    a. For sites that are small and at least in part covered by published literature on the estimated effects of best practices on impairment loads, we will use the published literature to estimate effects. The limitations of this approach are when the practices are installed in a series, the effects are likely to be larger than the published estimates.
    b. For the Butler & Cothern paired Watersheds site, which is a larger-scale paired watershed study, the published literature on the estimated effects of best practices on impairment loads do not adequately address this practice approach, thus we will employ Teledyne Iscos to collect water sample for analysis of E. *coli* load to determine the effects. Iscos will measure bacteria and turbidity in storm flows with samplers located at the outlets downstream from the restoration in the Cothern sub-basins and the outlets of the Butler sub-basins, which will be the control with no restoration activities.
2) Vegetation cover
    a. For photo point monitoring, our first criterion for monitoring locations is to be consistent. Generally, we stand downstream of restoration practice and take a photo of structure facing upstream, attempting to capture the banks that are potentially affected by the flow and the restoration structures in the photo. A qualitative assessment is the change in vegetation cover between the before and after photos. Photos would also include anything that would change as a result of flow changing as a result of the structure. As a general rule, photo point monitoring locations would be located about 5' downstream from a one-rock dam, and then adjusted as needed.
3) Flow and channel dynamics
    a. For the larger-scale paired watershed study, the flow dynamics of larger subbasins typically have unique geomorphic and ecological characteristics, and the precipitation dynamics are unique, thus we choose equipment to measure flow and sediment content and precipitation rain gauges.
4) Decreasing soil moisture
    a. Hobo pendants will be used in locations where we expect to get moisture differences and thus increased vegetation dynamics in locations where it is not possible to install

extensive equipment or where remote sensing will not be effective due to overstory canopy.

b. At locations where we can use remote sensing, we will estimate soil moisture changes based on vegetation changes.

5) Social context
   a. This indicator does not have an effect on our monitoring location selection.

The monitoring locations will be related to the final surveys and installation of the restoration practices. The monitoring locations for the Butler & Cothern paired Watersheds project for flow and *E. coli*/turbidity are indicated by the following map (Figure8).

Figure 8. Project Area with Monitoring Locations of Butler and Cothern Subbasins

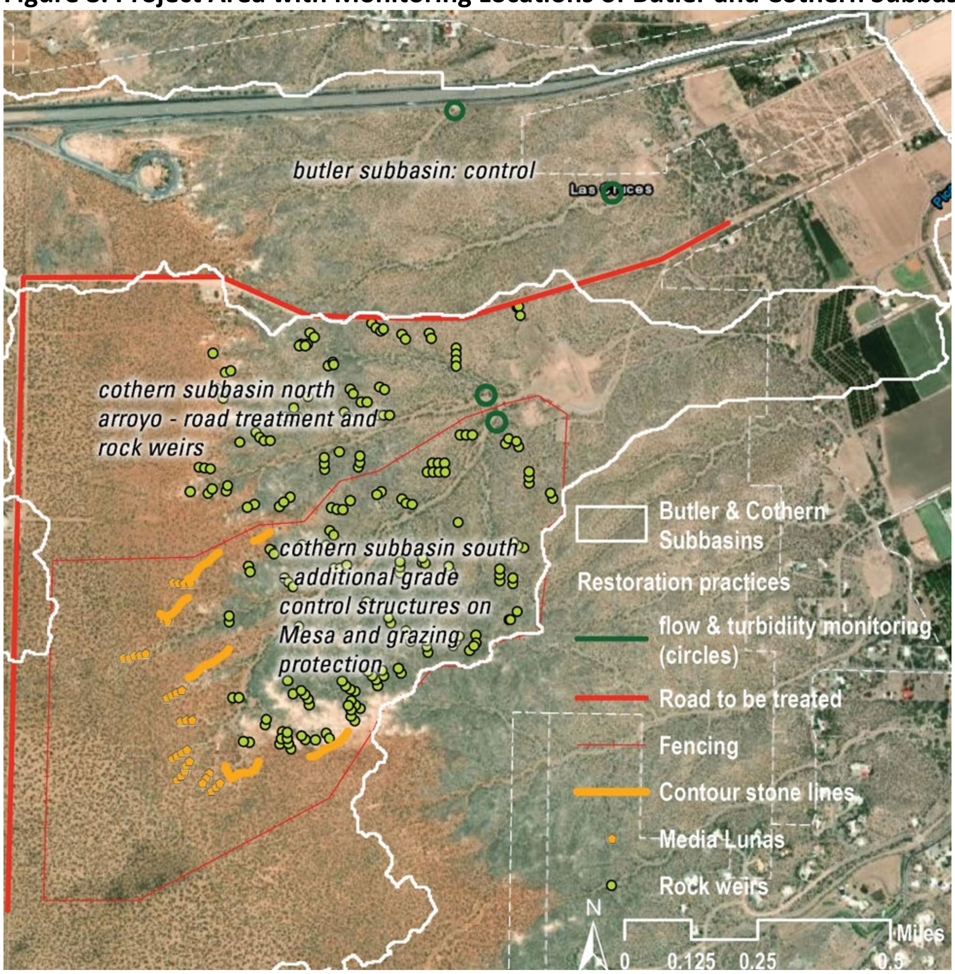


Table 3. Waterbody Attributes for the Project

Monitoring Station ID	WQS Citation	Assessment Unit ID	12-Digit HUC or Latitude and Longitude
RIO-GRANDE-AT-Bridge Near La Mesilla-42RGrand068.1	20.6.4.101	NM-2101-03	130301020608
RIO-GRANDE-AT-Picacho River Gage- 42RGrand072.0	20.6.4.101	NM-2101-03	130301020608

A7. Quality Objectives and Criteria for Measurements

Question/Decision

The baseline data collection and monitoring components of The Mesilla Valley Project are primarily intended to answer the following questions:

1) Will slowing and spreading of flood flow in upland watersheds reduce E. coli loading to impaired reaches of the lower Rio Grande?

Secondarily, but more directly, the data collection and monitoring will answer the following questions, which will suggest that *E. coli* will be reduced:

2) Will watershed restoration practices support an increase in vegetation cover?
3) Will watershed restoration practices reduce erosion by reducing peak flows during storm events?
4) Will watershed restoration practices increase soil moisture?
5) Will watershed restoration practices be adopted in the other parts of the region?

Data Quality Objective (DQO)

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 (Table 4).

Table 4. Data Quality Indicators and Methodologies

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 BLZZRD Sampler for each flood flow and refrigerated until the sample is collected. A signal that the arroyo ran and thus collected samples 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*: The mTEC method precision was found to be 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 photographs to identify precision and guide the remotely sensed data calibration. 3) Flow and channel dynamics and 4) Soil moisture (in applicable locations) 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 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 be calibrated by the flow volumes that are field-recorded and estimate the peak flow rates taking into account slope and surface roughness. 4 (in applicable locations)) Soil moisture – Measured with HOBO Pendant MX Water Temperature Data Loggers as a proxy for moisture. 5) Level of information, certainty and planning to achieve large watershed management potential: quality issues addressed in above indicators.
Bias	For all locations, random selection of similar conditions for the control areas of no interventions will minimize 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.

DQI	Determination Methodologies
	2) Vegetation cover monitoring data: We will compare our results to other sites within the same regional watershed sampled by NM WRRI. 3) Flow and channel dynamics and 4) Soil moisture (in applicable locations): 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. 4) Soil Moisture (in applicable locations): We will compare our results to other sites within the same region sampled by HDNP. 5) Social Context – not measured
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 freshwater samples. Five percent of the *E. coli* colonies observed gave a false negative reaction. 2) Vegetation cover monitoring data: The fine resolution images will serve to validate the accuracy of the remotely sensed data and provide a means of calibration. 3) Flow and channel dynamics and 4) Soil moisture: 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 re-measure 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: 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. Also, the fine scale of the remotely sensed data (3m resolution) will allow greater representation of the diversity of the site conditions.

DQI	Determination Methodologies
	3) Flow and channel dynamics and 4) Soil moisture: 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: 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 remote sensing images will minimize any sampling errors and ensure accuracy and thus comparability. 3) Flow and channel dynamics and 4) Soil moisture: 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: 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) Flow and channel dynamics and 4) Soil moisture: Hydrographs from approximately 3-6 events would likely supply enough variability of flows to determine representative flow dynamics and calibrate our hydrologic models.

DQI	Determination Methodologies
	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: 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* 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 cfu/100 mL, still well within the recreational water limit for *E. coli* (126 cfu/100mL). 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) Flow and channel dynamics and 4) Soil moisture: 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: issues addressed in above indicators.

A.8 Special Training/Certification

This project will be implemented by NMWRRI and its subcontractors who will have the expertise and training to perform procedures identified in SOPs referenced in this QAPP. Data collection and monitoring for this project will be implemented by NMWRRI and its subcontractors with technical assistance and oversight from the SWQB Project Officer. Volunteers will be trained and supervised by NMWRRI and its subcontractors in the field during data collection efforts. The training will be documented to ensure there is a record that individual had been trained in the appropriate field by experienced staff. 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 after submitted by Project Coordinator to the SWQB Project Officer.

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 by the Project Coordinator 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 and Project Coordinator 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 NM WRRI 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). 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 5. Data Records for the Project

Document	Type of Form	Storage Location	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 Cambell Scientific files	Locations E.11, E.12, E.13, H.1, and H.11	NA (file downloaded to laptop)
Infiltration data	Electronic Excel Files and Hobo Pendant 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.1, E.2, E.13, H.1	EPA method 1603 for *E. coli*.
Vegetation and soil monitoring Field sheets	Electronic Remote Sensing .tif files	Locations E.11, E.12, E.13, H.1, and H.11	NA
Photos	Electronic (.jpg)	Locations E.1, E.2, E.13, H.1 and H.11	Photo transection sheet. Located at https://jornada.nmsu.edu/monit-assess/manuals/monitoring https://jornada.nmsu.edu/files/Core_Methods.pdf
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

The 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. 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. 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. Where appropriate, samples will be taken at both the higher and the lower end of the range of elevations. The sampling will occur during rain/flows, typically between the months of July and December.

Our monitoring plan has differences per location as described in section A.6 Monitoring Location Selection Criteria, which are summarized in the Table below. The criterion for the selection of the monitoring approach is outlined in A.6 Project/Task Description, in the section titled "Monitoring Location Criteria". Monitoring locations accessibility will not be a problem due to signed agreements with collaborating agencies (e.g., BLM, WRRI, City of Las Cruces, NMSU, NM State Land Office). If location due become inaccessible due unforeseen circumstances (e.g., flooding) a new location will be chosen that are representative of inaccessible monitoring site.

Table 6. Project Monitoring Specifics

Responsible Party	Monitoring	Site area approach	Location	Frequency
NM WRRI / NMSU Biology Department	*E. coli*, and turbidity	Butler Cothern Subbasins: Iscos	Outlets of subbasins (Figure 3b)	Each flow event, primarily in monsoon season
		All other locations	N/A - analysis from published literature	After installation
NMWRRI or contractor	Vegetation cover	All locations: photo points	At a subset of restoration and control practices	Annually at height of vegetation response
NM WRRI		Butler Cothern Subbasins, Tortugas, and Sandhill arroyo: Remote sensing	The whole site	Annually at height of vegetation response
NMWRRI Contractor	Flow and infiltration	All locations except Butler Cothern Subbasins: channel assessment	At a subset of restoration practices and control locations	
NM WRRI		Butler Cothern Subbasins: measure and model flow volume and velocity, measure precipitation	Outlets of subbasins (Figure 3b)	Each flow event, primarily in monsoon season
NMWRRI Contractor	Soil Moisture	Salopek and Sandhill: measure soil moisture at selected restoration practices and controls	At a subset of restoration practices and control locations	Each flow and control event, primarily in monsoon season
NM WRRI		Butler Cothern Subbasins: measure sediment (turbidity and conductivity) content in flows	Outlets of subbasins (Figure 3b)	Each flow event, primarily in monsoon season

Additional location-specific notes:

Tortugas Arroyo Emergency Spillway Watershed Restoration

Monitoring at this project site will only include photo point monitoring to estimate vegetation percent increase.

Salopek Blvd. Green Infrastructure

Monitoring at this project site will include Photopoint monitoring to estimate vegetation percent increase, and HOBO Pendant MX Water Temperature Data Logger for soil temperatures as a proxy for increased soil moisture.

Sandhill Arroyo above Lavender Road

Monitoring at this project site will include photopoint monitoring to estimate vegetation percent increase and HOBO Pendant MX Water Temperature Data Logger for soil temperatures-as a proxy for increased soil moisture.

1) Sampling design for indicators for impairment Goal (*E. coli*): When flows occur, we will have devices in place prior to the 2024 monsoon season to collect water samples to measure *E. coli* in restoration subbasins and a control arroyo subbasin directly adjacent at the outlet of control and restoration subbasin, using EPA method 1603 for *E. coli* with data of critical interest. We will use a Teledyne BLZZRD Portable Refrigerated Sampler, which collects samples actuated by flood flow, that can collect up to a capacity of 20 liters of flood flow and refrigerates them for up to 48 hours. Additionally, we will use monitoring devices that measure turbidity and conductivity to estimate sediment load. We will then produce quantitative links to vegetative cover (see measure 2) and hydrologic flow (see measure 3) and the estimated sediment to predict extent of treatment required to achieve *E. coli* transport mitigation goals.

2) Sampling design for indicators for vegetation cover conditions: 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 for surface reflectance and orthorectified suitable for analytic and visual applications (Planet Labs Inc., 2020; Planet Team, 2017)) (Figure 4). We will collect cloud free images during the year at the approximate peak vegetation density in the year. For ground truthing, we will use photographs captured from aerial imagery or drone images, which will have better-than-submeter resolution.

The NDVI is a measurement that assesses vegetation by calculating the disparity between near-infrared light (which is strongly reflected by vegetation) and red light (which vegetation absorbs). Its value ranges from -1 to +1, with lower values indicating the absence of vegetation and higher values indicating a significant amount of dense green foliage. With the availability of daily images from Planet data, we can observe vegetation throughout the year across different seasons. 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 9).

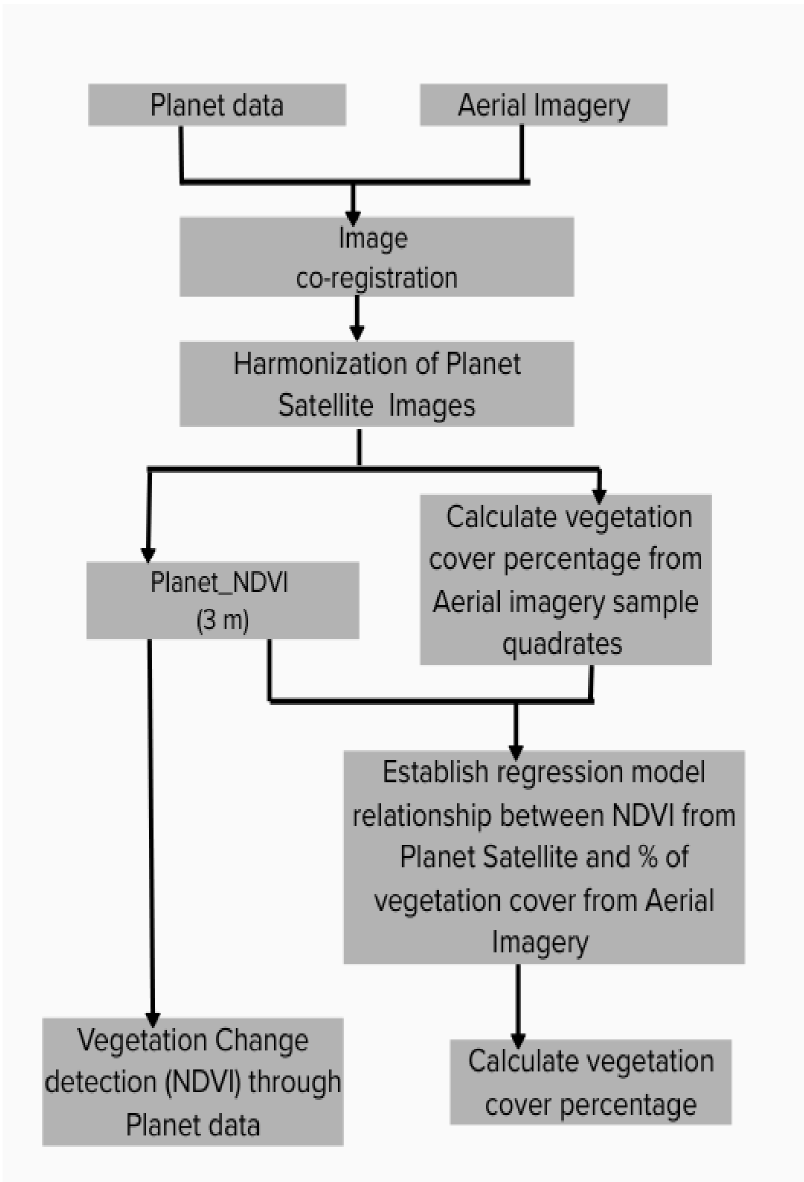


Figure 9. Workflow Diagram for use of Remote Sensing for Monitoring Vegetation Cover

3) Sampling design for indicators for flow and channel dynamics goal of hydrologic peak and volume: The sampling design for flood flow intends to have devices in place by the monsoon season of 2024 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 Leaders. We will measure stage using a Campbell Scientific pressure transducer

which uses a piezoresistive sensor which measures water pressure and stores the data in a logger connected to it. 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 pressure transducer collects data continuously, and the frequency of relevant samples will be dependent upon flood flow and volume, where particularly low flows may be difficult to measure and particularly high flows can be understated due to turbulence in the flows. . We will also validate or calibrate as necessary the flow measures with motion sensor wildlife cameras in the basin outlets. Using these field measures for calibration, we will then conduct hydrologic and hydraulic modeling of the flow and erosion dynamics of the watershed. A compact digital weather station will be established to record the precipitation and temperature.

4) Sampling design for indicators for soil moisture conditions goal - 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 will also be monitoring turbidity and conductivity of water in the outlet of each subbasins. Turbidity is a common surrogate measurement for suspended sediment concentration in aquatic systems. Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Organic compounds like oil, phenol, alcohol, and sugar do not conduct electrical current very well and therefore have a low conductivity when in water. Conductivity is also affected by temperature: the warmer the water, the higher the conductivity. For this reason, conductivity is reported as conductivity at 25 degrees Celsius (25 C).[1]

5) Sampling design for social context condition's goal measures – level of information, certainty and planning to achieve large watershed management potential: To understand the information needed to inform management, we will share our data with our steering committee approximately three times to both identify triggers for management responses or changes and identify needs for formulating and visualizing the data. Sampling designs are also addressed in other indicators above, as this goal is related to the synthesis of information.

B2. Sampling Methods

1) Sampling methods for indicators for impairment goal (*E. coli*): We will measure *E. coli* 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 of 2024. We will use a Teledyne BLZZRD Portable Refrigerated Sampler (collects 5 gallons of flood flow with liquid level sample actuator for automatic collection of water samples and refrigerates them for up to 48 hours).

2) Sampling methods for indicators for vegetation cover conditions: 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

[1] https://www.epa.gov/national-aquatic-resource-surveys/indicators-conductivity

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. The detailed workflow has been shown in Figure 4.

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.

3) Sampling methods for indicators for flow and channel dynamics goal of hydrologic peak and volume: Flow stage will be measured using a Campbell Scientific pressure transducers connected with 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-RAS 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). In the outlet, Campbell product ClimaVUE™50 compact digital weather station will monitor temperature, relative humidity, vapor pressure, baro-metric pressure, wind (speed, gust, and direction), solar radiation, precipitation, and lightning strikes (count and distance).

4) Sampling methods for indicators for soil moisture conditions goal - increasing the connectivity of flood flow to the floodplain: The hydraulic modeling described for sampling method 3) will estimate flood flow connectivity changes at the Bulter Cothern Subbasins location. For measurement of soil transport, we will measure turbidity and conductivity. We will use Turbidity Meters technically known as nephelometers – emit light and measure the amount scattered by particles in the sample. The units depend on the wavelength of the light and the angle of the detector(s)13; the most common units are Nephelometric Turbidity Units (NTU) or Formazin Nephelometric Units (FNU). Another term used for this type of instrument is a turbidimeter. For this study, we will use ClariVUE™10 sensor product of Campbell Scientific. Similarly for conductivity we will use Campbell Scientific product CS547A, which measures electrical conductivity (EC) is measured with three cylindrical stainless-steel electrodes

mounted in an epoxy housing. The electrode configuration eliminates ground loop problems associated with sensors in electrical contact with earth ground.[2]

For the Salopek Blvd and Sandhill Arroyo Restoration project sites, we will measure inundation and soil moisture retention using HOBO Pendant MX Water Temperature Data Logger 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. https://www.onsetcomp.com/products/data-loggers/mx2201

5) Sampling methods for social context condition's 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.

Because there are no plans to collect physical samples for the remaining methods for this project, there are no further handling requirements.

B4. Analytical Methods

This section identifies the procedures to analyze samples, and how good these have to be, (i.e., their performance criteria) to support any decisions to be made with the data.

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 turbidimeter using protocols by Turner Designs, the manufacturer of the Aquafluor system we are using. This is a single sample turbidimeter, 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/research-and-laboratory-safety/rsrch-lab-sub-folder/biosafety-related-training.html), with particular emphasis on sterile technique.

[2] https://www.campbellsci.com/cs547a-l

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. Because there are no plans to collect samples for laboratory analysis, no analytical methods are needed for the other indicators for this project.

B5. Quality Control

The quality control activities for all indicators 1-5 that 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:

Table 7. Quality Control Activities and Frequency

Frequency	Activity
Continuously	• Practice proper technique • Maintain data organization • Document errors • Keep the ecological content in mind • 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.

Frequency	Activity
	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 condition's 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 BLZZRD Portable Refrigerated Sampler, used to measure *E. coli* load and water quality-turbidity, with the capability to automatically collect and 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 campbell scientific pressure transducer connected to a 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. HOBO Pendant MX Water Temperature Data Logger placed at Salopek Blvd and Sandhill Arroyo Restoration project sites.
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. Turbidity meter and conductivity meter from Campbell Scientific will be used and inspected and tested as direction provided by the manufacturer.
8. The Turner Designs Aquaflow turbidimeter 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.
9. 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 the list below. 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 BLZZRD 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/Water_/Sampler%20Documents/Manuals/BLZZRD-Operation-Manual.pdf
2. Flow Stage Monitoring "well", includes a pressure transducer, using a Campbell submersible pressure transducer, 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://s.campbellsci.com/documents/us/manuals/cs451-cs456.pdf
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. Soil Turbidity Meter: This equipment will be inspected and before deployment and after retrieval and maintained in accordance with the directions provided by the manufacturer, as described in this location: https://www.campbellsci.com/turbidity
5. Precipitation Measurement: We will follow the instructions as guided by the company product manual. ClimaVUE50: Compact Digital Weather Sensor (campbellsci.com).
6. 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
7. Turner Designs Aquaflow turbidometer will be calibrated to begin the work, then as needed or monthly, whichever comes first.
8. 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.

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 weather stations that were installed and are 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 measurements 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 for the Mesilla Valley 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. The metadata for the DAC DEMs from the most recent set, 2018 (2014 and 2010 are similar) can be found in Appendix A.

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 November, by NM WRRI, 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 SWQB 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, 1/31/2025. 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 SWQB Project Officer to determine the potential cause and usability. 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 NM WRRI will ensure that valid and representative data are acquired. Verification of field sampling and analytical results will be performed by the NMWRRI and subcontractors in accordance with applicable sections of the SWQB SOP 15.0 for *Data Verification and Validation.* Verification and validation (V&V) of data will occur after every field season using the attached V&V worksheets. In the event questionable data are found, the SWQB Project Officer 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 *Managing watershed runoff into the Mesilla Valley* 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. 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.

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Acknowledgement Statement

New Mexico Environment Department Surface Water Quality Bureau

Managing watershed runoff into the Mesilla Valley

Quality Assurance Project Plan Acknowledgement Statement

This is to acknowledge that I have received a copy (in hard copy or electronic format) of the "Managing watershed runoff into the Mesilla Valley" Quality Assurance Project Plan.

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.

____
Signature or Electronic Signature (e-certified accepted)

____
Name (Please Print)

____
Date

Return to SWQB QAO

Appendix A. Metadata for the DAC DEMs

Appendix B. Verification and Validation Worksheet

Name of Individual Collecting Data:	Type of Data	Collection Date	Verified By (include date):	Validated By (include Date):