Appendix 1. Science & Technology #1751 Proposal

RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Research & Development Office | Science & Technology Program

FY 2017 Proposal Submission Form

DIRECTIONS

1. Review the *S&T FY 2017 Call for Proposals* website at:

   https://sites.google.com/a/usbr.gov/s-t-call/

2. Complete all sections of the form.
3. Save the form.
4. Electronically sign the form. For assistance with electronic signatures, visit the Adobe site.
5. Request signatures via email from your supervisor and, if applicable, the Chief of the Contracting Office or Designee. For assistance with electronic signatures, visit the Adobe site.
6. Email the signed form to **STIMS@usbr.gov** **no later than Midnight of Friday, 24 June 2016.**
7. Check your inbox for a confirmation email (delivered within 72 hours) of your proposal submission.

ADDITIONAL INFORMATION:

The deadline for proposal submits is Midnight on Friday, 24 June 2016.
Submit only one form per research proposal.

If you have questions or need assistance, please email STIMS@usbr.gov and a member of R&D Office will respond within 24 hours.

For technical issues, contact Ronda Dorsey at (303) 445-2624 or *rdorsey@usbr.gov*.

If you are collaborating with other researchers, consider using one of the templates below:

Spreadsheet - *https://drive.google.com/open?id=0B1kG9U-E0F0gSno3VkNKNlR2QjQ*

Document - *https://drive.google.com/open?id=0B1kG9U-E0F0gM2tuTlpZSE9uTGs*

Thank you in advance for submitting your research proposal.

SECTION I - PROJECT INFORMATION

Enter information about the project.

TITLE

The project title should be descriptive enough so that someone not familiar with the project will understand the objective of the work and any location information about where the work is conducted.

Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy during Climate Change

TYPE

*Choose either ST Internally Solicited, ST Internally Brokered, *ST Externally Brokered, *ST Brokered-Essential Research Services, or *Non Research. *Only S&T Staff should select one of these.*

ST Internally Solicited

END DATE

An S&T Project may last from 1-3 years. Select the final fiscal year of the project's implementation.

FY 2017

DESCRIPTION

Enter a short summary of the project that would be appropriate for website posting. This summary should briefly highlight research need, research strategy, expected outcome(s), and partners.

Installation of grade control structures (GCSs) across a landscape is an ancient practice that is increasingly used by land owners and managers for restoration and ecosystem support. Anecdotal evidence and limited research show that GCS installation reduces storm peak flows, decreases sediment transport, and increases base flow. This project will collect surface water flow, soil moisture, precipitation, and sediment transport data pre- and post- installation of GCSs to assess their impacts on local water resources, downstream surface water rights, and sediment transport. Hydrology and sediment transport monitoring is necessary to assess impacts of

TAGS

Provide keywords that would help a search engine find the project. Please limit to five (5) keywords.

The following link provides a listing of previously used tags: https://docs.google.com/a/doi.gov/document/d/1X1wJNzjEHHRB6emy4QzqZEXcSWztHYhWGU9xmgZSjxY/edit?usp=sharing

check dams, sediment control, habitat restoration, habitat connectivity, river restoration, conjunctive use, adaptive management, climate change, flood control, grade control structures, surface water flows, soil moisture, surface water rights, ecosystem services

SECTION II - KEY PERSON: PRINCIPAL INVESTIGATOR (PI)

Enter information about the Principal Investigator (PI).

PI

First Name		Last Name	
Deborah		Tosline	
Email	**Phone**	**Organization**	**Directorate**
dtosline@usbr.gov	623-773-6277	Program Development	

SECTION III - KEY PERSON(S): OTHER RESEARCHERS

Enter information about additional researchers involved in this project. Proposals should include a subject matter expert who will ensure the research is applicable and relevant to a current Reclamation issue.

KEY PERSON #1

First Name	Last Name		
Blair	Greimann		
Email	**Phone**	**Organization**	**Directorate**
bgreimann@usbr.gov	303-445-2563	USBR	Sedimentation and River Hyd
Project Responsibilities			
Technical expert.			
Relevant Expertise			
Sediment and river hydraulics			

KEY PERSON #2

First Name	Last Name		
Jeff	Riley		
Email	**Phone**	**Organization**	**Directorate**
jriley@usbr.gov	623-773-6457	USBR	Design and Construction Bra
Project Responsibilities			
Technical expert.			
Relevant Expertise			
Supervisor PXAO Engineering, provide field staff.			

KEY PERSON #3

First Name	Last Name		
Ken	Vonderscher		
Email	**Phone**	**Organization**	**Directorate**
KennethVonderscher@mail.n	(928) 501-9203	Maricopa County Parks and F	Planning and Development M
Project Responsibilities			
Manages Spur Cross Ranch Conservation Area			
Relevant Expertise			
Landscape Professional and MCPRD staff.			

KEY PERSON #4

First Name	Last Name		
Harry	Cooper		
Email	**Phone**	**Organization**	**Directorate**
harryCooper@mail.maricopa	602.506.2956	Flood Control District of Maric	

Project Responsibilities

Landscape Architecture and Water Conservation Branch Manager

Relevant Expertise

FCDMC seeks to develop water conservation and green infrastructure techniques and understand their effectiveness to improve flood hazard mitigation efforts, reduce sedimentation and erosion, and to improve water resources management.

KEY PERSON #5

First Name	Last Name		
Maggie	Messerschmidt		
Email	**Phone**	**Organization**	**Directorate**
maggie.messerschmidt@tnc.	602-322-6999	The Nature Conservancy	Urban Conservation Program

Project Responsibilities

Technical advisor, develop citizen science programming, liaison for communicating results between TNC and proposal partners and public information sharing.

Relevant Expertise

Establishing green urban infrastructure projects in the Phoenix metropolitan area.

ADDITIONAL KEY PERSON(S)

Include: First & Last Name, Email, Phone, and Organization/Directorate, Project Responsibilities, Relevant Expertise

Dagmar Llewellyn, dllewellyn@usbr.gov, 505-462-3594, USBR, Albuquerque Area Office, Hydrologist, submitting S&T proposal to characterize and model extreme storm events.

Kris Randall, kris_randall@fws.gov, 602-531-2232, US Fish and Wildlife Service, Partners for Fish and Wildlife, Riparian Ecologist working on enhancement of wildlife habitats. State Coordinator. Technical expert, advisor, guidance, review.

Laura Norman PhD, lnorman@usgs.gov, USGS Arizona Water Science Center, Technical expert. 2017, 2018, 2019 Research Physical Scientist working on restoration-site selection and design, assess restoration efforts and predict effects of climate and land-use change. I

Mary Nichols PhD, mary.nichols@ars.usda.gov, 520-647-9062, US Department of Agriculture - Southwest Watershed Research, Research Hydraulic Engineer conducting sediment transport and soil moisture research associated with rock check dams.

David F. Seibert PhD, dseibert@email.arizona.edu, 520-882-8202, Borderlands Restoration, L3C, Ecological restoration integrating erosion control, vegetation, fire, and cultural components on public, private, and Tribal lands.

James Duffield, James.Duffield@nau.edu, 928-380-9478, Hopi Tribe, Hopi Water Resources Program, Hydrogeologist associated with work to install trincheras for habitat and spring restoration.

Ben Ruddell, PhD, PE, bruddell@asu.edu, 480-727-5123, Arizona State University, Senior Sustainability Scientist, Assistant Professor,Technical expert, will contribute and install weather stations.

SECTION IV - PROPOSAL DETAILS

Enter information about details of the proposal.

PRODUCT TYPE

Select either Scoping or Conducting.

Definitions:

Scoping proposals generally contain less information than a conducting proposal and are typically used to support the development of conducting proposals. These projects should not rely on outside entities for funding nor include Acquisitions.

Conducting proposals are complete so as internal Regional reviewers can determine the relevancy and benefit of the work to Reclamation's mission; and where external technical reviewers can determine the technical adequacy of the study design.

Conducting

CONDUCTING TYPE

Choose either: Applied Research, Development, Demonstration and Technology Transfer, or N/A if Scoping.

Definitions:

Applied Research is defined as systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. Generally, Applied Research means that a specific use has been identified for the results.
Development is defined as systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods including design, development, and improvement of prototypes and new processes to meet specific requirements.
Demonstration and Technology Transfer is defined as the introduction of an existing technology, best practice, or method. These projects should have a strong and clear adoption strategy. For Demonstration Projects, the S&T program will fund the data collection and analysis of a research project and will not fund construction. An example is a million dollar or greater project that requires the purchase of equipment or construction. Other sources of funding should be acquired for the construction portion or equipment purchase, while S&T funds the research component, such as data collection and analysis.

Applied Research

INTELLECTUAL PROPERTY

Determine whether the project contains intellectual property.

Select Yes if any of the following conditions apply:

- *There is commercial interest or a high probability of commercialization in the future.*
- *The size of the potential market is large enough to justify the expense of commercialization.*
- *A patent plays a significant role in transferring the technology.*
- *The patent is enforceable if it is granted.*
- *The claims of the invention are sufficient in scope to justify patenting.*
- *The proposal contains a non-federal entity's intellectual property or confidential information, which means trade secrets or commercial or financial information that is privileged or confidential under the meaning of 5 USC 552(b)(4).*
- *Materials are donated by an external entity.*
- *Funding is being transferred from a private entity to improve their intellectual property.*

No, this project does not contain intellectual property.

Research Topics

Select Yes or No for each topic(s) that most closely align(s) with the project's objectives. Choose all that apply.

Environmental Issues for Water Delivery and Management (EN)

- No - Fish Passage and Entrainment EN1
- Yes - Ecosystem Needs EN2
- No - Invasive Species EN3
- Yes - Water Quality EN4
- Yes - Sediment Management and River Restoration EN5

Water and Power Infrastructure Reliability (IR)

- No - Condition Assessment IR1
- No - Repair Maintenance IR2
- No - Improving Geotechnical Infrastructure Reliability IR3
- No - Public Employee Safety IR4
- No - Improved Power Generation IR5

Water Operations Decision Support (DS)

- No - Managing Hydraulic Events DS1
- No - Water Supply Forecasting DS2
- No - Water Operations Models Decision Support Systems DS3
- No - Water Resource Data Analysis DS4

Conserving or Expanding Water Supplies (WS)

- Yes - Groundwater Storage WS1
- No - Desalination Water Treatment WS2
- No - Agriculture Water Supplies WS3
- No - Water Marketing WS4
- No - Supporting Irrigation Districts WS5

Priority Area

Select one priority area that most closely aligns with the project's objectives.

- Climate Change and Variability (CC)

Research Question (limit 1000 characters)

The research question should be short and focused on the issue or problem the research will address. The research question should define the problem and also incorporate a hypothesis about a solution. Short and focused questions demonstrate a consideration of the outcomes as well as a narrowed research project aimed to achieve certain goals within the time frame estimated.

What are the impacts of Grade Control Structures (GCSs) installed in ephemeral drainages on storm flows, local hydrology, soil moisture, and sediment transport and do GCSs reduce sediment deposition in reservoirs, enhance local water resources, reduce stream velocities, support ecosystems and optimize watershed function under climate change?

Land owners and managers of degraded landscapes install GCSs for land and ecosystem restoration however these installations typically do not include hydrologic monitoring. Water managers increasingly include GCSs as adaptation strategies for watershed resource planning. When storm flows are slowed do GCSs "capture flood flows" (ARS 45-141) and infringe on surface water appropriations? Anecdotal evidence indicates increases in local water resources following installation of GCSs. Hydrologic and sediment transport monitoring is required to accurately assess the impact of GCS installations.

Previous Work (limit 5000 characters)

Describe any previous work completed that relates to this project. This can help provide context on how this project will build on past projects to continue study on remaining research questions. Providing a note whether the work is related to a previous S&T project, other Reclamation work, or non-Reclamation work is helpful information to provide. List citations if possible.

Grassroots efforts have been underway in Arizona to install GCSs to reduce channel cutting, promote river and habitat restoration, increase and extend surface water flows, recharge groundwater systems, and reduce flood-flow sediment loads prior to storm flows discharging from a watershed.

Private property owners in southeastern Arizona installed thousands of GCSs and realized remarkable river and habitat restoration. Anecdotal evidence of GCS use indicates reduction in sediment transport, increases in water availability and ecosystem support. In 2014, the Sky Island Restoration Cooperative (SIRC) which established in southeastern Arizona, combined two million dollars' worth of in-kind resources from thirty-five contributing organizations on sixteen inter-disciplinary and cross-jurisdictional GCS installation projects.

Local and federal interest in using stormwater to enhance water supplies is gaining momentum. For example, the Environmental Protection Agency provided $774,283 in funding from 2015 through 2018 for the three year study "Assessment of Stormwater Harvesting via Managed Aquifer Recharge to Develop New Water supplies in the Arid West: the Salt Lake Valley Example." Also, in December 2015, the National Academies of Sciences, Committee on the On-Site Reuse of Graywater and Stormwater, put out pre-publication report "Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits." The Arizona Department of Water Resources (ADWR) provides technical support to the Arizona Water Protection Fund (AWPF) Commission which has awarded numerous grants for projects that have included the installation of similar types of structures for restoration, conservation, and protection of water resources.

Limited research has been conducted and is concentrated in southern Arizona. The U.S. Geological Survey (USGS) conducted hydrologic research in 2014 in the Chiricahua Mountains in southeastern Arizona, ran model simulations to assess changes in sediment yields and assessed vegetation changes using remote sensing. USGS research of a mature treated and untreated drainage equipped with stream flow measuring devises shows that in the treated drainage peak flood flows were reduced, surface water flow duration was extended temporally and spatially, and surface water flow volumes increased 28 percent (Norman, et al., 2015).

RESEARCH STRATEGY (LIMIT 5000 CHARACTERS)

Provide a brief overview of the tasks and analyses that will be undertaken to answer the Research Question. Justify the funding request and describe the process used to accomplish the research objectives of the research question. Consider including the following:

- *General Plan and Major Tasks: provide enough detail to convey how the project will progress from start to end. Key tasks may include, but are not limited to: Lit Reviews, Desktop Research, Field Work, Lab Work, Data Collection and/or Analysis, Final Report and Closeout process.*
- *Research Methodology: examples include data-based analysis, model-based analysis, or qualitative effort*
- *Data Collection: include how data will be collected, stored, and maintained after the research is complete*
- *Data Analysis: such as statistical, analytical, and/or numerical analysis*
- *Equipment: include a description of equipment needs, such as tools and/or software required to support the project.*
- *Researcher Role and Deliverables: describe who will conduct the research, such as Reclamation staff, contractor, University, other, and who will create deliverables*
- *Communication of Outcomes Plan: describe how to share outcomes of the research with stakeholders, the research office, and the rest of Reclamation, etc. Consider including a task for developing professional papers, presentations, and other activities that communicate findings Reclamation wide and to the technical community.*
- *Final Report Needs: Include a task for completing the final report, including peer review costs, Section 508 (ADA/accessibility) compliance costs, any technical writing services, and ensuring compliance with the Reclamation Visual Identity (VI) requirements. The Closeout Requirements provides more information.*
- *Bulletin: include a task for developing a two-page project bulletin/update for your project. Examples are available at: http://www.usbr.gov/research/publications/updates.html*

The primary focus of this proposal is to monitor hydrologic and sediment transport data collected pre- and post-GCS installations in ephemeral channels to assess hydrologic conditions, soil moisture, and sediment transport.

Two research sites are available for this project: 1) The Spur Cross Ranch Conservation Area (CA) in Cave Creek, Arizona, managed by the Maricopa County Parks and Recreation Department (MCPRD) and, 2) the Heard Boy Scout Camp (BS) located on the north side at the base of South Mountain in Phoenix, Arizona, owned by the Boy Scouts of America. The CA and BS sites each provide unique environmental conditions that will be useful in assessing use of GCSs. Each site has unique characteristics; site assessments will be conducted prior to starting work.

The CA drainage is a small, remote tributary to Cave Creek that appears undisturbed and supports a healthy ecosystem. Data collected at this site will provide information about GCS installations in an undisturbed ephemeral drainage and their impacts on hydrology and sediment transport. It will be of interest to observe how a healthy drainage system responds to GCS installations. Public education opportunities would be for adults and older children, the site is about one-mile from the parking lot.

The BS drainage is small and borders urban development and a mountain preserve. The wilderness area adjacent to the BS is degraded and there have been issues with storm flows and sedimentation. Data collected at this site will provide information about GCS installations in a disturbed ephemeral drainage and the impact on hydrology and sediment transport. It will be of interest to compare impacts of GCSs in a disturbed and an undisturbed area. The BS location would provide many opportunities for public education and volunteer opportunities.

FY2017: Work will begin immediately to establish project management scheduling, tracking, communication protocols, a share drive, and develop agreements which triggers procurement and obtaining clearances. Basic data collection will begin with channel surveys, aerial photograph acquisition and channel mapping. Monitoring locations will be identified, instrumented and pre-GCS installation data collection will begin for surface water gaging, precipitation, soil moisture, photo surveys and sediment transport. Tasks include: data analysis, information sharing and reporting.

FY2018: Management continues with project scheduling, tracking, information sharing and contractor procurement. An annual topographic survey and a post-GCS installation survey will be conducted. GCSs will be installed. Mapping will be updated. Monitoring will continue post-GCS installation. Assimilation of data for

Need, Benefit and Urgency (limit 1000 characters)

Need:

- *Describe the need that the Reclamation has for the research results. Provide information on how the project will benefit other Regions or a larger swath of Reclamation rather than just one project.*
- *Describe existing capabilities available to Reclamation from both internal and external sources; and explain why they are insufficient to adequately serve Reclamation's needs.*
- *Address how the research will add to the knowledge in this field.*
- *Identify a literature search or complete a Lit Review to help justify the need for new or continued research.*

Benefit:

- *Provide a description of how the research products will help complete mission-related actions better, faster, or cheaper. Be as quantitative as possible in the response, i.e., how much employee time, project time or budget can Reclamation potentially save through funding and application of the research?*
- *What is the Benefit-Cost Ratio (BCR) of this project?*

Urgency:

- *Describe the consequences if this research is not funded, i.e., if the anticipated results were unavailable, what would Reclamation use instead and what are the consequences?*

Climate change predictions include less frequent yet stronger precipitation events and fewer moderate events. GCSs may be installed to reduce sediment deposition in reservoirs, improve water quality, provide soil moisture for ecosystems, and increase water resources. However; hydrologic data are needed to inform policy. Reclamation has capabilities to conduct research and external partners will provide technical expertise with GCS installations and with sharing applicable research. USDA-ARS research provides a great foundation to build on, however there is "lack of (and need for) data to quantify their (GCS) impacts" (Nichols, et al., 2010). While a limited number of studies quantify the "impacts of check dams on sediment retention, studies specifically quantifying soil moisture impacts have not been conducted." (Nichols, et al., 2010). If this research is not funded, hydrologic and sediment transport data will not be available to assess GCSs as an adaptive water resource management strategy under climate change.

Mission Responsibility (limit 1000 characters)

Provide a direct connection to Reclamation's mission to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. Describe the relationship of the research to the DOI strategic plan, which is available at: https://www.doi.gov/performance/strategic-planning

Consider the following:

- *Why is this research a Reclamation responsibility?*
- *Why should this work be funded by the Federal Government?*
- *How will the research products contribute to Reclamation's mission, particularly to increasing water availability and increasing power generation?*
- *How will Reclamation's customers and stakeholders benefit?*

Support for GCS installations and urban green infrastructure projects is on the rise. Reclamation has the leadership and resources available to develop cross-jurisdictional collaborations and be responsive to publicly developed alternatives to manage water resources. Hydrologic and sediment transport data are necessary to assess impacts of GCSs on watershed resources. The research results will provide hydrologic and sediment transport data to support development of integrative storm water management systems for optimum water resource utilization. Data will be used by land and water resource managers, flood control districts, reservoir managers, and agencies who manage surface water rights and water quality to inform policy whether GCS installations are beneficial as an adaptive management alternative to optimize watershed function. Reclamation's Phoenix Area Office Hassayampa River and the Floodplain and Watershed Restoration Studies will also benefit from the research.

Other Comments (limit 500 characters)

This section is available to expand on any of the other sections, including references or additional context.

While interest and anecdotal information regarding GCS installations appears positive, questions remain about their impacts. There is a lack of pre- and post-GCS installation hydrologic and sediment monitoring due to the costs required to instrument, monitor and analyze the data. To reduce costs of this proposal, the scope may be reduced to install GCSs and monitor one drainage instead of two. In that case, criteria would be established and site assessments conducted to select the optimum site.

Benefiting Regions

Indicate with Yes or No which Reclamation Regions will benefit from this work. Coordinate proposal development with the Regional Coordinators in their respective Regions. Select all that apply.

Yes - Pacific Northwest	Yes - Upper Colorado
Yes - Mid-Pacific	Yes - Great Plains
Yes - Lower Colorado	Yes - Denver

Application Potential (limit 500 characters)

Describe the potential application of the research results.

Other federal agencies such as the US Fish and Wildlife Service and Natural Resource Conservation Service, US Geological Survey, and US Department of Agriculture would benefit through the data produced by this research. In addition the many locally-led watershed groups who are seeking funding to install GCS structures would benefit by showing funding entities what the functions and outcomes of installing these structures would have on the watershed.

Application Description (limit 500 characters)

Provide additional detail about where and how the research results can be applied.

Research will be used by entities such as The Nature Conservancy and Flood Control District of Maricopa County with their plans to use GCS installations in urban green infrastructure projects for restoration, to manage storm flows, reduce sedimentation, improve water quality and increase water resource availability under climate change. The research will inform local, state, and federal entities about using GCSs as adaptive watershed management strategies in watershed resource planning.

Field-Based Research Location

Indicate where this research will take place in the field.

Spur Cross Ranch Conservation Area, Cave Creek, Arizona and the Boys Scouts of America Heard Camp, Phoenix, Arizona.

Anticipated Research Products and Outcomes (limit 1000 characters)

A final report and fact sheet (Bulletin) is required for all research projects. Specific guidance is provided in the Closeout Requirements.

In addition to the final products, the proposal should contain:

- *A summary description of additional documentation that will be used to describe outcomes.*
- *Any additional reporting or journal articles produced, perhaps to satisfy partners or other Reclamation offices/programs.*
- *A description of how research results will be shared with peers, stakeholders (presentations, articles, papers, etc.).*
- *An explanation of how results will be communicated throughout Reclamation.*
- *Address how any collected or synthetic data sets resulting from this research project will be handled, managed, and maintained to ensure their continued value and accessibility to both Reclamation and the public.*
- *Add information related to planning for research adoption and implementation.*

NOTE: The S&T Program is interested in exploring alternative deliverables in FY17. A list of potential alternative deliverables is provided here: https://drive.google.com/open?id=1WtBMtjRt4vK5l6z0QEY2aMlkE95hEsMjntwrwoF8VFU

Research products and outcomes include documentation for agenda driven meetings with the technical team, partners and stakeholders, email notifications, meeting notes and presentations to document project status throughout the research effort. A share drive and an email notification list will be developed for information sharing.

A literature search update will build on the prior scoping proposal literature search to check current research, identify data gaps, eliminate duplication and identify collaborations.

Arrangements will be made to share data with others to benefit on-going or new research projects including the USGS and USDA-ARS who are conducting novel research of GCS installations in Arizona.

Talking Points - Bottom Line

This is the "elevator pitch." Describe how to "sell" this project to someone or get them interested in the project.

The reality is that land managers are currently installing GCSs for restoration and that water resource managers include the use of GCSs in water resource planning documents. Anecdotal information demonstrates multiple benefits associated with GCS installations, notably that local water resources appear to increase and sediment yields decrease. Water rights holders and managers are concerned about potential impacts of GCS installations on water appropriations. Arizona ecosystems were not allocated water rights and GCS installations may provide water resources to support ecosystems and their important function in the hydrologic cycle. Local,

Talking Points - Better, Faster, Cheaper (limit 140 characters)

Describe how this project will help Reclamation conduct operations, better, faster, cheaper. Messages of appropriate length for social media are encouraged.

Using GCS to reduce reservoir sedimentation. Spain installed 400 GCS resulting in 4.5 fold sediment yield reduction (Romero-Diaz et al 2007)

SECTION V - PROJECT MANAGEMENT

Enter information about how to manage the project.

TASK AND TASK DELIVERABLES (LIMIT 4000 CHARACTERS)

Provide a summary of the research strategy tasks, anticipated deliverables, and expected dates of completion for each task and deliverable.

The completion dates should be estimated and not simply defaulted to the end of the Fiscal Year. Research plans that enable significant work to begin early in the Fiscal Year are preferred.

Fiscal Year 2017

1. Management
   - 1.1. Coordination - on-going
   - 1.2. Prepare a two page bulletin to announce project - October 2016
   - 1.3. Develop share drive for wide access -October 2016
   - 1.4. Develop agreements - November 2016
   - 1.5. Prepare procurements - November 2016
   - 1.6. Public presentation - September 2017
2. Acquire Aerial photography - October 2016
3. Conduct site assessments - November 2016
4. Conduct Channel and Monitoring Location Surveys - November 2016
5. Mapping - November 2016
6. Monitoring
   - 6.1. Identify locations - December 2016
   - 6.2. Install instrumentation - March 2017
   - 6.3. Data collection - on-going
7. Annual reporting - September 2017

Fiscal Year 2018

1. Management
   - 1.1. Coordination - on-going
   - 1.2. Update project bulletin - October 2017
   - 1.3. Public presentations - September 2018
   - 1.4. Procure contractor, equipment and materials to install GCS - November 2017
2. Channel and Monitoring Location Survey
   - 2.1. Annual pre-installation GCS - November 2017
   - 2.2. Immediately post-installation GCS - March 2018
3. Install Grade Control Structures - March 2018
4. Mapping - Update channel morphology - March 2018
5. Monitoring - on-going
6. Analyze data - on-going
7. Annual reporting - September 2018

Fiscal Year 2019

1. Management
   - 1.1. Coordination - on-going
   - 1.2. Update project bulletin - October 2018
   - 1.3. Public presentations - September 2019
2. Annual Channel Survey - November 2018
3. Assess Grade Control Structures after one year - February 2019
4. Update Mapping - March 2019
5. Monitoring - on-going

Quality Control

Describe how the quality of data and results for the project will be managed. Address how the peer review process and/or guidelines will be applied to the project.

Data and reports will be checked by technical team. A review team will be established for quality control.

Communication

Identify how project results will be communicated. Note any planned or possible presentations at conferences, publications, press (print and/or web), interviews, etc.

An email notification list and a share drive will be established. Monthly status update meetings will be held with partners. Technical team meetings will be held more often. At least one presentation per year will be given at the Arizona Hydrological Society annual symposium. A two-page bulletin will be prepared and updated each year. A peer reviewed journal publication will be prepared. The team will discuss and plan for progressive methods of information sharing to promote wide dissemination of research efforts and results. Public education opportunities will be promoted. If possible, news for social media will be developed. Volunteer opportunities will be identified and citizen science opportunities explored.

Risk Management

Describe how risks will be managed in the project. List known risks to project scope, schedule and costs, and consider mitigation strategies.

Job Hazard Analysis will be prepared identifying participants, operations, and hazards for field work. Risks to project schedule could result from administrative processing delays.

MILESTONES

Enter three (3) milestones for each project year with a focus on Year 1 Milestones.

Year 1	
Milestone #1 Description Prepare agreement with Maricopa County Parks and Recreation Department, US Geological Survey, The Nature Conservancy, Flood Control District of Maricopa County and others. Obtain any required clearances. Procure equipment.	Due Date 11/15/2016
Milestone #2 Description Complete channel surveys, mapping and identify monitoring and grade control structure locations. Install monitoring equipment, collect data, assess pre-GCS installation data. Reporting.	Due Date 03/01/2017
Milestone #3 Description Collect, process, analyze data and report on results.	Due Date 09/01/2017
Year 2 (if applicable)	
Milestone #1 Description Procure contractor to install grade control structures. Conduct annual survey.	Due Date 11/15/2017
Milestone #2 Description Install grade control structures in two drainages and survey.	Due Date 03/31/2018
Milestone #3 Description Collect, process, analyze data and report on results. Assimilate model data.	Due Date 09/30/2018
Year 3 (if applicable)	
Milestone #1 Description Develop 2-D and 3-D modeling.	Due Date 06/30/2019
Milestone #2 Description Assess monitoring program and next steps.	Due Date 03/30/2019
Milestone #3 Description Collect, process, analyze data and report on results. Final report and Journal article.	Due Date 09/30/2019

OTHER COMMENTS

List additional details related to the project management approach worth noting to the proposal reviewers.

SECTION VI – BUDGET

Budget information is required for each year of the project and categorized by Budget Type. The description of how each budget line will be used should be consistent with the Task and Task Deliverables section of the proposal form.

Incomplete budgets will be returned to the PI for correction. If not corrected, proposals will not be considered.

New 2017 Budget Requirement: For conducting projects proposing Acquisitions, a signature from the Chief of the Contracting Office (or Designee) is required. PIs must confer with Acquisitions to identify the appropriate funding vehicle and agreement type. This will assist in executing external funding actions.

The name of this person for each office is listed below.
Pacific Northwest - Jericho Lewis
Mid-Pacific - Brenda Davis
Lower Colorado - Beverly Nelson
Upper Colorado - James Durrant
Great Plains - Chandler Worley
Denver/Washington Office - Katherine Segura

Review the Acquisition and Assistance Management Division's decision tree as well as their website to learn more.

Guide for Budget	
Budget Type	**Description**
Labor	• *Describe whether labor is for PI and/or funded team member.* • *Itemize by Denver Directorate, Region, and include Acquisition labor if applicable.* • *Include administrative staff time for tasks, such as project management, data management, administrative meetings, funding requests for future project years, progress reporting, and closeout requirements reporting.*
Travel	• *Describe whether travel is for PI and/or funded team member.* • *Itemize by Denver Directorate, Region, and include Acquisition labor if applicable.*
Transportation of Things	• *Include freight and express charges by common carrier and contract carrier, such as switching, crating, refrigerating, and other incidental expenses.*
Rent, Communications, and Utilities	• *Include payments for the use of land, structures, and/or equipment owned by others and/or charges for communication and utility services.* • *Include dock fees, lab fees, and/or facility rental fees paid to agencies or organizations.*
Printing and Reproduction	• *Include costs ordering and printing official publications through Reclamation and/or the Department print shops.*
Contractual Services/Grants	• *Describe if funding will be paid to outside contractors and/or agencies and any mechanisms/authorities needed for payments and transfers.* • *Do not include the labor associated with developing contracts/grants; list under Labor)* • *Do not include purchase card associated costs; list under respective Budget Type(s)*
Supplies and Materials	• *Include commodities consumed within one year of purchase, such as: office IT, lab supplies, materials and parts used in the construction, repair, or production of supplies, equipment, machinery, buildings, and other structures.* • *Include supplies/materials for contracts and/or purchase card.* • *If the amount is larger than the micro-purchase limit of $3500, a contract will be assumed unless otherwise noted.*
Equipment	• *Include personal property of a durable nature, furniture and fixtures, publications for permanent collections, tools and implements, machinery including construction machinery, instruments and apparatus.* • *Include information technology hardware or software, custom and commercial off-the-shelf software (regardless of cost), including central processing units (CPUs), modems, signaling equipment, telephone and telegraph equipment, and large scale system integration services.* • *Include equipment for contracts and/or purchase card.* • *If the amount is larger than the micro purchase limit of $3500, a contract will be assumed unless otherwise noted.*

Example Budget		
Budget Type	Proposed Budget	Itemized Description
Labor	19,000	1,000 PI (TSC) 10,000 TSC Researcher 2,000 PN Region Biologist 3,000 MP Region Researcher 3,000 Acquisition Specialist
Travel	20,000	5,000 PI (TSC) – site visits 10,000 TSC Researcher and PI (TSC) – field research 5,000 PN Region Biologist – field research
Transportation of Things	200	200 FedEx
Rent, Communications, and Utilities	5,000	2,500 Lab fees 2,500 Dock fees
Printing and Reproduction	1,000	1,000 Denver Print Shop
Contractual Services/Grants	50,000	20,000 Financial Assistance Agreement with New Mexico State University 30,000 Grant with Colorado State University
Supplies and Materials	5,000	4,000 TSC Researcher 1,000 MP Region Researcher
Equipment	5,000	2,000 Computer 3,000 Boat Engine
Year 1 Total	**$105,200**	

BUDGET - YEAR 1

Budget information is required for each year of the project.

Budget Type	Proposed Budget	Itemized Description
Labor	47000	30,000 PI (PXAO) 8,000 PXAO Land Surveyor (PXAO) 4,000 USBR Archaeologist (PXAO) 5,000 USBR Region Acquisition Specialist
Travel		
Transportation of Things		
Rent, Communications, and Utilities		
Printing and Reproduction		
Contractual Services/Grants	123,460	65,460 USGS to install in two drainages 3 CSA gages, One Scour Chain, One Large Scale Photo Image Velocimetry gage and one sediment gage 58,000 USGS monitor, data process and reporting, two drainages
Supplies and Materials	11,000	Presentation, field materials and contingency.
Equipment		
Year 1 Total	$181,460	

BUDGET - YEAR 2

If the project only requires only one year of funding, leave blank.

Budget Type	Proposed Budget	Itemized Description
Labor	76000	30,000 PI (PXAO) 16,000 USBR Land Surveyor (PXAO) 25,000 USBR Denver TSC Tech Expert, model data assimilation 5,000 USBR Region Acquisition Specialist
Travel		
Transportation of Things		
Rent, Communications, and Utilities		
Printing and Reproduction		
Contractual Services/Grants	98,000	58,000 USGS monitor, data process and reporting, two drainages 40,000 Grade Control Structure Installations, two drainages
Supplies and Materials	15,000	Presentation, field materials and contingency.
Equipment		
Year 2 Total	$189,000	

BUDGET - YEAR 3

If the project only requires only one or two years of funding, leave blank.

Budget Type	Proposed Budget	Itemized Description
Labor	98000	40,000 PI (PXAO) 8,000 USBR Land Surveyor (PXAO) 45,000 USBR Denver TSC Tech Expert 2-D and 3-D models 5,000 USBR Region Acquisition Specialist
Travel		
Transportation of Things		
Rent, Communications, and Utilities		
Printing and Reproduction		
Contractual Services/Grants	58,000	58,000 USGS monitor, data process and reporting, two drainages
Supplies and Materials	10,000	Presentation, field materials and contingency.
Equipment		
Year 3 Total	$166,000	

SECTION VII - PARTNER CONTRIBUTIONS

Describe the relationship of partner(s) and whether there are any other agreements in place that establish a cost sharing relationship.

Consider the following when discussing the Partner Relationship:

- *Highlight team members' experience and roles in the project. Also, give specific examples of team members who have successfully completed similar research or work in the area.*
- *Teams may include members from various regions or area offices within Reclamation as well as end users, customers, and stakeholders who have interest in the outcome.*
- *Team members may also include those instrumental in implementation or communication of research and its partnerships, such as within Reclamation and with external stakeholders providing cost sharing or in kind services. These types of partnerships enhance the likelihood of receiving funding.*
- *Firm commitments are preferred and must be backed by available funding and/or time agreed to by the partner/team member. Attaching a signed memo to the proposal is one way to document this commitment.*
- *It is highly recommended the team identifies a project champion. This is often the highest-level manager or executive who agrees to sponsor the project in the Area Office or Region where the project, results and/or implementation will first be tested and/or applied.*
- *Discuss any required field work and face-to-face meeting with area, regional office and other partners.*

For Research Partnerships with USACE: The S&T Program closely coordinates research needs and potential projects in three (3) topic areas with the U.S. Army Corps of Engineers (USACE). Contact the person in the respective area for additional information:

Infrastructure: Bobbi Jo Merten bmerten@usbr.gov
Ecohydraulics: Rod Wittler rjwittler@usbr.gov
Invasive Species: Denise Hosler dhosler@usbr.gov

PARTNER #1

Organization – Directorate	Organization - Division	Role
Maricopa County	Parks & Recreation Department	Partner, provide research location

Contact First and Last Name	Contact Email
Ken Vonderscher	KennethVonderscher@mail.maricopa.gov

Fiscal Year	Amount	Type of Contribution
2017, 2018, 2019	Land	In Kind - Firm

Partner Relationship

MCPRD is providing the land at Spur Cross Ranch Conservation Area (CA) for Reclamation to conduct monitoring to assess grade control structures and sediment transport associated with installation of grade control structures (GCSs). MCPRD is interested in methods to enhance habitat and water resources at the CA. Information collected at the project will be used to assess use of GCSs at other MCPRD locations.

PARTNER #2

Organization – Directorate	Organization - Division	Role
The Nature Conservancy	Cities Program	Partner

Contact First and Last Name	Contact Email
Maggie Messerschmidt	maggie.messerschmidt@tnc.org

Fiscal Year	Amount	Type of Contribution
2017, 2018, 2019	$8,000	In Kind - Firm

Partner Relationship

Maggie is the TNC Urban Conservation Program Associate. TNC seeks to develop green infrastructure projects in urban areas to improve natural habitat, reduce sedimentation and enhance water resources. TNC will promote citizen science programming, act as a liaison between project partners, network with others and use the project to valuate co-benefits.

PARTNER #3

Organization – Directorate	Organization - Division	Role
Maricopa County	Flood Control District	Key researcher and Partner

Contact First and Last Name	Contact Email
Harry R. Cooper, RLA	harrycooper@mail.maricopa.gov

Fiscal Year	Amount	Type of Contribution
2017, 2018, 2019	$8,000	In Kind - Firm

Partner Relationship

Harry is a registered landscape architect in Arizona and manager of the Landscape Architecture/Water Conservation Branch at the Flood Control District of Maricopa County (FCDMC). FCDMC seeks to develop water conservation and green infrastructure techniques and understand their effectiveness to improve flood hazard mitigation efforts, reduce sedimentation and erosion, and to improve water resources management. FCDMC will assist in ECS design and siting, assist in collaboration efforts, provide technical reviews and expertise, and use the project to promote the primary and secondary benefits of using these techniques to address erosion, sedimentation, and water harvesting benefits.

ADDITIONAL PARTNER(S)

Include: Organization – Directorate, Organization – Division, Role, Contact First Name and Last Name, Contact Email, Fiscal Year, Amount, Type of Contribution (Cash or In Kind, Firm or Not Firm), Partner Relationship

Mary Reece, mreece@usbr.gov, 623-773-6270, USBR Chief Program Development, Engineer, provided funding for the Hassayampa River Study (HRS) and the Floodplain Restoration Study (FRS); of which $25,000, firm will be applied to this S&T in FY2017 as the work supports the HRS and the FRS.

Dagmar Llewellyn, dllewellyn@usbr.gov, 505-462-3594, USBR, Albuquerque Area Office, Hydrologist, submitting S&T proposal to characterize and model extreme storm events. In kind - not firm, FY 2017, 2018, 2019, $15,000 (est. 40 hours/yr at est $110/hr).

Suzanne Herrmann, suzanne.herrmann@scouting.org, Boy Scouts of America, contribute research site. In-kind - firm, FY 2017, 2018, 2019.

Thomas Loomis, trl@mail.maricopa.gov, Flood Control District of Maricopa County, Special Projects Branch Manager, opportunities to assist and collaborate. In kind - not firm, FY 2017, 2018, 2019.

Laura Norman PhD, lnorman@usgs.gov, USGS Arizona Water Science Center, Technical expert. 2017, 2018, 2019 Research Physical Scientist working on restoration-site selection and design, assess restoration efforts and predict effects of climate and land-use change. In kind - not firm, FY 2017, 2018, 2019, $6,000 (est. 24 hours/yr at est $110/hr).

Mary Nichols PhD, mary.nichols@ars.usda.gov, 520-647-9062, US Department of Agriculture - Southwest Watershed Research, Research Hydraulic Engineer conducting sediment transport and soil moisture research associated with rock check dams. In kind - not firm, FY 2017, 2018, 2019, $6,000 (est. 24 hours/yr at est $110/hr).

Kris Randall, kris_randall@fws.gov, 602-531-2232, US Fish and Wildlife Service, Partners for Fish and Wildlife, Riparian Ecologist working on enhancement of wildlife habitats. State Coordinator. Technical expert, advisor, guidance, review. In kind - not firm FY 2017, 2018, 2019 $15,000 (est. 40 hours/yr at est $110/hr).

David F. Seibert PhD, dseibert@email.arizona.edu, 520-882-8202, Borderlands Restoration, L3C, Ecological restoration integrating erosion control, vegetation, fire, and cultural components on public, private, and Tribal lands. In kind - not firm FY 2017, 2018, 2019, $6,000 (est. 24 hours/yr at est $110/hr).

James Duffield, James.Duffield@nau.edu, 928-380-9478, Hopi Tribe, Hopi Water Resources Program, Hydrogeologist associated with work to install trincheras for habitat and spring restoration. In kind - not firm FY 2017, 2018, 2019, $6,000 (est. 24 hours/yr at est $110/hr).

Ben Ruddell, PhD, PE, bruddell@asu.edu, 480-727-5123, Arizona State University, Senior Sustainability Scientist, Assistant Professor,Technical expert, will contribute and install six weather stations. In kind - firm, FY 2017, 2018, 2019

SECTION VIII - APPROVALS

Request the following signatures before submitting:

PRINCIPAL INVESTIGATOR (PI)

First Name	Last Name
Deborah	Tosline

Signature	Date
DEBORAH TOSLINE Digitally signed by DEBORAH TOSLINE Date: 2016.06.22 16:59:25 -07'00'	

SUPERVISOR

First Name	Last Name
Mary	Reece

Signature	Date
MARY REECE Digitally signed by MARY REECE Date: 2016.06.22 16:50:18 -07'00'	

CHIEF OF CONTRACTING OFFICE OR DESIGNEE

First Name	Last Name
Beverly K.	Nelson

Signature	Date
BEVERLY NELSON Digitally signed by BEVERLY NELSON Date: 2016.06.24 11:35:11 -07'00'	06/24/2016

Thank you for completing the proposal and for your interest in R&D's Science and Technology Program.

Submit the proposal via email to **STIMS@usbr.gov**

Confirmation of submission via email is within 72 hours

The deadline for submission is Midnight on Friday, 24 June 2016

If you have questions or need assistance, please email STIMS@usbr.gov and a member of R&D Office will respond within 24 hours.

For technical issues, contact Ronda Dorsey at (303) 445-2624 or rdorsey@usbr.gov.

Appendix 2. Summary of 2017 Study Activities

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
Deborah Tosline, Bureau of Reclamation, Study Manager dtosline@usbr.gov 623-773-6277
July 2017 Update

Status update for US Bureau of Reclamation's (Reclamation) Science & Technology Program study #1751 ***Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy (Study)*** authorized for Fiscal Year (FY) 2017 through FY 2019.

Background

The Study consists of hydrologic monitoring pre- and post-Grade Control Structure (GCS) installations with one year of pre-GCS installation monitoring; installation of GCS's during the second year; and about two years of post-GCS installation monitoring. At the conclusion of the Study, the GCS installations will remain and the monitoring equipment will be removed, unless additional funding is acquired.

FY2017 Accomplishment Narrative

October 2016 through May 2017

In October 2016, efforts began to prepare a Memorandum of Understanding (MOU) between Maricopa County Parks and Recreation Department (MCPRD) and Reclamation and also between the Boy Scouts of America, Grand Canyon Council (Boy Scouts) and Reclamation to use their lands for hydrologic research and GCS installations. At the same time efforts began to develop an Interagency Agreement between Reclamation and the U.S. Geological Survey (USGS) for monitoring work. In late October, a request was sent to contractors for pricing information for market research to prepare a purchase request to hire a contractor to install GCSs in FY2018. In January 2017, a request was submitted to obtain Reclamation approval for USGS to control and operate an Unmanned Aircraft System (UAS) for channel surveys. Hydrologic monitoring installation locations were identified and in May 2017, Reclamation completed surveys to meet National Environmental Policy Act requirements.

June through July 2017

Reclamation received SHPO concurrence for cultural surveys and completed a Categorical Exclusions Checklist (CEC) for the HSP site. Monitoring equipment installations began the week of June 26, 2017 and ended July 11, 2017. USGS installed one surface water flow monitoring station, a video camera, three sediment scour chains and piloted an UAS for channel surveys. Mike Milczarek, GeoSystems Analysis, Inc. provided recommendations for soil moisture sensor installations. Reclamation installed two Weather Hawk Signature Series weather stations provided by Dr. Ben Ruddell, Northern Arizona University. Reclamation drilled and installed two wells equipped with water level sensors and soil moisture/temperature sensors. One two-inch well was completed at 50-feet, below land surface (ft, bls) and a second two-inch well was completed at 20-ft, bls with six soil moisture sensors attached. Drill cuttings were logged and submitted for laboratory analyses. Drill hole completion schematics are attached. USGS Laura Norman provided Natalie Wilson staff time for a site visit and plant survey support as in-kind cost share.

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
Deborah Tosline, Bureau of Reclamation, Study Manager dtosline@usbr.gov 623-773-6277
July 2017 Update

FY2017 Schedule

10/3/17 – Begin development of two Memorandum of Understanding documents, one Inter-governmental Agreement and one purchase request.
10/20/17 – Send information package to potential consultants for GCS installation to collect Pricing Information for Market Research for purchase request.

4/7/17 – Reclamation and MCPRD mutually agree, to not proceed with the MOU at this time. Due to time constraints, the MOU would not be completed in time for monsoon monitoring and the one year timeframe for pre-GCS installation data collection.
4/25/17 –Establish Memorandum of Understanding between Boy Scouts of America, Grand Canyon Council and Reclamation Phoenix Area Office (PXAO). MOU No. 17-MOU-32-0003 for Science & Technology Program No. 1751 Installing Grade Control Structures for Hydrologic Research.

5/4/17 - US Army Corps of Engineer (ACOE) determines that the washes within the HSP site are non- jurisdictional, and not subject to authorization by the USACE.
5/5/17 - Reclamation staff David Gifford completes Class I records review and Class III cultural resource survey of the HSP site.
5/18/17 – Intergovernmental Agreement executed between the USGS and Reclamation PXAO for monitoring at the HSP.
5/22/17 – Receive Reclamation approval for USGS to control and operate a UAS to survey the HSP site channels.

6/7/17 – Receive State Historic Preservation Office (SHPO) concurrence with Reclamation's determination of no historic properties adversely affected.
6/23/17 – Reclamation completes the Categorical Exclusion Checklist (CEC) for GCS monitoring and installations at the HSP.
6/26/17 – US Geological Survey staff Jay Cederberg, Bruce Gungle and Nick Peretti install surface water monitoring equipment.
6/27/17 – USGS staff Geoffrey Debenedetto and John Vogel operate and pilot an Unmanned Aircraft System to conduct channel surveys of the HSP study area.
6/28/17 - Reclamation PXAO staff Dennis VanRyckeghem, Ryan Revells, and Helena Yomantas install Weather Hawk weather stations.
6/29/17 – Reclamation drill rig operator Delbert Smith, with assistance from Robert Firasek and Willie Nelson use an AMS 9500 rig to drill a well. Regional Geologist Michael Miller logs drill cuttings. The attempt is abandoned when drilling hits refusal.

7/7/17 –Reclamation drill rig operator Robert Firasek with assistance from Willie Nelson and Jordan Mogdolino operates a CME 75 auger rig to drill two wells. Regional Geologist Michael Miller logs drill cuttings.
7/11/17 –All HSP study area monitoring stations logging data.

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
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July 2017 Update

7/18/17 - site visit to view surface water monitoring locations on the Verde River watershed, US Forest Service, Region 3, Kaibab National Forest to assess the potential to partner on a second site to conduct hydrologic research pre- and post-GCS installations. Existing monitoring would potentially extend the pre-GCS installation monitoring from one to four years and post-monitoring from two years to a decade.
7/21/17 – USGS Natalie Wilson conducted a site visit to assess plant survey requirements of the HSP study area.
7/29/17 – Reclamation staff Dennis VanRyckeghem surveys all monitoring installations.
9/1/17 to 12/31/17 – Reclamation staff Ryan Revells downloaded weather and pressure transducer data monthly. No surface water flow events were measured.

Photos taken by Deborah Tosline

6/27/17 USGS install surface water monitoring station at HSP study area.

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
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July 2017 Update

6/27/17 USGS control and operate Unmanned Aircraft System for HSP study area channel surveys.

7/7/17 Reclamation drill crew and regional geologist drill and install two wells at the HSP.

7/7/17 Well completions. HSP-1, 50-feet, below land surface in foreground andHSP-2, 20-ft, bls background. Photo looking upstream, west-southwest

7/21/17 USGS surface water datalogger housing, a USGS surface water sensor at the edge of the channel, and groundwater wells HSP-1 and HSP-2. Photo looking north.

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
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July 2017 Update

7/20/17 Weather Hawk south installation at Boy Scouts shooting range and the base of South Mountain. Photo looking north-northwest.

6/29/17 Weather Hawk north installation near the surface water and groundwater monitoring sites. Photo looking northeast.

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
Deborah Tosline, Bureau of Reclamation, Study Manager dtosline@usbr.gov 623-773-6277
July 2017 Update

6/21/17 Storm cloud over the HSP? Photo looking south.

7/28/17 USGS Scour Chain location and surface water monitoring sensor. Evidence of minor flow. See HSP wells. Photo looking downstream and east.

Appendix 3. Categorical Exclusion Checklist

United States Department of the Interior

BUREAU OF RECLAMATION
Lower Colorado Region
Phoenix Area Office
6150 West Thunderbird Road
Glendale, AZ 85306-4001

IN REPLY REFER TO:
PXAO-1500
ENV-6.00

JUN 23 2017

MEMORANDUM

To: Area Manager
Attention: PXAO-1000

From: Sean M. Heath
for Manager, Environmental Resource Management Division

Subject: Categorical Exclusion Checklist (CEC) – Grade Control Structure Monitoring and Installation at Heard Scout Pueblo, Phoenix, Maricopa County, Arizona

The subject CEC is attached for your approval and signature. If you have any questions, please contact Ms. Johnida Dockens at 623-773-6256.

Attachment

cc: LC-2624 (Env. Library) (w/att)
PXAO 4000 (Herndon-Ladewig, Castaneda) (w/att)

Categorical Exclusion Checklist

Date: June 21, 2017

Project: Grade Control Structure Monitoring and Installation at Heard Scout Pueblo, Phoenix, Maricopa County, Arizona

Nature of Action: Installation of monitoring equipment and grade control structures in ephemeral drainages.

Exclusion Category: 516 DM 14.5 B(1) – Routine planning investigation activities where the impacts are expected to be localized, such as land classification surveys, topographic surveys, archeological surveys, wildlife studies, economic studies, social studies, and other study activity during any planning, preconstruction, construction, or operation and maintenance phase.

Evaluation of criteria for Categorical Exclusion:

1.	This action would have a significant effect on the quality of the human environment. (40 CFR § 1502.3)	No X	Uncertain__	Yes__
2.	This action would have highly controversial environmental effects, or involve unresolved conflicts concerning alternative uses of available resources. (43 CFR § 46.215 (c))	No X	Uncertain__	Yes__
3.	This action would have significant impacts on public health or safety. (43 CFR § 6.215 (a))	No X	Uncertain__	Yes__
4.	This action would have significant impacts on such natural resources and unique geographical characteristics as historic or cultural resources; parks, recreation and refuge lands; wilderness areas; wild or scenic rivers; natural national landmarks; sole source aquifers; wetlands (EO 11990); floodplains (EO 11988); prime farmlands; migratory birds; and other ecologically significant or critical areas. (43 CFR § 46.215 (b))	No X	Uncertain__	Yes__

5.	This action would have highly uncertain and potentially significant environmental effects or involve unique or unknown environmental risk. (43 CFR § 46.215 (d))	No X	Uncertain__	Yes__
6.	This action would establish a precedent for future actions, or represent a decision in principle about future actions with potentially significant effects. (43 CFR § 46.215 (e))	No X	Uncertain__	Yes__
7.	This action would have a direct relationship to other actions with individually insignificant, but cumulatively significant effects. (43 CFR § 46.215 (f))	No X	Uncertain__	Yes__
8.	This action would have significant impacts on properties listed, or eligible for listing on the National Register of Historic Places as determined by the bureau. (43 CFR § 46.215 (g))	No X	Uncertain__	Yes__
9.	This action would have significant impacts on species listed, or proposed to be listed on the List of Endangered or Threatened Species, or have significant impacts on designated Critical Habitat for these species. (43 CFR § 46.215 (h))	No X	Uncertain__	Yes__
10.	This action would violate Federal, State, local, or tribal law or requirements imposed for protection of the environment. (43 CFR § 46.215 (i))	No X	Uncertain__	Yes__
11.	This action would adversely affect Indian Trust Assets (ITAs). (SO 3175)	No X	Uncertain__	Yes__
12.	This action would have a disproportionately high and adverse effect on low income or minority populations. (43 CFR § 215 (j))	No X	Uncertain__	Yes__

13.	This action would limit access to and ceremonial use of Indian sacred sites on Federal lands by Indian religious practitioners, or adversely affect the physical integrity of such sacred sites (EO 13007). (43 CFR § 215 (k))	No X	Uncertain__	Yes__
14.	This action would contribute to the introduction, continued existence, or spread of noxious weeds or non-native invasive species known to occur in the area, or result in actions that may promote the introduction, growth, or expansion of the range of such species. (EO 13112). (43 CFR § 215 (l))	No X	Uncertain__	Yes__

NEPA Action – Categorical Exclusion X
EA __
EIS __

Explanation/remarks:

Project Description

The Bureau of Reclamation proposes to install monitoring equipment and grade control structures (GCS) at the Heard Scout Pueblo at 1901 E. Dobbins Road, Phoenix, Maricopa County, Arizona. The project is on private land in Township 1 South, Range 3 East, Sections 3 and 10 (Gila and Salt River Baseline and Meridian). The proposed project area comprises 3,800 linear feet of ephemeral washes within about 14 acres of the Heard Scout Pueblo.

The project includes research to assess the impact of GCS installed in ephemeral drainages on hydrology, storm flows, soil moisture, and sediment transport. Equipment, including meteorological stations and a 10- to 15-foot-deep piezometer, would be installed to monitor soil moisture and groundwater level data before and after installation of the GCS. Each monitoring station would measure wind speed and direction, precipitation, air temperature, humidity, solar radiation, soil moisture, soil temperature, and water depth.

GCS would be installed at about 75 discrete locations within the identified washes. Rock piles would be installed in-channel to dissipate flows. Rock piles would be about 3 feet wide and 10 feet long, and would be installed to a depth of about 2 to 3 feet. The total combined footprint for all 75 GCS locations would be about 2,250 square feet (0.05 acre).

Access to the project area will be via existing roads. Project materials will be delivered to monitoring and GCS locations via existing access or via off-road, overland routes. No new roads will be constructed as part of the proposed project activities. Staging areas would be located

within existing disturbed or paved areas at the Heard Scout Pueblo.

Installation of monitoring equipment will begin no sooner than June 26, 2017. Installation of the GCS may begin in October 2017, but no later than May 2018. The GCS will take 90 days to construct on-site. All monitoring equipment will be removed after about three years, unless alternate agreements are developed. The GCS will remain in place.

Biological Resources

The project is located in a previously developed landscape. No federally listed or candidate species, or suitable habitat for those species are known to occur within the action area. Therefore, Reclamation's proposed action will not affect federally listed species.

Cultural Resources

A Class I records check revealed five previous cultural resource surveys in the surrounding one-mile radius and nine previously recorded archaeological sites. In addition, South Mountain is a Traditional Cultural Property (TCP) and Sacred Landscape to the Tohono O'odham people, and Heard Scout Pueblo is a historic facility managed by the Boy Scouts of America as a campground and retreat since 1925.

A Class III cultural resource survey was completed by Reclamation on May 5, 2017. The entire project area was surveyed; no National Register eligible historic or prehistoric properties were identified during the survey other than the South Mountain TCP and Heard Scout Pueblo. The State Historic Preservation Office concurred with Reclamation's determination of no historic properties adversely affected on June 7, 2017.

Water Resources

The U.S. Army Corps of Engineers (USACE) has determined that washes within the project area are non-jurisdictional, and therefore the project is not subject to authorization by the USACE.

Environmental Stipulations

a) The Contractor shall obtain rock materials from an environmentally approved commercial source (e.g., Arizona Department of Transportation-approved material sources). Alternatively, the Contractor shall provide environmental clearance documentation to Reclamation's Environmental Resources Management Division if other material sources will be used.

Preparer's Name and Title: Johnida S. Dockens, Environmental Protection Specialist

Archaeologist concurrence: Dal J. [illegible]

Biologist concurrence: Johnida S Dockens

Environmental Protection Specialist concurrence: Johnida S Dockens

Concur: Sandra E for Manager, Environmental Resource Management Division Date: 6/23/2017

Acting For

Approve: [illegible] Area Manager Date: 6/23/17

Categorical Exclusion No. PXAO-17-24 Date: JUN 23 2017

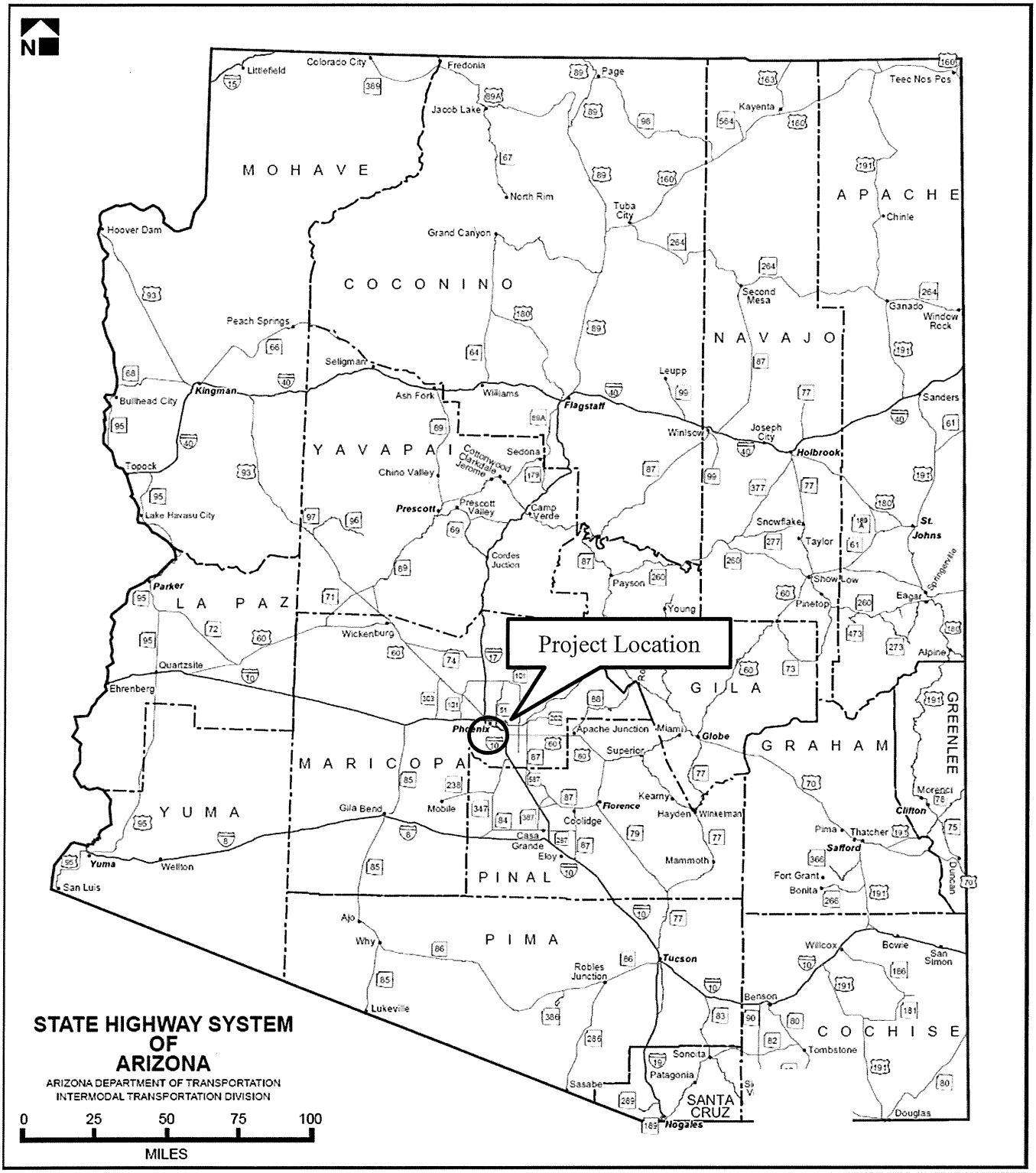

Figure 1. Project Location

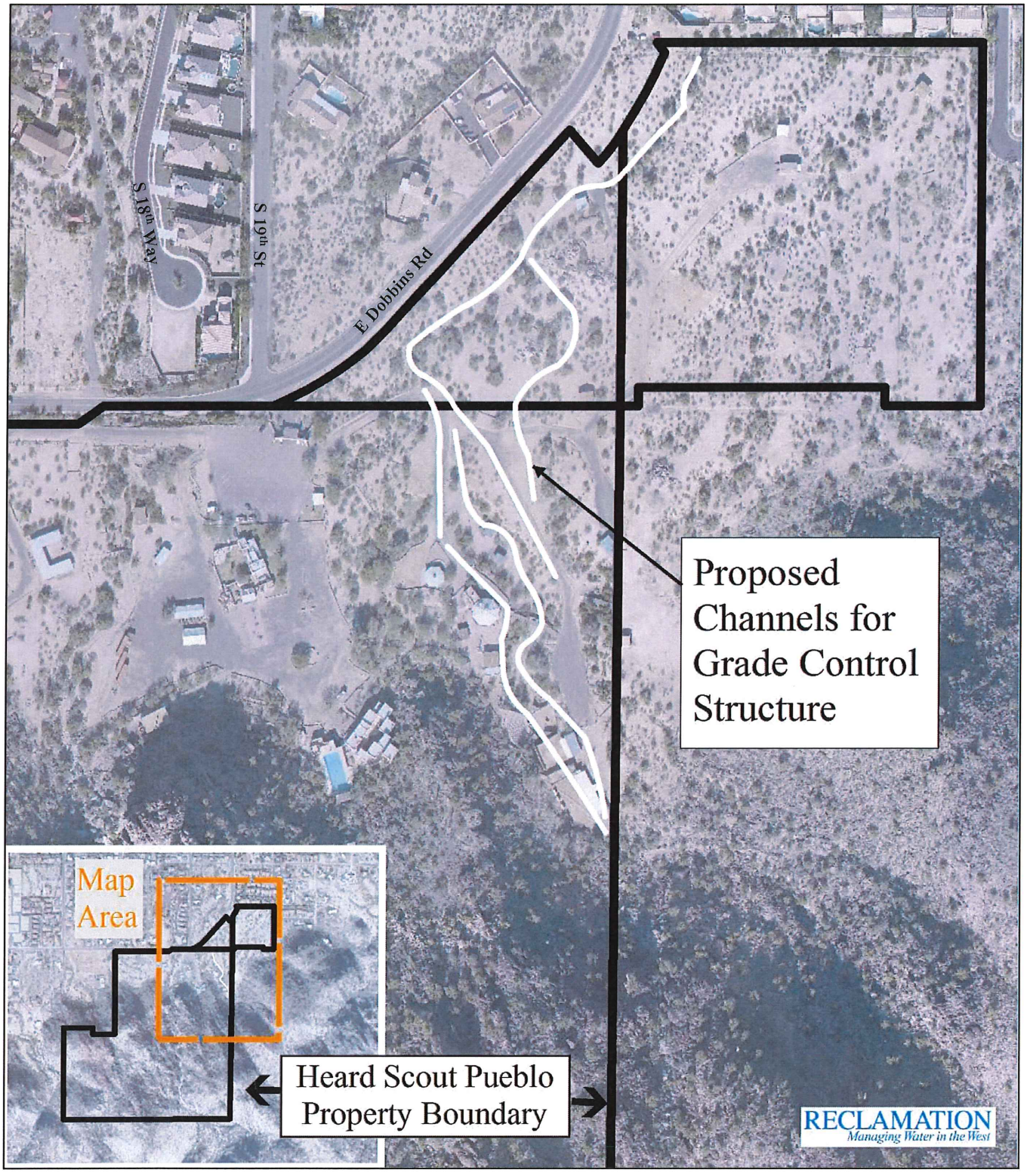

Figure 2. Heard Scout Pueblo Channel Locations for GCS

Appendix 4. Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activities

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

June 27, 2017 USGS install surface water monitoring station at HSP study area.

Jay Cederberg (USGS) at surface water monitoring station.

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

USGS surface water datalogger housing, a USGS surface water sensor at the edge of the channel, and groundwater wells HSP-1 and HSP-2. Photo looking north.

USGS main surface water sensor connected to water monitoring station.

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Location of USGS downstream surface water sensor, adjacent to HSP fence line.

USGS downstream surface water sensor.

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USGS upstream surface water sensor.

July 28, 2017 USGS Scour Chain location and upstream surface water monitoring sensor. Evidence of minor flow. See downstream HSP wells. Photo looking downstream and east.

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Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

July 7, 2017 Reclamation drill crew and regional geologist drill and install two wells at the HSP.

July 7, 2017 Reclamation drill crew Robert Firasek, Willie Nelson, and Jordan Mogdolino installing two monitor wells at the HSP.

July 7, 2017 Reclamation drill crew Robert Firasek, Willie Nelson, and Jordan Mogdolino.

July 7, 2017 Deborah Tosline (Reclamation) Study Manager and Reclamation drill crew Robert Firasek, Willie Nelson, and Jordan Mogdolino

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Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

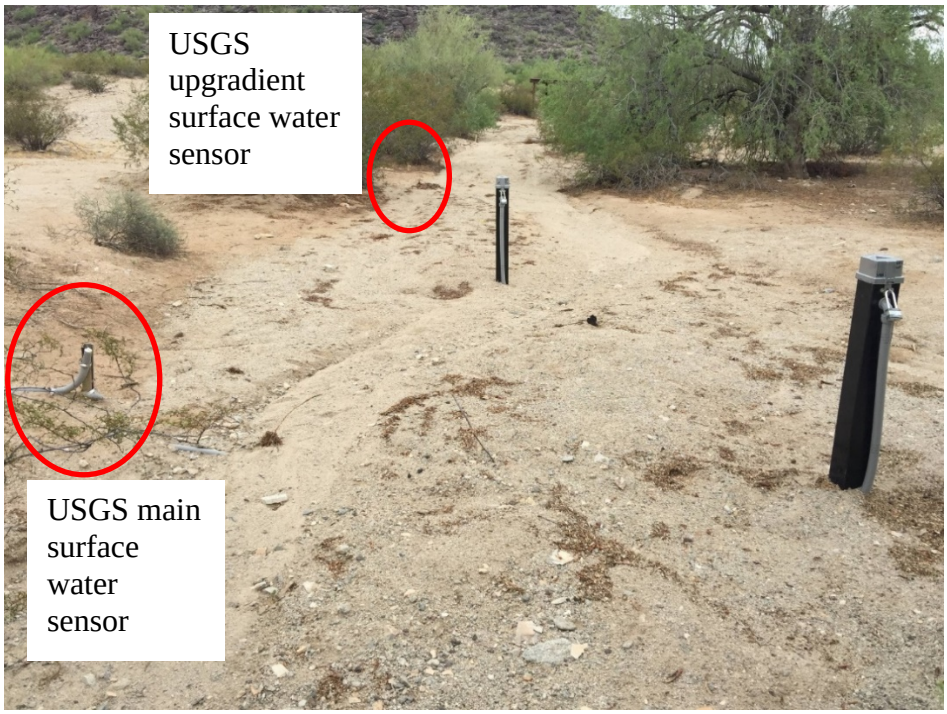
Reclamation's Lower Colorado Regional Geologist Michael Miller logs drill hole cuttings.

July 7, 2017 HSP-2 well casing with soil moisture sensors attached to casing before installation in the drill borehole.

July 7, 2017 HSP-2 well casing with soil moisture sensor cables before installation in the drill borehole.

Soil moisture sensor installed outside of the HSP-2 well casing.

July 7, 2017 Robert Firasek (Reclamation) feeds soil moisture sensor cables into the HSP-2 borehole.



July 7, 2017 Well completions. HSP-1, 50-feet, below land surface in foreground and HSP-2, 20-ft, bls background. Photo looking upstream, west-southwest.

July 7, 2017 HSP-2 Transducer installation in monitor well HSP-2.

Weather Hawk in a box. Northern Arizona University provided two calibrated Weather Hawks for installation by Reclamation at the Heard Scout Pueblo.

June 29, 2017 Reclamation staff Ryan Revells, Dennis VanRyckeghem, and Helena Yomamatas install Weather Hawk stations at the HSP.

June 29, 2017 Upgradient Weather Hawk installation near the surface water and groundwater monitoring sites. Photo looking northeast.

June 29, 2017 Downgradient Weather Hawk installation near the surface water and groundwater monitoring sites. Photo looking northeast.

June 27, 2017 – USGS staff Geoffrey Debenedetto and John Vogel operate and pilot an Unmanned Aircraft System to conduct channel surveys of the HSP study area.

June 27, 2017 – USGS staff Geoffrey Debenedetto and John Vogel operate and pilot UAS while Reclamation staff Ryan Revells, and Helena Yomantas observe.

June 27, 2017 USGS control and operate Unmanned Aircraft System for HSP study area channel surveys.

USGS Unmanned Aircraft System for channel surveys.

Natural Channel Design, Inc., worked with the American Conservation Experience (ACE) installed the Grade Control Structures.

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Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

American Conservation Experience (ACE) excavation for Grade Control Structure installation.


American Conservation Experience (ACE) building Grade Control Structures.

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

Northern Arizona University Citizen Science Stage, take a photo during stormflow and send it in.


Northern Arizona University Citizen Science Stage.

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Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

USGS Terrestrial Land Survey at HSP on March 3, 2020

March 3, 2020 USGS Terrestrial Land Survey at HSP

March 3, 2020 USGS Terrestrial Land Survey at HSP

March 3, 2020 USGS Terrestrial Land Survey at HSP

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Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

Grade Control Structure #1 Looking Upstream after installation in 2018.

Sedimentation at Grade Control Structure #1 Looking Upstream, March 2020.

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Remnant grade control feature in HSP channel.

Dennis VanRyckeghem (Reclamation) surveys remnant grade control feature in HSP channel.

March 13, 2017 Looking upstream the channel begins at the base of South Mountain Park/Preserve and flows through the shooting range

March 13, 2017 Looking upstream after the channel flows through the shooting gallery and an outdoor amphitheater

March 13, 2017 Looking downstream as the channel flows beneath a bridge

March 13, 2017 Heard Scout Pueblo channel conditions

March 13, 2017 Heard Scout Pueblo channel conditions

March 13, 2017 Heard Scout Pueblo channel conditions

March 13, 2017 Heard Scout Pueblo channel conditions

March 13, 2017 Heard Scout Pueblo channel conditions

March 13, 2017 Heard Scout Pueblo channel conditions

March 13, 2017 Heard Scout Pueblo channel conditions

Science & Technology #1751 Impacts of Grade Control Structure Installations on Hydrology and Sediment Transport as an Adaptive Management Strategy
Heard Scout Pueblo Site Conditions, Monitoring Installations and Field Activity Photos

June 21, 2017 Storm cloud over the HSP? No, the storm cloud did not reach the HSP site. View looking towards the South Mountain Park/Preserve from North Phoenix Mountain Preserve.

Appendix 5. Monitor Well HSP-1 and HSP-2 Details and Well Schematics

GEOLOGIC LOG OF DRILL HOLE NO. DH-HSP-1 (ADWR 55-227363)

FEATURE: GRADE CONTROL STRUCTURES
LOCATION: WASH
BEGUN: 7/7/2017 FINISHED: 7/7/2017
DEPTH AND ELEV OF WATER LEVEL
AND DATE MEASURED: DRY ON 7/7/2017

PROJECT: HEARD SCOUT PUEBLO
COORDINATES: N. 860273.40 E. 662401.56
NAD83, AZ STATE PLANE GRID, CENTRAL ZONE
TOTAL DEPTH: 50.0'
DEPTH TO BEDROCK: 50.0'

STATE: ARIZONA
GROUND ELEVATION (NAVD88): 1205.1'
ANGLE FROM HORIZONTAL: 90°
LOGGED BY : M. MILLER
BUREAU OF RECLAMATION

NOTES

PURPOSE OF HOLE:
Install instrumentation at bottom of hole to measure ground water elevation.

DRILL SITE & SET UP:
Drilled on natural ground within a small wash approx. 10 ft. northwest of the stream bank and 15 ft. upstream of a palo verde tree.

DRILL EQUIPMENT:
CME-75 truck-mounted rotary drill rig, 5 ft. long, 3-1/4 in. I.D., 6-1/2 in. O.D. hollow stem augers.

DRILLER:
USBR Yuma Area Office
Robert Firasek, driller
Willie Nelson, drill worker
Jordan Magdaleno. drill worker

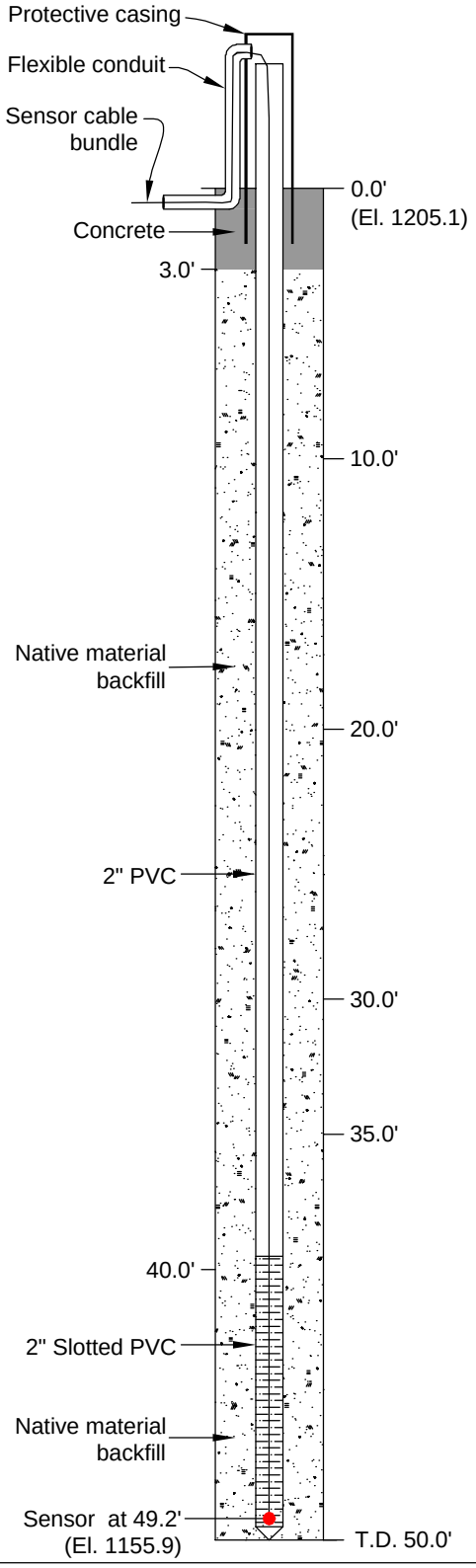
DRILLING METHODS:
0.0 to 50.0 ft. 6-1/2 in. O.D. auger.

DRILLING CONDITIONS:
Drill smoothly from 0 to 28 ft; from 28 to 33 ft. drilled rough, interpreted as gravelly layer. At 50.0 ft augers would not proceed, rig jumping, assumed bed rock or large cobble or boulder.

HOLE COMPLETION:
Installed 2 in. dia. blank PVC through hollow stem augers with screened interval from 39.5-49.5 ft.; pulled augers to backfill hole with cuttings. Concrete plug placed from 0.0-3.0 ft. Left 3.0 ft. of PVC stickup within a steel protective casing with a padlocked lid. Piezometer sensor installed inside PVC at 49.2 ft.

REASON FOR TERMINATION:
Met refusal at 50.0 ft.; assumed as bedrock.

HOLE COMPLETION



CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 50.0 ft. Quaternary Alluvium (Qal):

0.0 to 10.0 ft. Poorly Graded Sand with Silt (SP-SM):
Approximately 85% fine to coarse, angular sand, 10% nonplastic fines, 5% fine, angular gravel. Maximum size, 3/4 inch. Dry, light gray in color with no reaction to HCl from 0.0-5.0 ft., strong reaction with HCl below 5.0 ft.

10.0 to 20.0 ft. Poorly Graded Sand with Silt and Gravel (SP-SM)g:
Approximately 70% fine to coarse, angular sand, 10% nonplastic fines, 20% predominantly fine to coarse, angular gravel. Maximum size, 1 inch. Dry, light to medium gray in color with strong reaction to HCl.

20.0 to 30.0 ft. Silty Sand with Gravel (SM)g:
Approximately 65% fine to coarse, angular sand, 15% nonplastic fines, 20% predominantly fine to coarse, angular gravel. Maximum size, 3 inches. Dry, light brownish tan in color with strong reaction to HCl.

Lab Test Data from 20.0 to 25.0 ft.: Silty Sand with Gravel (SM)g.
65% sand, 19% nonplastic fines, 18% gravel.

30.0 to 35.0 ft. Poorly Graded Sand with Gravel (SP)g:
Approximately 75% fine to coarse, angular sand, 5% nonplastic fines, 20% fine to coarse, angular gravel. Maximum size, 4 inches. Dry, light brownish tan in color with strong reaction to HCl. Gravelly layer from 33.0-33.5 ft.

35.0 to 50.0 ft. Silty Sand (SM):
Approximately 75% fine to coarse, angular sand, 20% nonplastic fines, 5% fine to coarse, angular gravel. Maximum size, 3 inches. Dry, light brownish tan in color with strong reaction to HCl.

COMMENTS:
All measurements are from ground surface unless otherwise noted.
Material descriptions are based on visual classification of auger cuttings unless noted as Lab Test Data.

GEOLOGIC LOG OF DRILL HOLE NO. DH-HSP-2 (ADWR 55-227500)

FEATURE: GRADE CONTROL STRUCTURES
LOCATION: WASH
BEGUN: 7/7/2017 FINISHED: 7/7/2017
DEPTH AND ELEV OF WATER LEVEL
AND DATE MEASURED: DRY ON 7/7/2017

PROJECT: HEARD SCOUT PUEBLO
COORDINATES: N. 860261.78 E. 662396.75
NAD83, AZ STATE PLANE GRID, CENTRAL ZONE
TOTAL DEPTH: 20.5'
DEPTH TO BEDROCK: N/A

STATE: ARIZONA
GROUND ELEVATION (NAVD88): 1205.0'
ANGLE FROM HORIZONTAL: 90°
LOGGED BY : M. MILLER
BUREAU OF RECLAMATION

NOTES

PURPOSE OF HOLE:
Install instrumentation at predetermined intervals to measure soil moisture.

DRILL SITE & SET UP:
Drilled on natural ground within a small wash approx. 10 ft. NW of the stream bank and 25 ft. upstream of a palo verde tree.

DRILL EQUIPMENT:
CME-75 truck-mounted rotary drill rig, 5 ft. long, 3-1/4 in. I.D., 6-1/2 in. O.D. hollow stem augers.

DRILLER:
USBR Yuma Area Office
Robert Firasek, driller
Willie Nelson, drill worker
Jordan Magdaleno. drill worker

DRILLING METHODS:
0.0 to 20.5 ft. 6-1/2 in. O.D. auger.

DRILLING CONDITIONS:
Drill smoothly from 0 to 20.5 ft.

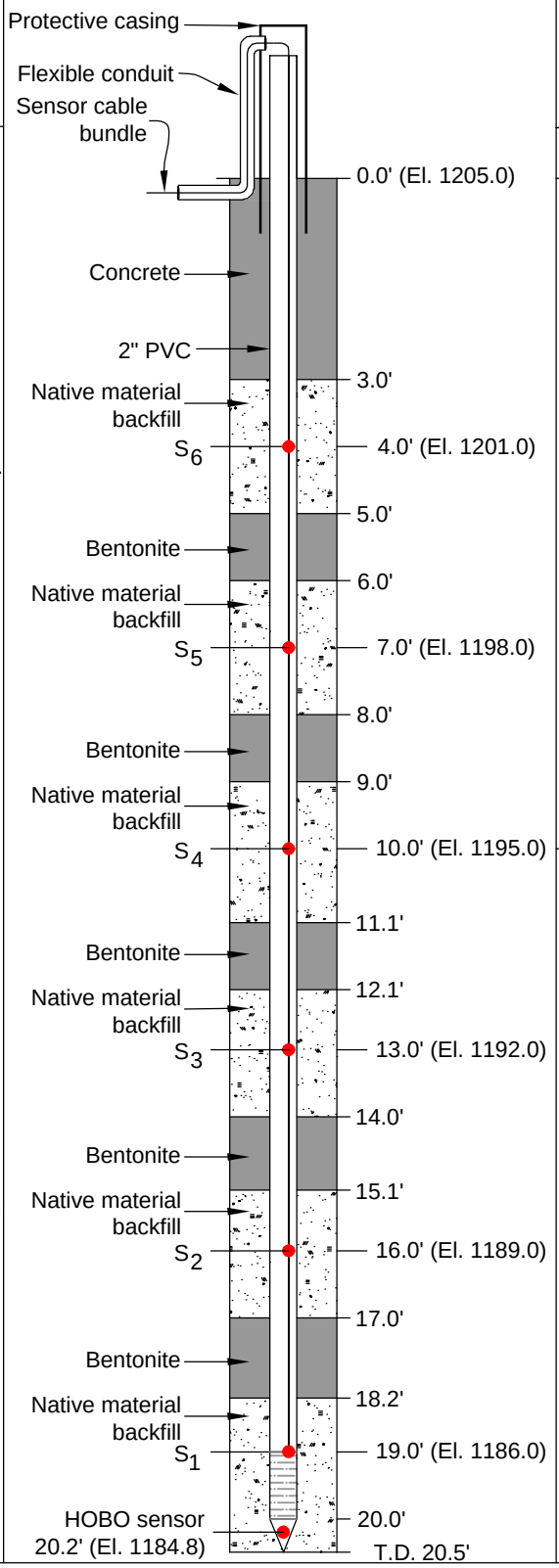
HOLE COMPLETION:
Installed 2 in. dia. blank PVC from 0.0-19.0 ft.; slotted casing from 19.0-20.0 ft.; end cap from 20.0-20.5 ft. Six soil moisture sensors attached to the outside of the PVC at the following depths:

Sensor	Depth (ft.)
S_1	19.0
S_2	16.0
S_3	13.0
S_4	10.0
S_5	7.0
S_6	4.0

Pulled augers slowly to backfill approx. 1 ft. above and below each sensor with native material and placed a 1 ft. thick bentonite plug between each sensor installation to prevent communication down the hole. Concrete plug placed from 0.0-3.0 ft. Installed a HOBO water level sensor inside the PVC at 20.2 ft. bgs. Left 2.82 ft. of PVC stickup within a steel protective casing with a padlocked lid.

REASON FOR TERMINATION:
Predetermined depth.

HOLE COMPLETION



CLASSIFICATION AND PHYSICAL CONDITION

0.0 to 20.5 ft. Quaternary Alluvium (Qal):

0.0 to 10.0 ft. Poorly Graded Sand with Silt (SP-SM): Approximately 80% fine to coarse, angular sand, 10% nonplastic fines, 10% predominantly fine to coarse, angular gravel. Maximum size, 2 inches. Dry, light gray in color with no reaction to HCl.

10.0 to **20.5 ft. Poorly Graded Sand with Gravel (SP)g:** Approximately 65% fine to coarse, angular sand, 10% nonplastic fines, 20% predominantly fine to coarse, angular gravel. Maximum size, 3 inches. Dry, light brownish tan in color with strong reaction to HCl.

Lab Test Data from 10.0 to 15.0 ft.: Silty Sand with Gravel (SM)g.
71% sand, 15% gravel, 14% nonplastic fines.

COMMENTS:
All measurements are from ground surface unless otherwise noted.
Material descriptions are based on visual classification of auger cuttings unless noted as Lab Test Data.

Appendix 6. HSP-1 Pressure Transducer and HSP-2 Soil Moisture Sensor Data

A portion of this dataset is provided in this appendix. The entire dataset is available at Reclamation's Information Sharing Environment (RISE) site: https://data.usbr.gov/catalog/4408

Heading input	Label	Data title	Notes
Date	MM/DD/YY	Date	
Time	HH:MM:SS	Time in UTC	MST = UTC -7 hours
Batt	Battery	Batery voltage (in volts DC)	
SDI02	stage_un	Uncorrected stage	Stopped recording 8/8/2017 when transducer was changed
SDI12	baro	Barometric pressure	Stopped recording 8/8/2017 when transducer was changed
Fnt01	stage	Stage (in feet)	Uncorrected data
SDI01	stagtemp	Stage temperature (in DegC)	For reference only
DigIO1	ISCO	Automatic sampler status	0 = off, 1 = on
DigIO2	Camera	Camera recording status	0 = off, 1 = on
SDI21	W1_psi	Borehole waterlevel (in psi)	logged for BOR
SDI22	W1_temp	Borehole transducer temperature (in DegC)	logged for BOR
SDI31	SM1_SM	Soil mosture from borehole probe 1	logged for BOR
SDI32	SM1_TEMP	Temperature from borehole probe 1	logged for BOR
SDI41	SM2_SM	Soil mosture from borehole probe 2	logged for BOR (sensor malfunction)
SDI42	SM2_TEMP	Temperature from borehole probe 2	logged for BOR (sensor malfunction)
SDI51	SM3_SM	Soil mosture from borehole probe 3	logged for BOR (sensor malfunction)
SDI52	SM3_TEMP	Temperature from borehole probe 3	logged for BOR (sensor malfunction)
SDI61	SM4_SM	Soil mosture from borehole probe 4	logged for BOR (sensor malfunction)
SDI62	SM4_TEMP	Temperature from borehole probe 4	logged for BOR (sensor malfunction)
SDI71	SM5_SM	Soil mosture from borehole probe 5	logged for BOR
SDI72	SM5_TEMP	Temperature from borehole probe 5	logged for BOR
SDI81	SM8_SM	Soil mosture from borehole probe 6	logged for BOR
SDI82	SM8_TEMP	Temperature from borehole probe 6	logged for BOR

Design Analysis
Waterlog -- H-522PluDATAFILE
Sensor Serial # = 7A105275V4.48
Filename = HSP_mid 0

Date	Time	Batt	TASK1	SDI02	DigIO1	DigIO2	SDI21	SDI22	SDI31	SDI32	SDI41	SDI42	SDI51	SDI52	SDI61	SDI62	SDI71	SDI72	SDI81	SDI82	SDI02	Fnt01	SDI01
MM/DD/YY	HH:MM:SS	Battery	stage	stagtemp	ISCO	Camera	W1_psi	W1_temp	SM1_SM	SM1_TEMP	SM2_SM	SM2_TEMP	SM3_SM	SM3_TEMP	SM4_SM	SM4_TEMP	SM5_SM	SM5_TEMP	SM8_SM	SM8_TEMP	stage_un	stage	stagtemp
7/11/2017	18:55:00	12.52		0	0	0	0	26.95	3.74	26.1	5.08	26.1	7.9	26.5	4.89	27.3	8.79	29.6	4.14	34.2	0	-17.19	0
7/11/2017	19:00:00	12.6		0	0	0	0	26.95	3.74	26.1	5.09	26.1	7.92	26.6	4.9	27.4	8.81	29.6	4.15	34.2	0	-17.19	0
7/11/2017	19:05:00	13.23		32.34	0	0	0	26.96	3.74	26.2	5.09	26.1	7.9	26.5	4.89	27.3	8.81	29.6	4.15	34.2	42.49	1.13	14.02
7/11/2017	19:10:00	12.68		32.33	0	0	0	26.96	3.74	26.2	5.09	26.1	7.9	26.5	4.9	27.4	8.8	29.5	4.15	34.2	42.88	1.12	14.02
7/11/2017	19:15:00	12.6		32.33	0	0	0	26.96	3.75	26.2	5.1	26.1	7.89	26.6	4.89	27.4	8.81	29.6	4.14	34.2	42.69	1.12	14.02
7/11/2017	19:20:00	13.15		32.32	0	0	0	26.96	3.75	26.2	5.09	26.1	7.9	26.6	4.9	27.3	8.79	29.6	4.14	34.2	43.07	1.12	14.01
7/11/2017	19:25:00	13.31		32.32	0	0	0	26.96	3.75	26.2	5.09	26.1	7.9	26.5	4.88	27.4	8.79	29.7	4.14	34.2	43.8	1.11	14.01
7/11/2017	19:30:00	12.6		32.31	0	0	0	26.96	3.74	26.2	5.09	26.1	7.9	26.6	4.88	27.3	8.8	29.7	4.13	34.2	44.49	1.11	14.01
7/11/2017	19:35:00	12.52		32.32	0	0	0	26.96	3.74	26.2	5.08	26.1	7.9	26.6	4.88	27.4	8.78	29.7	4.14	34.2	43.8	1.12	14.01
7/11/2017	19:40:00	12.52		32.31	0	0	0	26.96	3.75	26.2	5.09	26.1	7.9	26.5	4.89	27.4	8.8	29.6	4.13	34.2	43.53	1.11	14.01
7/11/2017	19:45:00	12.44		32.31	0	0	0	26.96	3.74	26.2	5.11	26.1	7.91	26.5	4.89	27.4	8.81	29.6	4.15	34.2	43.6	1.11	14.01
7/11/2017	19:50:00	12.44		32.31	0	0	0	26.96	3.76	26.1	5.1	26.1	7.9	26.6	4.9	27.4	8.82	29.6	4.15	34.2	43.13	1.12	14.01
7/11/2017	19:55:00	12.44		32.31	0	0	0	26.96	3.75	26.2	5.12	26.1	7.9	26.6	4.89	27.4	8.81	29.6	4.14	34.2	42.52	1.11	14.01
7/11/2017	20:00:00	12.44		32.3	0	0	0	26.96	3.76	26.2	5.1	26.1	7.9	26.6	4.89	27.4	8.8	29.6	4.15	34.2	42.65	1.11	14
7/11/2017	20:05:00	12.44		32.3	0	0	0	26.96	3.77	26.2	5.08	26.1	7.9	26.6	4.88	27.3	8.81	29.6	4.14	34.2	42.72	1.11	14
7/11/2017	20:10:00	12.36		32.3	0	0	0	26.96	3.76	26.2	5.11	26.1	7.89	26.5	4.88	27.4	8.81	29.6	4.15	34.2	42.55	1.11	14
7/11/2017	20:15:00	12.52		32.3	0	0	0	26.96	3.76	26.2	5.11	26.1	7.9	26.5	4.89	27.4	8.8	29.6	4.15	34.2	42.49	1.11	14
7/11/2017	20:20:00	12.68		32.3	0	0	0	26.96	3.77	26.2	5.11	26.1	7.89	26.6	4.89	27.3	8.8	29.6	4.15	34.2	42.24	1.11	14
7/11/2017	20:25:00	12.91		32.29	0	0	0	26.96	3.76	26.2	5.11	26.1	7.89	26.6	4.9	27.3	8.81	29.5	4.15	34.2	42.34	1.1	14
7/11/2017	20:30:00	12.68		32.29	0	0	0	26.96	3.76	26.2	5.08	26.1	7.9	26.6	4.89	27.3	8.81	29.6	4.15	34.2	42.43	1.1	14
7/11/2017	20:35:00	12.83		32.28	0	0	0	26.96	3.76	26.2	5.08	26.1	7.9	26.6	4.9	27.4	8.81	29.6	4.15	34.2	42.68	1.1	14
7/11/2017	20:40:00	13.15		32.28	0	0	0	26.96	3.77	26.2	5.1	26.1	7.9	26.5	4.89	27.4	8.8	29.6	4.15	34.2	43.16	1.09	13.99
7/11/2017	20:45:00	13.23		32.26	0	0	0	26.96	3.76	26.2	5.12	26.1	7.9	26.6	4.9	27.3	8.81	29.5	4.15	34.2	44.59	1.08	13.99
7/11/2017	20:50:00	13.23		32.25	0	0	0	26.96	3.75	26.2	5.11	26.1	7.89	26.5	4.89	27.4	8.81	29.6	4.15	34.2	45.58	1.08	13.99
7/11/2017	20:55:00	12.68		32.25	0	0	0	26.96	3.76	26.2	5.12	26.1	7.9	26.5	4.89	27.4	8.81	29.5	4.15	34.2	45.55	1.08	13.99
7/11/2017	21:00:00	12.68		32.25	0	0	0	26.96	3.76	26.2	5.11	26.1	7.89	26.6	4.88	27.3	8.79	29.5	4.15	34.2	45.27	1.08	13.99
7/11/2017	21:05:00	12.68		32.25	0	0	0	26.96	3.77	26.2	5.09	26.1	7.89	26.6	4.89	27.4	8.8	29.6	4.15	34.2	45.57	1.07	13.98
7/11/2017	21:10:00	12.68		32.24	0	0	0	26.96	3.75	26.2	5.12	26.1	7.89	26.6	4.88	27.4	8.8	29.6	4.15	34.2	45.95	1.07	13.98
7/11/2017	21:15:00	12.6		32.23	0	0	0	26.96	3.77	26.2	5.11	26.1	7.89	26.5	4.89	27.3	8.81	29.6	4.15	34.2	46.8	1.06	13.98
7/11/2017	21:20:00	12.6		32.23	0	0	0	26.96	3.75	26.2	5.11	26.1	7.89	26.6	4.89	27.4	8.79	29.6	4.15	34.2	46.6	1.06	13.98
7/11/2017	21:25:00	12.52		32.23	0	0	0	26.96	3.75	26.2	5.12	26.1	7.9	26.5	4.88	27.3	8.8	29.6	4.15	34.2	46.61	1.06	13.98
7/11/2017	21:30:00	12.52		32.22	0	0	0	26.96	3.75	26.2	5.09	26.1	7.9	26.5	4.9	27.4	8.8	29.6	4.15	34.2	46.77	1.06	13.98
7/11/2017	21:35:00	12.52		32.22	0	0	0	26.96	3.74	26.2	5.08	26.1	7.89	26.6	4.88	27.4	8.81	29.5	4.15	34.2	46.84	1.05	13.97
7/11/2017	21:40:00	12.52		32.21	0	0	0	26.96	3.77	26.2	5.12	26.1	7.89	26.5	4.88	27.4	8.8	29.6	4.15	34.2	47.2	1.05	13.97
7/11/2017	21:45:00	12.52		32.2	0	0	0	26.96	3.76	26.1	5.09	26.1	7.89	26.6	4.87	27.4	8.81	29.6	4.15	34.2	48.28	1.04	13.97
7/11/2017	21:50:00	12.44		32.19	0	0	0	26.96	3.76	26.1	5.11	26.1	7.89	26.5	4.88	27.4	8.79	29.5	4.15	34.2	48.88	1.04	13.97
7/11/2017	21:55:00	12.44		32.19	0	0	0	26.96	3.77	26.1	5.11	26.1	7.88	26.6	4.88	27.4	8.8	29.5	4.15	34.2	49.32	1.03	13.96
7/11/2017	22:00:00	12.36		32.19	0	0	0	26.96	3.76	26.2	5.09	26.1	7.89	26.6	4.89	27.3	8.8	29.5	4.15	34.2	48.98	1.03	13.96
7/11/2017	22:05:00	12.36		32.18	0	0	0	26.96	3.76	26.2	5.12	26.1	7.88	26.6	4.89	27.4	8.81	29.5	4.14	34.2	49.47	1.03	13.96
7/11/2017	22:10:00	12.36		32.18	0	0	0	26.96	3.76	26.2	5.09	26.1	7.89	26.5	4.88	27.3	8.8	29.5	4.15	34.2	49.66	1.03	13.96
7/11/2017	22:15:00	12.36		32.17	0	0	0	26.96	3.77	26.2	5.12	26.1	7.89	26.5	4.87	27.3	8.79	29.5	4.15	34.2	49.78	1.02	13.96
7/11/2017	22:20:00	12.36		32.17	0	0	0	26.96	3.77	26.1	5.12	26.1	7.88	26.6	4.88	27.4	8.79	29.5	4.14	34.2	49.51	1.03	13.96
7/11/2017	22:25:00	12.28		32.18	0	0	0	26.96	3.76	26.1	5.12	26.1	7.89	26.5	4.89	27.4	8.8	29.5	4.15	34.2	48.35	1.04	13.95
7/11/2017	22:30:00	12.36		32.18	0	0	0	26.96	3.76	26.2	5.09	26.1	7.89	26.5	4.9	27.4	8.81	29.5	4.15	34.2	46.76	1.04	13.95
7/11/2017	22:35:00	12.28		32.18	0	0	0	26.96	3.76	26.1	5.12	26.1	7.88	26.5	4.89	27.4	8.8	29.5	4.15	34.2	47.04	1.04	13.95
7/11/2017	22:40:00	12.28		32.18	0	0	0	26.96	3.77	26.2	5.11	26.1	7.89	26.5	4.89	27.4	8.78	29.5	4.15	34.2	46.63	1.04	13.95
7/11/2017	22:45:00	12.28		32.18	0	0	0	26.96	3.76	26.2	5.09	26.1	7.88	26.5	4.88	27.4	8.8	29.5	4.15	34.2	46.75	1.04	13.95
7/11/2017	22:50:00	12.28		32.18	0	0	0	26.96	3.76	26.1	5.09	26.1	7.89	26.5	4.89	27.4	8.8	29.5	4.14	34.2	46.47	1.04	13.95
7/11/2017	22:55:00	12.28		32.18	0	0	0	26.96	3.76	26.2	5.12	26.1	7.89	26.6	4.88	27.4	8.78	29.5	4.14	34.2	46.68	1.04	13.95

Design Analysis
Waterlog -- H-522PluDATAFILE
Sensor Serial # = 7A105275V4.48
Filename = HSP_mid 0

Date	Time	Batt	TASK1	SDI02	DigIO1	DigIO2	SDI21	SDI22	SDI31	SDI32	SDI41	SDI42	SDI51	SDI52	SDI61	SDI62	SDI71	SDI72	SDI81	SDI82	SDI02	Fnt01	SDI01
MM/DD/YY	HH:MM:SS	Battery	stage	stagtemp	ISCO	Camera	W1_psi	W1_temp	SM1_SM	SM1_TEMP	SM2_SM	SM2_TEMP	SM3_SM	SM3_TEMP	SM4_SM	SM4_TEMP	SM5_SM	SM5_TEMP	SM8_SM	SM8_TEMP	stage_un	stage	stagtemp
7/11/2017	23:00:00	12.2		32.17	0	0	0	26.96	3.77	26.2	5.12	26.1	7.87	26.6	4.89	27.3	8.8	29.5	4.14	34.2	46.88	1.03	13.95
7/11/2017	23:05:00	12.2		32.18	0	0	0	26.96	3.76	26.2	5.12	26.1	7.91	26.5	4.88	27.3	8.8	29.5	4.14	34.2	46.35	1.04	13.95
7/11/2017	23:10:00	12.2		32.18	0	0	0	26.96	3.77	26.2	5.09	26.1	7.89	26.5	4.88	27.4	8.8	29.6	4.15	34.2	45.76	1.04	13.95
7/11/2017	23:15:00	12.2		32.18	0	0	0	26.96	3.76	26.2	5.12	26.1	7.88	26.5	4.88	27.4	8.77	29.5	4.15	34.2	45.74	1.04	13.95
7/11/2017	23:20:00	12.2		32.18	0	0	0	26.96	3.75	26.2	5.12	26.1	7.87	26.6	4.89	27.4	8.81	29.6	4.14	34.2	45.41	1.04	13.95
7/11/2017	23:25:00	12.2		32.18	0	0	0	26.96	3.75	26.1	5.13	26.1	7.88	26.6	4.87	27.3	8.8	29.6	4.15	34.2	45.2	1.04	13.95
7/11/2017	23:30:00	12.2		32.18	0	0	0	26.96	3.77	26.2	5.12	26.1	7.88	26.6	4.88	27.3	8.79	29.6	4.15	34.2	45.02	1.04	13.95
7/11/2017	23:35:00	12.2		32.18	0	0	0	26.96	3.75	26.2	5.12	26.1	7.87	26.6	4.87	27.3	8.79	29.6	4.15	34.2	44.5	1.04	13.95
7/11/2017	23:40:00	12.2		32.18	0	0	0	26.96	3.75	26.2	5.1	26.1	7.89	26.5	4.87	27.4	8.78	29.6	4.15	34.2	44.16	1.04	13.95
7/11/2017	23:45:00	12.2		32.18	0	0	0	26.96	3.76	26.2	5.09	26.1	7.88	26.5	4.88	27.3	8.8	29.6	4.14	34.2	43.94	1.04	13.95
7/11/2017	23:50:00	12.2		32.18	0	0	0	26.96	3.77	26.2	5.09	26.1	7.87	26.6	4.87	27.3	8.76	29.5	4.14	34.2	44.05	1.04	13.95
7/11/2017	23:55:00	12.2		32.18	0	0	0	26.96	3.76	26.2	5.12	26.1	7.88	26.5	4.88	27.3	8.8	29.5	4.15	34.2	43.91	1.04	13.95
7/12/2017	0:00:00	12.2		32.18	0	0	0	26.96	3.76	26.2	5.09	26.1	7.88	26.6	4.88	27.3	8.76	29.5	4.15	34.2	43.62	1.04	13.95
7/12/2017	0:05:00	12.2		32.18	0	0	0	26.96	3.77	26.2	5.13	26.1	7.88	26.6	4.87	27.4	8.8	29.5	4.15	34.2	43.82	1.04	13.95
7/12/2017	0:10:00	12.2		32.16	0	0	0	26.96	3.75	26.2	5.09	26.1	7.88	26.5	4.88	27.3	8.8	29.5	4.15	34.2	44.61	1.03	13.95
7/12/2017	0:15:00	12.2		32.15	0	0	0	26.96	3.77	26.2	5.12	26.1	7.88	26.5	4.88	27.3	8.77	29.5	4.14	34.2	45.69	1.02	13.94
7/12/2017	0:20:00	12.2		32.15	0	0	0	26.95	3.75	26.2	5.1	26.1	7.88	26.5	4.87	27.3	8.8	29.5	4.15	34.2	46.55	1.01	13.94
7/12/2017	0:25:00	12.2		32.14	0	0	0	26.96	3.77	26.1	5.09	26.1	7.89	26.5	4.86	27.4	8.8	29.5	4.14	34.2	47.52	1	13.94
7/12/2017	0:30:00	12.2		32.13	0	0	0	26.95	3.77	26.1	5.13	26.1	7.87	26.5	4.87	27.4	8.78	29.5	4.14	34.2	48.24	1	13.94
7/12/2017	0:35:00	12.2		32.13	0	0	0	26.96	3.77	26.1	5.13	26.1	7.88	26.5	4.88	27.3	8.8	29.5	4.14	34.2	48.33	1	13.94
7/12/2017	0:40:00	12.2		32.13	0	0	0	26.96	3.75	26.2	5.09	26.1	7.87	26.6	4.87	27.3	8.76	29.5	4.14	34.2	48.49	1	13.94
7/12/2017	0:45:00	12.2		32.13	0	0	0	26.96	3.76	26.1	5.12	26.1	7.88	26.5	4.88	27.4	8.8	29.5	4.14	34.2	48.9	1	13.94
7/12/2017	0:50:00	12.2		32.13	0	0	0	26.96	3.77	26.1	5.13	26.1	7.87	26.6	4.87	27.3	8.79	29.5	4.15	34.2	48.08	1	13.94
7/12/2017	0:55:00	12.2		32.13	0	0	0	26.95	3.76	26.1	5.1	26.1	7.87	26.6	4.87	27.3	8.75	29.5	4.14	34.2	47.96	1	13.94
7/12/2017	1:00:00	12.2		32.13	0	0	0	26.95	3.76	26.1	5.09	26.1	7.88	26.6	4.86	27.4	8.79	29.5	4.14	34.2	48.07	1	13.94
7/12/2017	1:05:00	12.2		32.13	0	0	0	26.95	3.76	26.1	5.13	26.1	7.87	26.6	4.86	27.3	8.76	29.5	4.14	34.2	48.51	1	13.94
7/12/2017	1:10:00	12.2		32.14	0	0	0	26.96	3.77	26.1	5.13	26.1	7.88	26.5	4.87	27.3	8.77	29.6	4.14	34.2	47.93	1.01	13.94
7/12/2017	1:15:00	12.2		32.14	0	0	0	26.95	3.76	26.2	5.09	26.1	7.87	26.6	4.87	27.3	8.75	29.5	4.14	34.2	47.46	1.01	13.94
7/12/2017	1:20:00	12.12		32.14	0	0	0	26.95	3.75	26.2	5.13	26.1	7.87	26.5	4.87	27.3	8.75	29.5	4.14	34.2	48.03	1.01	13.94
7/12/2017	1:25:00	12.12		32.15	0	0	0	26.95	3.77	26.2	5.13	26.1	7.87	26.5	4.86	27.3	8.76	29.6	4.13	34.2	47.04	1.02	13.94
7/12/2017	1:30:00	12.12		32.16	0	0	0	26.95	3.76	26.2	5.13	26.1	7.88	26.6	4.87	27.3	8.76	29.5	4.15	34.2	45.93	1.02	13.95
7/12/2017	1:35:00	12.12		32.16	0	0	0	26.95	3.77	26.1	5.13	26.1	7.88	26.6	4.87	27.4	8.78	29.6	4.14	34.2	45.39	1.03	13.95
7/12/2017	1:40:00	12.12		32.16	0	0	0	26.96	3.76	26.2	5.14	26.1	7.87	26.5	4.87	27.3	8.75	29.6	4.14	34.2	45.35	1.03	13.95
7/12/2017	1:45:00	12.12		32.16	0	0	0	26.95	3.76	26.1	5.13	26.1	7.87	26.5	4.86	27.3	8.75	29.5	4.14	34.2	45.37	1.03	13.95
7/12/2017	1:50:00	12.12		32.17	0	0	0	26.95	3.76	26.2	5.13	26.1	7.88	26.5	4.87	27.4	8.78	29.6	4.14	34.2	45.15	1.03	13.95
7/12/2017	1:55:00	12.12		32.17	0	0	0	26.95	3.78	26.1	5.1	26.1	7.87	26.5	4.87	27.3	8.78	29.6	4.14	34.2	44.79	1.03	13.95
7/12/2017	2:00:00	12.12		32.17	0	0	0	26.95	3.76	26.2	5.13	26.1	7.87	26.5	4.85	27.4	8.74	29.5	4.14	34.2	44.71	1.03	13.95
7/12/2017	2:05:00	12.12		32.18	0	0	0	26.95	3.77	26.2	5.09	26.1	7.87	26.5	4.86	27.4	8.78	29.5	4.14	34.2	43.85	1.04	13.95
7/12/2017	2:10:00	12.12		32.19	0	0	0	26.95	3.77	26.1	5.1	26.1	7.87	26.6	4.87	27.4	8.77	29.5	4.14	34.2	42.85	1.05	13.95
7/12/2017	2:15:00	12.12		32.2	0	0	0	26.95	3.78	26.1	5.13	26.1	7.87	26.5	4.86	27.3	8.79	29.5	4.14	34.2	41.88	1.06	13.95
7/12/2017	2:20:00	12.12		32.2	0	0	0	26.95	3.77	26.1	5.1	26.1	7.87	26.5	4.87	27.3	8.77	29.6	4.14	34.2	41.38	1.06	13.95
7/12/2017	2:25:00	12.12		32.2	0	0	0	26.95	3.75	26.2	5.13	26.1	7.87	26.5	4.87	27.3	8.74	29.6	4.14	34.2	40.82	1.06	13.95
7/12/2017	2:30:00	12.12		32.21	0	0	0	26.95	3.76	26.1	5.13	26.1	7.87	26.5	4.87	27.4	8.77	29.6	4.13	34.2	40.52	1.06	13.95
7/12/2017	2:35:00	12.12		32.21	0	0	0	26.95	3.78	26.1	5.1	26.1	7.88	26.6	4.87	27.3	8.74	29.5	4.14	34.2	40.21	1.06	13.95
7/12/2017	2:40:00	12.12		32.21	0	0	0	26.95	3.76	26.1	5.13	26.1	7.87	26.5	4.87	27.4	8.74	29.5	4.14	34.2	40.03	1.06	13.96
7/12/2017	2:45:00	12.12		32.21	0	0	0	26.95	3.77	26.2	5.09	26.1	7.87	26.5	4.86	27.4	8.75	29.6	4.14	34.2	39.82	1.06	13.96
7/12/2017	2:50:00	12.12		32.21	0	0	0	26.95	3.77	26.2	5.14	26.1	7.86	26.6	4.87	27.4	8.76	29.6	4.14	34.2	39.67	1.06	13.96
7/12/2017	2:55:00	12.12		32.21	0	0	0	26.95	3.77	26.2	5.1	26.1	7.88	26.5	4.86	27.3	8.74	29.6	4.13	34.2	39.51	1.06	13.96
7/12/2017	3:00:00	12.12		32.21	0	0	0	26.95	3.77	26.1	5.12	26.1	7.87	26.5	4.86	27.4	8.77	29.5	4.14	34.2	39.41	1.06	13.96

Design	Analysis																							
Waterlog	--	H-522Plu	DATAFILE																					
Sensor	Serial	#	=	7A105275	V4.48																			
Filename	=	HSP_mid	0																					
Date	Time	Batt	TASK1	SDI02	DigIO1	DigIO2	SDI21	SDI22	SDI31	SDI32	SDI41	SDI42	SDI51	SDI52	SDI61	SDI62	SDI71	SDI72	SDI81	SDI82	SDI02	Fnt01	SDI01	
MM/DD/YY	HH:MM:SS	Battery	stage	stagtemp	ISCO	Camera	W1_psi	W1_temp	SM1_SM	SM1_TEMP	SM2_SM	SM2_TEMP	SM3_SM	SM3_TEMP	SM4_SM	SM4_TEMP	SM5_SM	SM5_TEMP	SM8_SM	SM8_TEMP	stage_un	stage	stagtemp	
7/12/2017	3:05:00	12.05		32.22	0	0	0	26.95	3.76	26.1	5.14	26.1	7.86	26.5	4.87	27.4	8.78	29.5	4.14	34.2	39.33	1.07	13.96	
7/12/2017	3:10:00	12.05		32.23	0	0	0	26.95	3.77	26.2	5.12	26.1	7.87	26.5	4.87	27.3	8.77	29.5	4.14	34.2	38.96	1.07	13.97	
7/12/2017	3:15:00	12.05		32.23	0	0	0	26.95	3.77	26.1	5.1	26.1	7.87	26.5	4.86	27.4	8.74	29.6	4.14	34.2	38.28	1.07	13.97	
7/12/2017	3:20:00	12.05		32.23	0	0	0	26.95	3.76	26.1	5.14	26.1	7.87	26.5	4.86	27.3	8.74	29.6	4.14	34.2	37.95	1.07	13.97	
7/12/2017	3:25:00	12.05		32.23	0	0	0	26.95	3.76	26.1	5.14	26.1	7.87	26.5	4.86	27.3	8.76	29.5	4.14	34.2	37.69	1.07	13.97	
7/12/2017	3:30:00	12.05		32.23	0	0	0	26.95	3.77	26.1	5.13	26.1	7.86	26.5	4.85	27.4	8.74	29.6	4.15	34.2	37.42	1.07	13.97	
7/12/2017	3:35:00	11.97		32.24	0	0	0	26.95	3.77	26.1	5.1	26.1	7.86	26.5	4.86	27.4	8.73	29.6	4.15	34.2	37.16	1.07	13.97	
7/12/2017	3:40:00	11.97		32.24	0	0	0	26.95	3.76	26.1	5.13	26.1	7.86	26.5	4.87	27.3	8.77	29.6	4.14	34.2	36.95	1.07	13.98	
7/12/2017	3:45:00	11.97		32.24	0	0	0	26.95	3.76	26.2	5.13	26.1	7.86	26.6	4.86	27.4	8.73	29.6	4.14	34.2	36.82	1.07	13.98	
7/12/2017	3:50:00	11.97		32.24	0	0	0	26.95	3.76	26.1	5.11	26.1	7.87	26.5	4.86	27.3	8.76	29.6	4.14	34.2	36.72	1.07	13.98	
7/12/2017	3:55:00	11.97		32.24	0	0	0	26.95	3.75	26.1	5.11	26.1	7.86	26.5	4.87	27.4	8.76	29.6	4.15	34.2	36.5	1.07	13.98	
7/12/2017	4:00:00	11.97		32.24	0	0	0	26.95	3.75	26.1	5.14	26.1	7.87	26.5	4.86	27.3	8.75	29.6	4.15	34.2	36.35	1.07	13.98	
7/12/2017	4:05:00	11.97		32.24	0	0	0	26.95	3.75	26.1	5.14	26.1	7.86	26.5	4.87	27.3	8.77	29.6	4.14	34.2	36.27	1.07	13.98	
7/12/2017	4:10:00	11.97		32.25	0	0	0	26.95	3.76	26.2	5.13	26.1	7.86	26.5	4.86	27.3	8.73	29.6	4.15	34.2	36.14	1.07	13.98	
7/12/2017	4:15:00	11.97		32.25	0	0	0	26.95	3.77	26.1	5.14	26.1	7.86	26.5	4.85	27.3	8.75	29.6	4.15	34.2	36.04	1.08	13.98	
7/12/2017	4:20:00	11.97		32.25	0	0	0	26.95	3.75	26.1	5.14	26.1	7.86	26.5	4.85	27.3	8.74	29.5	4.15	34.2	35.91	1.08	13.98	
7/12/2017	4:25:00	11.97		32.25	0	0	0	26.95	3.77	26.2	5.13	26.1	7.87	26.5	4.86	27.3	8.77	29.6	4.14	34.2	35.86	1.08	13.98	
7/12/2017	4:30:00	11.97		32.25	0	0	0	26.95	3.78	26.1	5.1	26.1	7.86	26.6	4.85	27.4	8.75	29.6	4.14	34.2	35.8	1.08	13.99	
7/12/2017	4:35:00	11.97		32.26	0	0	0	26.95	3.77	26.2	5.14	26.1	7.86	26.6	4.86	27.3	8.73	29.6	4.15	34.2	35.75	1.08	13.99	
7/12/2017	4:40:00	11.97		32.26	0	0	0	26.95	3.77	26.1	5.1	26.1	7.86	26.5	4.85	27.3	8.73	29.6	4.14	34.2	35.66	1.08	13.99	
7/12/2017	4:45:00	11.97		32.26	0	0	0	26.95	3.77	26.1	5.13	26.1	7.86	26.5	4.86	27.4	8.75	29.6	4.14	34.2	35.58	1.08	13.99	
7/12/2017	4:50:00	11.97		32.26	0	0	0	26.95	3.76	26.1	5.14	26.1	7.86	26.5	4.86	27.4	8.73	29.6	4.14	34.2	35.46	1.08	13.99	
7/12/2017	4:55:00	11.97		32.26	0	0	0	26.95	3.77	26.1	5.11	26.1	7.86	26.5	4.87	27.4	8.73	29.6	4.14	34.2	35.39	1.08	13.99	
7/12/2017	5:00:00	11.97		32.26	0	0	0	26.95	3.77	26.1	5.1	26.1	7.86	26.5	4.86	27.3	8.75	29.6	4.14	34.2	35.32	1.08	13.99	
7/12/2017	5:05:00	11.97		32.27	0	0	0	26.95	3.77	26.1	5.1	26.1	7.86	26.6	4.86	27.3	8.75	29.6	4.14	34.2	35.27	1.08	13.99	
7/12/2017	5:10:00	11.97		32.26	0	0	0	26.95	3.76	26.1	5.1	26.1	7.86	26.5	4.86	27.3	8.73	29.6	4.14	34.2	35.21	1.08	13.99	
7/12/2017	5:15:00	11.97		32.27	0	0	0	26.95	3.77	26.2	5.11	26.1	7.86	26.5	4.85	27.4	8.74	29.6	4.13	34.2	35.14	1.08	13.99	
7/12/2017	5:20:00	11.97		32.27	0	0	0	26.95	3.76	26.1	5.14	26.1	7.86	26.5	4.85	27.4	8.72	29.6	4.13	34.2	35.1	1.08	13.99	
7/12/2017	5:25:00	11.97		32.27	0	0	0	26.95	3.77	26.2	5.13	26.1	7.85	26.5	4.85	27.4	8.74	29.5	4.14	34.2	34.97	1.08	13.99	
7/12/2017	5:30:00	11.97		32.27	0	0	0	26.95	3.77	26.1	5.11	26.1	7.86	26.5	4.85	27.4	8.72	29.6	4.14	34.2	34.89	1.08	13.99	
7/12/2017	5:35:00	11.97		32.27	0	0	0	26.95	3.77	26.1	5.14	26.1	7.86	26.5	4.85	27.3	8.75	29.6	4.14	34.2	34.81	1.08	13.99	
7/12/2017	5:40:00	11.97		32.26	0	0	0	26.95	3.76	26.2	5.11	26.1	7.86	26.5	4.86	27.3	8.72	29.6	4.13	34.2	34.73	1.08	13.99	
7/12/2017	5:45:00	11.89		32.26	0	0	0	26.95	3.76	26.1	5.14	26.1	7.86	26.6	4.85	27.4	8.74	29.6	4.14	34.2	34.67	1.08	13.99	
7/12/2017	5:50:00	11.97		32.27	0	0	0	26.95	3.76	26.2	5.1	26.1	7.85	26.5	4.86	27.3	8.75	29.5	4.14	34.2	34.59	1.08	13.99	
7/12/2017	5:55:00	11.89		32.27	0	0	0	26.95	3.77	26.2	5.14	26.1	7.87	26.5	4.86	27.3	8.74	29.6	4.14	34.2	34.59	1.08	13.99	
7/12/2017	6:00:00	11.89		32.27	0	0	0	26.95	3.77	26.2	5.14	26.1	7.85	26.5	4.85	27.3	8.75	29.6	4.13	34.2	34.58	1.08	13.99	
7/12/2017	6:05:00	11.89		32.27	0	0	0	26.95	3.76	26.1	5.11	26.1	7.86	26.5	4.85	27.3	8.74	29.6	4.14	34.2	34.54	1.08	13.99	
7/12/2017	6:10:00	11.89		32.27	0	0	0	26.95	3.77	26.1	5.14	26.1	7.86	26.5	4.86	27.4	8.74	29.6	4.14	34.2	34.51	1.08	13.99	
7/12/2017	6:15:00	11.89		32.27	0	0	0	26.95	3.78	26.2	5.14	26.1	7.85	26.6	4.85	27.3	8.72	29.6	4.13	34.2	34.47	1.08	14	
7/12/2017	6:20:00	11.89		32.27	0	0	0	26.95	3.76	26.1	5.14	26.1	7.86	26.5	4.85	27.3	8.74	29.6	4.14	34.2	34.42	1.09	14	
7/12/2017	6:25:00	11.89		32.27	0	0	0	26.95	3.76	26.2	5.11	26.1	7.86	26.5	4.84	27.4	8.73	29.6	4.14	34.2	34.36	1.09	14	
7/12/2017	6:30:00	11.89		32.28	0	0	0	26.95	3.76	26.1	5.14	26.1	7.85	26.6	4.84	27.4	8.72	29.5	4.13	34.2	34.3	1.09	14	
7/12/2017	6:35:00	11.89		32.28	0	0	0	26.95	3.76	26.1	5.14	26.1	7.85	26.5	4.84	27.3	8.72	29.6	4.13	34.2	34.25	1.09	14	
7/12/2017	6:40:00	11.89		32.27	0	0	0	26.95	3.76	26.2	5.11	26.1	7.86	26.5	4.85	27.4	8.72	29.5	4.14	34.2	34.16	1.09	14	
7/12/2017	6:45:00	11.89		32.27	0	0	0	26.95	3.76	26.1	5.14	26.1	7.85	26.6	4.85	27.3	8.72	29.6	4.14	34.2	34.05	1.09	14	
7/12/2017	6:50:00	11.89		32.27	0	0	0	26.95	3.76	26.1	5.13	26.1	7.85	26.5	4.85	27.3	8.74	29.6	4.13	34.2	33.92	1.09	14	
7/12/2017	6:55:00	11.89		32.27	0	0	0	26.95	3.77	26.1	5.14	26.1	7.85	26.5	4.85	27.4	8.72	29.6	4.13	34.2	33.8	1.09	14	
7/12/2017	7:00:00	11.89		32.27	0	0	0	26.95	3.77	26.1	5.12	26.1	7.85	26.5	4.85	27.3	8.73	29.6	4.14	34.2	33.69	1.08	14	
7/12/2017	7:05:00	11.89		32.27	0	0	0	26.95	3.77	26.1	5.14	26.1	7.85	26.6	4.85	27.3	8.73	29.6	4.14	34.2	33.56	1.08	14	

The entire data set is stored in Reclamation's Information Sharing Environment (RISE) site: https://data.usbr.gov/catalog/4408

Appendix 7. HSP-2 Pressure Transducer Data

A portion of this dataset is provided in this appendix. The entire dataset is available at Reclamation's Information Sharing Environment (RISE) site: https://data.usbr.gov/catalog/4408

HSP-2 Monitor Well Pressure Transducer Data Example - will be uploaded to RISE									
Date Time, GMT-07:00	Water Level, feet (LGR S/N: 9811768)	Abs Pres, psi (LGR S/N: 9811768, SEN S/N: 9811768)	Temp, °F (LGR S/N: 9811768, SEN S/N: 9811768)	Abs Pres Barom., psi (LGR S/N: 9811769, SEN S/N: 9811769)		Coupler Detached (LGR S/N: 9811768)	Coupler Attached (LGR S/N: 9811768)	Host Connected (LGR S/N: 9811768)	End Of File (LGR S/N: 9811768)
9/7/2018 10:39				14.08					
9/7/2018 10:44				14.0816					
9/7/2018 10:48	0.066	14.1011	92.55						
9/7/2018 10:49						Logged			
9/7/2018 10:49				14.0829					
9/7/2018 10:53	0.056	14.0939	93.304						
9/7/2018 10:54				14.0781					
9/7/2018 10:58	0.043	14.0865	91.987						
9/7/2018 10:59				14.0778					
9/7/2018 11:03	0.037	14.0846	90.495						
9/7/2018 11:04				14.0785					
9/7/2018 11:08	0.027	14.0791	89.384						
9/7/2018 11:09				14.0769					
9/7/2018 11:13	0.021	14.0755	88.282						
9/7/2018 11:14				14.0761					
9/7/2018 11:18	0.026	14.0755	87.186						
9/7/2018 11:19				14.0732					
9/7/2018 11:23	0.026	14.0737	86.459						
9/7/2018 11:24				14.0723					
9/7/2018 11:28	0.02	14.0719	85.735						
9/7/2018 11:29				14.0737					
9/7/2018 11:33	0.027	14.0737	85.014						
9/7/2018 11:34				14.0711					
9/7/2018 11:38	0.023	14.0682	84.474						
9/7/2018 11:39				14.0668					
9/7/2018 11:43	0.031	14.0701	84.115						

The entire data set is stored in Reclamation's Information Sharing Environment (RISE):
https://data.usbr.gov/catalog/4408

Appendix 8. Heard Scout Pueblo Field Notes

Date	Time	Name	Recorder	Weather	Wind	Maintenance	Battery volt	Records number	Records start	Records end	Notes
8/21/2017	NA	WH_S	RR	Cloudy	Breezy	YES	13.1	58780	8/7/2017	8/19/2021	Changed intervfal timer from 5 min. to 10 mins.; Set clock to correct time- ended 08/19/17 actual end date is 08/21/17- 2days, 1.5hrs behind
8/21/2017	NA	WH_N	RR	Cloudy	Breezy	YES	6.9	6916	7/28/2017	8/10/2017	Changed main battery, removed RF unit, replaced CR2016 battery, recording started 8/21/17
8/21/2017	NA	HOBO_BARO	RR	Cloudy				11008	8/9/2017	8/21/2017	
8/21/2017	NA	HOBO_DTW	RR	Cloudy				11008	8/9/2017	8/21/2017	
8/21/2017	NA	HOBO_TRIB2	RR	Cloudy				30784	7/17/2017	8/21/2017	
9/18/2017	NA	WH_S	RR, JC	Sunny	Breezy	NO	13.8	68651	8/7/2017	9/18/2017	
9/18/2017	NA	WH_N	RR, JC	Sunny	Breezy	NO	13.1	68550	7/28/2017	9/18/2017	
9/18/2017	NA	HOBO_BARO	RR, JC	Sunny				11519	8/9/2017	9/18/2017	
9/18/2017	NA	HOBO_DTW	RR, JC	Sunny				11520	8/9/2017	9/18/2017	
9/18/2017	NA	HOBO_TRIB2	RR, JC	Sunny				18106	7/17/2017	9/18/2017	
10/17/2017	7:30	WH_S	RR	Sunny	Calm	NO	13.17	70969	8/7/2017	10/17/2017	
10/17/2017	7:30	WH_N	RR	Sunny	Breezy	NO	13.23	70953	7/28/2017	10/17/2017	
10/17/2017	7:30	HOBO_BARO	RR	Sunny				60096	8/9/2017	10/17/2017	
10/17/2017	7:30	HOBO_DTW	RR	Sunny				60096	8/9/2017	10/17/2017	
10/17/2017	7:30	HOBO_TRIB2	RR	Sunny				65536	7/17/2017	9/30/2017	HOBO was pulled out from position; Status check- "Logger is full" (exceeded memory capacity)
11/20/2017	12:20	WH_S	RR	Sunny	Calm	NO	13.29	83987	8/7/2017	11/20/2017	
11/20/2017	12:20	WH_N	RR	Partly Cloudy	Calm	NO	13.24	84005	7/28/2017	11/20/2017	
11/20/2017	12:20	HOBO_BARO	RR	Partly Cloudy				9850	10/17/2017	11/20/2017	Shuttle lights were blinking when attempting to download. Removed/ disconnected shuttle & HOBO then reattached. No blinking, but no data when read-out. It created a folder named with a string of numbers that contained the data and collection form was updated post-processing
11/20/2017	12:20	HOBO_DTW	RR	Partly Cloudy				9844	10/17/2017	11/20/2017	
11/20/2017	12:20	HOBO_TRIB2	RR	Partly Cloudy				30080	10/17/2017	11/20/2017	
12/15/2017	10:50	WH_S	RR	Sunny	Calm	NO	13.46	61289	8/7/2017	12/15/2017	Clock is correct
12/15/2017	10:50	WH_N	RR	Sunny	Breezy	NO	13.31	61307	7/28/2017	12/15/2017	Tire tracks to WH & USGS station. Spilt sand on the ground with fresh shoe prints on south side of USGS station
12/15/2017	10:50	HOBO_BARO	RR	Sunny				7188	11/20/2017	12/15/2017	
12/15/2017	10:50	HOBO_DTW	RR	Sunny				7188	11/20/2017	12/15/2017	
12/15/2017	10:50	HOBO_TRIB2	RR	Sunny				7189	11/20/2017	12/15/2017	
1/18/2018	11:07	WH_S	RR, DT	Sunny	Calm	NO	13.47	83528	8/7/2017	1/18/2018	
1/18/2018	11:07	WH_N	RR, DT	Sunny	Breezy	NO	13.39	83495	7/28/2017	1/18/2018	
1/18/2018	11:07	HOBO_BARO	RR, DT	Sunny				51520	11/20/2017	1/18/2018	Clock ahead by 6 seconds, synced clock, Launched shuttle, battery is 96%- 2.76 volts, shuttle lights did not shine at all
1/18/2018	11:07	HOBO_DTW	RR, DT	Sunny				9795	11/20/2017	1/18/2018	Shuttle lights shown correctly (yellow then green)
1/18/2018	11:07	HOBO_TRIB2	RR, DT	Sunny				29952	12/15/2017	1/18/2018	Memory 21 of 64 kb, launched shuttle
2/13/2018	10:05	WH_S	RR	Cloudy	Calm	NO	13.54	63760	1/18/2018	2/13/2018	Clock was 3 minutes fast (10:16 stated time vs 10:13 actual/PC time). Set clock after download.
2/13/2018	10:05	WH_N	RR	Cloudy	Breezy	NO	13.44	63778	1/18/2018	2/13/2018	Clock was 6 minutes fast (10:43 stated time vs 10:37 actual/PC time). Set clock after download.

Date	Time	Name	Recorder	Weather	Wind	Maintenance	Battery volt	Records number	Records start	Records end	Notes
2/13/2018	10:05	HOBO_BARO	RR	Sunny				22976	1/18/2018	2/13/2018	Clock ahead by 1 minute, 59 seconds per "Status" check. Synced clock before relaunching.
2/13/2018	10:05	HOBO_DTW	RR	Sunny				22976	1/18/2018	2/13/2018	
2/13/2018	10:05	HOBO_TRIB2	RR	Sunny					1/18/2018	2/13/2018	
3/13/2018		WH_S	RR	Cloudy	Breezy	NO	13.32	68821	2/13/2018	3/13/2018	clock ahead by 12 seconds, set clock to PC clock
3/13/2018		WH_N	RR	Cloudy	Breezy	NO	13.24	68856	2/13/2018	3/13/2018	clock ahead by 1 minute 17 seconds, set clock to PC clock
3/13/2018		HOBO_BARO	RR	Cloudy				47232	1/18/2018	3/13/2018	It appears HOBO did not relaunch last visit
3/13/2018		HOBO_DTW	RR	Cloudy				24768	2/13/2018	3/13/2018	
3/13/2018		HOBO_TRIB2	RR	Cloudy				24832	2/13/2018	3/13/2018	
4/4/2018		WH_S	RR	Sunny	Calm	NO	13.17	154114	2/13/2018	4/4/2018	
4/4/2018		WH_N	RR	Sunny	Breezy	NO	13.1	120561	2/13/2018	4/4/2018	
4/4/2018		HOBO_BARO	RR	Sunny				19584	3/13/2018	4/4/2018	
4/4/2018		HOBO_DTW	RR	Sunny				19584	3/13/2018	4/4/2018	
4/4/2018		HOBO_TRIB2	RR	Sunny				19584	3/13/2018	4/4/2018	
5/2/2018		WH_S	RR	Cloudy	Windy	NO	13.33	68787	4/4/2018	5/2/2018	Light, sparse rain (sprinkle), clock ahead by 60 seconds, set clock to PC clock
5/2/2018		WH_N	RR	Partly Cloudy	Calm	NO	13.3	68788	4/4/2018	5/2/2018	Clouds quickly moved past site. clock ahead by 1 minute 57 seconds, set clock to PC clock
5/2/2018		HOBO_BARO	RR	Partly Cloudy				24768	4/4/2018	5/2/2018	
5/2/2018		HOBO_DTW	RR	Partly Cloudy				24768	4/4/2018	5/2/2018	
5/2/2018		HOBO_TRIB2	RR	Partly Cloudy				24768	4/4/2018	5/2/2018	
6/4/2018		WH_S	RR	Sunny	Calm	NO	13.06	120986	4/16/2018	6/4/2018	clock ahead by 5 seconds, set clock to PC clock
6/4/2018		WH_N	RR	Sunny	Calm	NO	12.99	81109	5/2/2018	6/4/2018	clock ahead by 34 seconds, set clock to PC clock
6/4/2018		HOBO_BARO	RR					29120	5/2/2018	6/4/2018	
6/4/2018		HOBO_DTW	RR					29120	5/2/2018	6/4/2018	
6/4/2018		HOBO_TRIB2	RR					29120	5/2/2018	6/4/2018	
7/2/2018		WH_S	RR	Sunny	Breezy	NO	13.05	78757	6/4/2018	7/6/2018	clock ahead by 2 minutes, 12 seconds, set clock to PC clock
7/2/2018		WH_N	RR	Sunny	Windy	NO	12.99	78757	6/4/2018	7/6/2018	clock ahead by 2 minutes, 23 seconds, set clock to PC clock
7/2/2018		HOBO_BARO	RR					28288	6/4/2018	7/6/2018	
7/2/2018		HOBO_DTW	RR					28288	6/4/2018	7/6/2018	
7/2/2018		HOBO_TRIB2	RR					29120			
8/9/2018		WH_S	RR	Sunny	Calm	NO	13.16	89222	7/6/2018	8/9/2018	Clock ahead by 2 minutes, 18 seconds. Inspected rain cup for dirt or debris, appeared clean. Multiple "USB Device not recognize" and " USB Device Malfunctioned" midway through durning download (40% on on) despite connection being veried as secure. Records copied count and progress bar continued to progress during the error.
8/9/2018		WH_N	RR	Sunny	Breezy	NO	13.07	83223	7/6/2018	8/9/2018	clock ahead by 2 minutes 21 seconds , set clock to PC clock.
8/9/2018		HOBO_BARO	RR					29824	7/6/2018	8/9/2018	Difficulty connecting and reading out. About 5 tries stated to device supported foun, and 2 no records found, before readout successful. Hobo shuttle green light first try, but after w2-3 tries with no device supported, removed to try again, then about 2 tries where flashed red, 1 kept flashing yellow.
8/9/2018		HOBO_DTW	RR					29824	7/6/2018	8/9/2018	HOBO felt cool to the touch and briefly fingerprints would stay as perspiration.
8/9/2018		HOBO_TRIB2	RR								

Date	Time	Name	Recorder	Weather	Wind	Maintenance	Battery volt	Records number	Records start	Records end	Notes
9/7/2018		WH_S	RR, VS	Sunny	Breezy	NO	13.17	71207	8/9/2018	9/7/2018	Clock ahead by 1 minute, 50 seconds. Inspected rain cup for dirt or debris, appeared clean.
9/7/2018		WH_N	RR, VS	Sunny	Breezy	NO	13.08	71132	8/9/2018	9/7/2018	Clock ahead by 2 minutes 46 seconds , set clock to PC clock.
9/7/2018		HOBO_BARO	RR, VS					25600	8/9/2018	9/7/2018	
9/7/2018		HOBO_DTW	RR, VS					25600	8/9/2018	9/7/2018	
9/7/2018		HOBO_TRIB2	RR, VS								
10/5/2018		WH_S	RR	Sunny	Calm	NO	13.26	68787	9/7/2018	10/5/2018	Clock ahead by 2 minute, 4 seconds. Inspected rain cup for dirt or debris, appeared clean.
10/5/2018		WH_N	RR	Sunny	Calm	NO	13.17	68771	9/7/2018	10/5/2018	Clock ahead by 3 minutes 30 seconds , set clock to PC clock.
10/5/2018		HOBO_BARO	RR					24768	9/7/2018	10/5/2018	HOBO felt cool to the touch.
10/5/2018		HOBO_DTW	RR					24768	9/7/2018	10/5/2018	HOBO felt cool to the touch.
11/7/2018		WH_S	RR	Sunny	Calm	NO	13.34	81142	10/5/2018	11/7/2018	Clock ahead by 5 seconds. Inspected rain cup for dirt or debris, appeared clean.
11/7/2018		WH_N	RR	Sunny	Breezy	NO	13.24	81174	10/5/2018	11/7/2018	Clock ahead by 22 seconds , set clock to PC clock. Attempted redownloading records for records count, appears 16 records per interval (16 records are all that were counted in the new attempt).
11/7/2018		HOBO_BARO	RR					29120	10/5/2018	11/7/2018	HOBO felt cool to the touch, black cap had condesation/ moisture visable
11/7/2018		HOBO_DTW	RR					29120	10/5/2018	11/7/2018	HOBO felt cool to the touch, fine soil particals built up & adheared to black cap as if dust had accumulated.
12/10/2018		WH_S	RR	Sunny	Calm	NO	13.5	81074	11/7/2018	12/10/2018	Clock ahead by 8 seconds. Inspected rain cup for dirt or debris, appeared clean.
12/10/2018		WH_N	RR	Sunny	Breezy	NO	13.4	81041	11/7/2018	12/10/2018	Clock ahead by 13 seconds , set clock to PC clock.
12/10/2018		HOBO_BARO	RR					29056	11/7/2018	12/10/2018	HOBO felt cold to the touch, the logger had many water droplets as if it were submerged. Note that this logger is to uppermost logger.
12/10/2018		HOBO_DTW	RR					29056	11/7/2018	12/10/2018	HOBO was not cool or had any moisture. Black cap had soil particles built up on the tip.
1/7/2019		WH_S	RR	Sunny	Calm	NO	13.83	68736	12/10/2018	1/7/2019	Clock behind by 16 seconds. Water droplets hanging from weather station. Inspected rain cup for dirt or debris, appeared clean.
1/7/2019		WH_N	RR	Sunny	Breezy	NO	13.52	68737	12/10/2018	1/7/2019	Clock ahead by 5 seconds , set clock to PC clock.
1/7/2019		HOBO_BARO	RR					24768	12/10/2018	1/7/2019	HOBO felt cold to the touch, the logger had many water droplets as if it were submerged. Note that this logger is to uppermost logger.
1/7/2019		HOBO_DTW	RR					24768	12/10/2018	1/7/2019	HOBO was cool and had moisture on one section of the cap. Black cap had few soil particles built up on the tip.
2/26/2019		WH_S	DT	Sunny	Calm	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Unable to download; appears to be cable issue RS232
2/26/2019		WH_N	DT	Sunny	Calm	Not recorded	Not recorded	Not recorded	Not recorded	Not recorded	Unable to download; appears to be cable issue RS232
2/26/2019		HOBO_BARO	DT	Sunny	Calm			42880	1/7/2019	2/25/2019	
2/26/2019		HOBO_DTW	DT	Sunny	Calm			Not recorded	1/7/2019	2/25/2019	
2/26/2019		HOBO_TRIB2	DT								No longer installed
3/22/2019		WH_S	RT	Sunny	Breezy	YES	13.39	122138	1/11/2019	3/22/2019	1/7 to 1/11 no data (overwritten). Battery needs to be above 12 volts otherwise take battery out of solar panel to check with voltmeter.
3/22/2019		WH_N	RT	Sunny	Breezy	YES	13.25	122139	1/11/2019	3/22/2019	1/7 to 1/11 no data (overwritten). Reset from 1 hour to 10 minute readings.
3/22/2019		HOBO_BARO	RT	Sunny	Breezy			22206	2/25/2019	3/22/2019	Battery good.
3/22/2019		HOBO_DTW	RT	Sunny	Breezy			22208	2/25/2019	3/22/2019	Field notes note: reset clock. 2/25/2019 at 10:20 last 10 minute reading then 1 hour.
3/22/2019		HOBO_TRIB2	RT					N/A			Not installed at this time.

Date	Time	Name	Recorder	Weather	Wind	Maintenance	Battery volt	Records number	Records start	Records end	Notes
4/24/2019		WH_S	DT, RT	Partly Cloudy	Calm	YES	Not recorded	81006	3/22/2019	4/24/2019	Bird droppings on solar panel. Truck or heavy equipment used to deposit sand pile adjacent and in channel at base of mountain and some changes to flow channel through shooting range (see photos). This may impact southwest flows in channel aboce GCS structures.
4/24/2019		WH_N	DT, RT	Partly Cloudy	Calm	YES	Not recorded	81041	3/22/2019	4/24/2019	
4/24/2019		HOBO_BARO	DT, RT	Partly Cloudy	Calm			29056	3/22/2019	4/24/2019	
4/24/2019		HOBO_DTW	DT, RT	Partly Cloudy	Calm			29056	3/22/2019	4/24/2019	
4/24/2019		HOBO_TRIB2	DT, RT					N/A			Not installed at this time.
5/24/2019		WH_S	DT, RT	Sunny	Breezy	YES	13.3	73551	4/24/2019	5/24/2019	Sediment deposit - backhoe work remains the same; not cleared or smoothed.
5/24/2019		WH_N	DT, RT	Sunny	Breezy	YES	Not recorded	73543	Not recorded	5/24/2019	
5/24/2019		HOBO_BARO	DT, RT	Sunny	Breezy			26432	4/24/2019	5/24/2019	Battery good.
5/24/2019		HOBO_DTW	DT, RT	Sunny	Breezy			26432	4/24/2019	5/24/2019	Battery good.
5/24/2019		HOBO_TRIB2	DT, RT					N/A			Not installed at this time.
6/25/2019		WH_S	DT, MS	Sunny	Calm	YES	13.14	78654	5/24/2019	6/25/2019	
6/25/2019		WH_N	DT, MS	Sunny	Calm	YES	13.05	78655	5/24/2019	6/25/2019	
6/25/2019		HOBO_BARO	DT, MS	Sunny	Calm			28224	Not recorded	6/25/2019	Data possibly recorded in wrong place on data sheet.
6/25/2019		HOBO_DTW	DT, MS	Sunny	Calm			28224	Not recorded	Not recorded	Data recorded in wrong place on data sheet.
6/25/2019		HOBO_TRIB2	DT, MS					N/A			Not installed at this time. (Data written here in notes, but for HOBO_BARO or HOBO_TRIB2.)
7/19/2019		WH_S	DT	Partly Cloudy	Windy	YES	13.2	59124	6/25/2019	7/19/2019	
7/19/2019		WH_N	DT	Partly Cloudy	Windy	YES	13.04	59108	6/25/2019	7/19/2019	
7/19/2019		HOBO_BARO	DT	Partly Cloudy	Windy			49024	6/25/2019	7/19/2019	
7/19/2019		HOBO_DTW	DT	Partly Cloudy	Windy			21376	6/25/2019	7/19/2019	
7/19/2019		HOBO_TRIB2	DT					N/A			Not installed at this time.
8/15/2019		WH_S	DT	Sunny	Breezy	YES	13.15	66061	7/19/2019	8/15/2019	
8/15/2019		WH_N	DT	Sunny	Breezy	Not recorded	13.05	66045	7/19/2019	8/15/2019	
8/15/2019		HOBO_BARO	DT	Sunny	Breezy			65536	7/15/2019	8/15/2019	
8/15/2019		HOBO_DTW	DT	Sunny	Breezy			44608	7/15/2019	8/15/2019	
8/15/2019		HOBO_TRIB2	DT					N/A			Not installed at this time.
9/20/2019		WH_S	DT, LB	Sunny	Calm	YES	13.19	122138	8/2/2019	9/20/2019	Site val file is remote, inaccessible, or does not exist.
9/20/2019		WH_N	DT, LB	Sunny	Breezy	YES	13.07	122139	8/2/2019	9/20/2019	
9/20/2019		HOBO_BARO	DT, LB	Sunny	Calm			31744	Not recorded	9/20/2019	Battery level 36%.
9/20/2019		HOBO_DTW	DT, LB	Sunny	Calm			31744	Not recorded	9/20/2019	
9/20/2019		HOBO_TRIB2	DT, LB					N/A			Not installed at this time.
10/23/2019		WH_S	DT	Sunny	Calm	YES	13.27	81108	9/20/2019	10/23/2019	
10/23/2019		WH_N	DT	Sunny	Calm	YES	13.14	81109	9/20/2019	10/23/2019	
10/23/2019		HOBO_BARO	DT	Sunny	Calm			60288	Not recorded	Not recorded	Battery status good.
10/23/2019		HOBO_DTW	DT	Sunny	Calm			60288	Not recorded	Not recorded	Battery status good. USGS transducer did not look as taped up as in past. Sent photos to Jay Cederberg.
10/23/2019		HOBO_TRIB2	DT					N/A			Not installed at this time.
11/22/2019		WH_S	DT, LR	Sunny	Calm	YES	13.43	73831	10/23/2019	11/22/2019	
11/22/2019		WH_N	DT, LR	Sunny	Calm	YES	13.32	73866	10/23/2019	11/22/2019	
11/22/2019		HOBO_BARO	DT, LR	Sunny	Calm			65536	10/23/2019	10/29/2019	Battery status is good. Data logger stopped loggining 10/29/2019; relaunched 11/22/2019.

Date	Time	Name	Recorder	Weather	Wind	Maintenance	Battery volt	Records number	Records start	Records end	Notes
11/22/2019		HOBO_DTW	DT, LR	Sunny	Calm			65536	10/23/2019	10/29/2019	Battery status is good. Data logger stopped loggining 10/29/2019; relaunched 11/22/2019.
11/22/2019		HOBO_TRIB2	DT, LR					N/A			Not installed at this time.
12/18/2019		WH_S	DT	Sunny	Calm	YES	13.47	63998	11/22/2019	12/18/2019	
12/18/2019		WH_N	DT	Sunny	Breezy	YES	13.42	16366	11/22/2019	12/18/2019	
12/18/2019		HOBO_BARO	DT	Sunny	Calm			no files	N/A	N/A	33% battery.
12/18/2019		HOBO_DTW	DT	Sunny	Calm			no files	N/A	N/A	33% battery.
12/18/2019		HOBO_TRIB2	DT					N/A			
1/10/2020		WH_S	DT			N/A	N/A	N/A	N/A	N/A	
1/10/2020		WH_N	DT			N/A	N/A	N/A	N/A	N/A	
1/10/2020		HOBO_BARO	DT	Sunny	Breezy			N/A	1/10/2020	N/A	Installed new pressure transducer HOBO-U20L-04. Water level SN 20741796; 0 to 13 feet.
1/10/2020		HOBO_DTW	DT	Sunny	Breezy			N/A	1/10/2020	N/A	Installed new pressure transducer HOBO-U20L-02. Water level SN 20698037; 0 to 100 feet.
1/10/2020		HOBO_TRIB2	DT					N/A			Not installed at this time.
2/7/2020		WH_S	DT	Sunny	Calm	Not recorded	13.36	119432	12/19/2019	2/7/2020	
2/7/2020		WH_N	DT	Sunny	Calm	Not recorded	13.34	14881	12/19/2019	2/7/2020	One data point per day collected instead of every 10 minutes.
2/7/2020		HOBO_BARO	DT	Sunny	Calm			12672	1/10/2020	2/7/2020	
2/7/2020		HOBO_DTW	DT	Sunny	Calm			12672	1/10/2020	2/7/2020	
2/7/2020		HOBO_TRIB2	DT					N/A			Not installed at this time.
3/13/2020		WH_S	DT, RB	Cloudy/Rain	Breezy	Not recorded	13.63	122138	1/24/2020	Not recorded	
3/13/2020		WH_N	DT, RB	Cloudy/Rain	Breezy	Not recorded	Not recorded	122063	10/23/2019	3/13/2020	Had to download driver for com. Used new serial connector and driver for that.
3/13/2020		HOBO_BARO	DT, RB	Cloudy/Rain	Breezy			15680	2/7/2020	3/13/2020	
3/13/2020		HOBO_DTW	DT, RB	Cloudy/Rain	Breezy			15680	Not recorded	Not recorded	Raining during download.
3/13/2020		HOBO_TRIB2	DT, RB					N/A			Not installed at this time.

Appendix 9. WeatherHawk Data

A portion of this dataset is provided in this appendix. The entire dataset is available at Reclamation's Information Sharing Environment (RISE) site: https://data.usbr.gov/catalog/4408

Example Weather Station Data - entire data set is stored in Reclamation's Information Sharing Environment (RISE): https://data.usbr.gov/catalog/4408

TIMESTAMP	RECORD	BatVolt_V	BatVolt_V_Min	AirTemp_C_Avg	RH_Avg	WindSpeed_ms_Avg	Solar_Avg	ETo	AirTemp_C_Min	AirTemp_C_TMn	AirTemp_C_Max	AirTemp_C_TMx	WindSpeed_ms_WVc(1)	WindSpeed_ms_WVc(2)	WindSpeed_ms_Max	WindSpeed_ms_TMx	Barometer_KPa	RainYearly_mm	Station	SP83AZCntrl0202_IntFt_X	SP83AZCntrl0202_IntFt_Y	SP83AZCntrl0202_IntFt_Z	AirTempAve_F	Rainfall_Inches	Rainfall_Event
6/26/2017 18:00	0	12.95086	12.92652	35.86837	24.37613	0.01094566	130.5171	0.013121	23.24347	6/26/2017 17:01	45.2486	6/26/2017 17:59	0.01094566	158.4067	0.4265	6/26/2017 17:01	96.77895	0	WH_North	662301.32	860254.92	1268.923	96.563066	0	0
6/26/2017 19:00	1	12.92484	12.90553	47.87636	8.90554	0.008515371	37.74746	0.021102	45.19781	6/26/2017 18:00	49.54428	6/26/2017 18:56	0.008515371	159.8614	0.503	6/26/2017 18:18	96.68567	0	WH_North	662301.32	860254.92	1268.923	118.177448	0	0
6/27/2017 12:00	2	12.98024	12.95926	38.00687	11.18371	1.00E-05	158.0363	0.04836	36.04114	6/27/2017 11:38	39.81372	6/27/2017 12:00	1.00E-05	158.8452	1.00E-05	6/27/2017 11:38	96.93101	0	WH_North	662301.32	860254.92	1268.923	100.412366	0	0
6/27/2017 13:00	3	12.88035	12.87699	46.95957	4.519525	1.00E-05	177.7285	0.009052	46.70007	6/27/2017 12:56	47.24094	6/27/2017 13:00	1.00E-05	158.9314	1.00E-05	6/27/2017 12:56	96.92637	0	WH_North	662301.32	860254.92	1268.923	116.527226	0	0
6/27/2017 14:00	4	12.85769	12.84677	49.018	3.710984	0.002379394	184.5831	0.171169	47.07449	6/27/2017 13:03	51.15378	6/27/2017 13:57	0.002379394	158.9663	0.4265	6/27/2017 13:36	96.89201	0	WH_North	662301.32	860254.92	1268.923	120.2324	0	0
6/27/2017 15:00	5	12.85852	12.83334	50.11861	3.342004	0.3564247	58.06841	0.006878	41.0043	6/27/2017 14:56	52.21002	6/27/2017 14:58	0.3564247	7.49307	1.115	6/27/2017 14:56	96.83683	0	WH_North	662301.32	860254.92	1268.923	122.213498	0	0
6/27/2017 16:00	6	12.86272	12.83502	50.83364	2.698089	0.4850536	105.7619	0.104737	48.10245	6/27/2017 15:45	53.28156	6/27/2017 15:53	0.4850536	298.3353	2.1095	6/27/2017 15:23	96.78177	0	WH_North	662301.32	860254.92	1268.923	123.500552	0	0
6/27/2017 17:00	7	12.86608	12.83838	50.22234	2.474394	0.5145856	164.3345	0.166936	48.20349	6/27/2017 16:12	53.30923	6/27/2017 16:45	0.5145856	298.9184	2.8745	6/27/2017 16:48	96.68319	0	WH_North	662301.32	860254.92	1268.923	122.400212	0	0
6/27/2017 18:00	8	12.8963	12.85852	48.89354	2.626324	0.4679843	144.4183	0.005215	47.18271	6/27/2017 17:45	51.13712	6/27/2017 17:12	0.4679843	287.76	2.4155	6/27/2017 17:11	96.58121	0	WH_North	662301.32	860254.92	1268.923	120.008372	0	0
6/28/2017 15:00	9	13.0709	12.96765	40.93544	14.25156	0.09446573	12.75464	0.00884	38.50241	6/28/2017 14:39	44.202	6/28/2017 14:59	0.09446573	260.3534	2.1095	6/28/2017 14:58	96.81671	0	WH_North	662301.32	860254.92	1268.923	105.683792	0	0
6/28/2017 16:00	10	12.9475	12.8644	50.09824	5.400846	0.1147604	99.76535	0.067878	47.16156	6/28/2017 15:34	52.20218	6/28/2017 15:50	0.1147604	260.1611	1.3445	6/28/2017 15:57	96.73712	0	WH_North	662301.32	860254.92	1268.923	122.176832	0	0
6/28/2017 17:00	11	12.86104	12.86104	50.37925	5.277781	1.00E-05	147.029	0.00033	50.31595	6/28/2017 16:59	50.43375	6/28/2017 16:59	1.00E-05	144.9941	1.00E-05	6/28/2017 16:59	48.38829	0	WH_North	662301.32	860254.92	1268.923	122.68265	0	0
6/29/2017 11:00	12	13.039	12.93659	36.41718	11.31473	1.336351	910.1348	10.75039	34.25122	6/29/2017 10:20	39.85223	6/29/2017 10:38	1.336351	9.03842	3.3335	6/29/2017 10:53	96.90501	0	WH_North	662301.32	860254.92	1268.923	97.550924	0	0
6/29/2017 12:00	13	12.99032	12.93323	37.66626	10.027	1.435104	990.4883	0.828457	35.27618	6/29/2017 11:12	41.00323	6/29/2017 11:43	1.435104	67.2459	3.6395	6/29/2017 11:25	96.83447	0	WH_North	662301.32	860254.92	1268.923	99.799268	0	0
6/29/2017 13:00	14	12.94918	12.91309	38.83525	8.503035	1.910489	1015.248	0.893378	36.53302	6/29/2017 12:06	41.73837	6/29/2017 12:27	1.910489	47.68484	3.9455	6/29/2017 12:06	96.76945	0	WH_North	662301.32	860254.92	1268.923	101.90345	0	0
6/29/2017 14:00	15	12.93323	12.91225	40.03349	6.216773	2.003744	986.3316	0.884704	37.84784	6/29/2017 13:05	42.71072	6/29/2017 13:49	2.003744	170.3179	5.3225	6/29/2017 13:52	96.66442	0	WH_North	662301.32	860254.92	1268.923	104.060282	0	0
6/29/2017 15:00	16	12.9517	12.92316	40.80177	5.848008	2.119355	889.5691	0.821542	38.74976	6/29/2017 14:42	44.06216	6/29/2017 14:49	2.119355	297.7688	5.1695	6/29/2017 14:59	96.63775	0	WH_North	662301.32	860254.92	1268.923	105.443186	0	0
6/29/2017 16:00	17	13.02137	12.91393	41.31023	5.683708	1.834647	745.6355	0.680924	39.70895	6/29/2017 15:34	44.00858	6/29/2017 15:43	1.834647	13.77367	4.328	6/29/2017 15:29	96.54527	0	WH_North	662301.32	860254.92	1268.923	106.358414	0	0
6/30/2017 8:00	18	13.19262	13.10028	31.60617	16.51228	0.9494488	406.0918	0.226147	29.9223	6/30/2017 7:21	34.16806	6/30/2017 7:52	0.9494488	321.3586	3.0275	6/30/2017 7:16	96.80948	0	WH_North	662301.32	860254.92	1268.923	88.891106	0	0
6/30/2017 9:00	19	13.10952	13.03984	33.94072	12.91014	0.5760091	586.5174	0.413542	31.65747	6/30/2017 8:01	37.44089	6/30/2017 8:53	0.5760091	357.1501	2.033	6/30/2017 8:42	96.89301	0	WH_North	662301.32	860254.92	1268.923	93.093296	0	0
6/30/2017 10:00	20	13.09021	13.00039	35.53651	7.992623	1.201556	767.4991	0.611035	33.54446	6/30/2017 9:06	39.45923	6/30/2017 9:10	1.201556	312.2877	3.41	6/30/2017 9:43	96.83649	0	WH_North	662301.32	860254.92	1268.923	95.965718	0	0
6/30/2017 11:00	21	13.03565	12.95674	35.9865	5.803454	1.698999	911.9539	0.765023	33.73895	6/30/2017 10:01	38.29959	6/30/2017 11:00	1.698999	303.2136	3.6395	6/30/2017 10:52	96.85651	0	WH_North	662301.32	860254.92	1268.923	96.7757	0	0
6/30/2017 12:00	22	13.02725	12.91728	37.77494	5.015694	1.407974	999.6981	0.824589	35.12921	6/30/2017 11:00	41.65558	6/30/2017 11:54	1.407974	334.1415	3.3335	6/30/2017 11:27	96.78336	0	WH_North	662301.32	860254.92	1268.923	99.994892	0	0
6/30/2017 13:00	23	13.00039	12.92904	39.53723	3.679398	1.86554	1028.426	0.896404	36.87357	6/30/2017 12:21	42.55035	6/30/2017 12:55	1.86554	207.9503	4.0985	6/30/2017 12:10	96.72152	0	WH_North	662301.32	860254.92	1268.923	103.167014	0	0
6/30/2017 14:00	24	12.94499	12.90469	40.58492	3.669748	1.718835	994.3323	0.864054	38.00357	6/30/2017 13:08	44.39783	6/30/2017 13:31	1.718835	164.6151	4.4045	6/30/2017 13:58	96.61456	0	WH_North	662301.32	860254.92	1268.923	105.052856	0	0
6/30/2017 15:00	25	12.98612	12.90553	41.51049	3.413759	1.88952	901.3705	0.808582	39.26651	6/30/2017 14:02	44.28113	6/30/2017 14:05	1.88952	285.9501	4.5575	6/30/2017 14:32	96.5525	0	WH_North	662301.32	860254.92	1268.923	106.718882	0	0
6/30/2017 16:00	26	13.03565	12.924	41.48944	3.588406	2.079999	758.1513	0.709078	39.6882	6/30/2017 15:22	44.54767	6/30/2017 15:56	2.079999	188.8093	6.317	6/30/2017 15:47	96.47007	0	WH_North	662301.32	860254.92	1268.923	106.680992	0	0

Appendix 10. Reclamation Land Survey Results

S&T 1751 Survey of Monitoring locations at Heard Scout Pueblo

Project file data		Coordinate System	
Name:	V:\SHARED\Survey Projects\Projects-Dennis V R k h \2017 07 H d S t P bl	Name:	United States/State Plane 1983
Size:	85 KB	Datum:	NAD 1983 (Conus)
Modified:	7/28/2017 2:23:06 PM (UTC:-7)	Zone:	Arizona Central 0202
Time zone:	US Mountain Standard Time	Geoid:	GEOID12B (Conus)
Reference number:		Vertical datum:	
Description:			
Comment 1:			
Comment 2:			
Comment 3:			

Point List

ID	Northing (International foot)	Easting (International foot)	Elevation (International foot)	Feature Code
101	858960.87	662264.51	1317.775	WH-SOUTH
102	858960.22	662266.80	1317.804	WH-SOUTH BASE
103	858962.69	662264.41	1317.763	WH-SOUTH BASE
104	858960.08	662261.73	1317.673	WH-SOUTH BASE
105	858957.57	662264.09	1317.724	WH-SOUTH BASE
106	858960.88	662264.58	1317.741	WH-SOUTH
107	859440.97	661843.90	1286.556	WTRIB
108	859044.45	662301.32	1319.211	E.HEAD-CUT
109	860254.92	662448.38	1268.923	WH-EAST
110	860254.74	662450.29	1268.810	WH-NORTH BASE
111	860256.57	662448.09	1268.794	WH-NORTH BASE
112	860254.12	662446.17	1268.881	WH-NORTH BASE
113	860252.32	662448.72	1268.897	WH-NORTH BASE
114	860248.46	662436.33	1268.691	SW-HOUSING
115	860250.47	662437.46	1268.598	SW
116	860251.64	662435.61	1268.719	SW
117	860249.48	662434.44	1268.658	SW
118	860249.40	662434.31	1268.654	USGS BC
119	860264.41	662407.70	1263.943	SW 1
120	860261.78	662396.75	1263.026	HSP-2
121	860273.40	662401.56	1263.120	HSP-1
122	860348.86	662423.47	1261.740	SW1-DS
123	860252.08	662389.15	1263.155	SEDCHAIN-1
124	860240.36	662378.92	1263.369	SEDCHAIN-2
125	860204.68	662347.50	1263.747	SEDCHAIN-3
126	860201.27	662347.30	1264.363	SW1-US
127	859920.89	662074.56	1272.667	US-BERML
128	859917.72	662077.29	1272.614	US-BERML
129	859914.15	662083.40	1272.693	US-BERML
130	859926.64	662083.21	1275.157	US-BERML
131	859886.84	662058.75	1274.478	US-BERML
132	859885.46	662065.00	1274.674	US-BERMR
133	859867.32	662060.05	1276.087	US-BERMR
134	859871.77	662053.64	1274.833	US-BERMR

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Appendix 11. Natural Channel Design Grade Control Structure Installation Report

BUREAU OF RECLAMATION
HEARD SCOUT RANCH
GRADE CONTROL STRUCTURES

CONSTRUCTION & MONITORING REPORT

September 2019

Natural Channel Design, Inc.

BUREAU OF RECLAMATION
HEARD SCOUT RANCH
GRADE CONTROL STRUCTURES

CONSTRUCTION & MONITORING REPORT

Submitted to:

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Natural Channel Design, Inc.

September 2019

Contents

PROJECT OVERVIEW

The Bureau of Reclamation (BOR) is assessing the impact of rock grade control structures installed on approximately 1,800 feet of ephemeral channel on property owned by the Boy Scouts of America (BSA). Heard Scout Pueblo is located at the base of South Mountain, south of Dobsen Rd in Phoenix, AZ (Figure 1). Natural Channel Design, Inc. (NCD) was contracted to design and install twenty rock grade control structures (GCS) within the project reach. NCD subcontracted with American Conservation Experience (ACE) to provide materials and labor for installation of the structures. The BOR, in cooperation with the U.S.G.S is gaging from the project area.

The BOR provided project Lidar data and aerial photographs of the site. This information was used to determine current channel conditions, structure size and spacing and to estimate rock quantities. A total of twenty-four grade control structures, twenty-five small one rock dams, three overflow channel rock plugs and six rock sills were installed (Figure 2). Construction occurred over three work periods. The first was November 13 through 19th with a five person crew plus an equipment operator for three days. The next work period was November 28 through December 1st with a 7 person crew and equipment operator for three days and the final work period was January 15 through the 18th with an 8-9 person crew and an equipment operator for three days..

Figure 1. Project Location Map

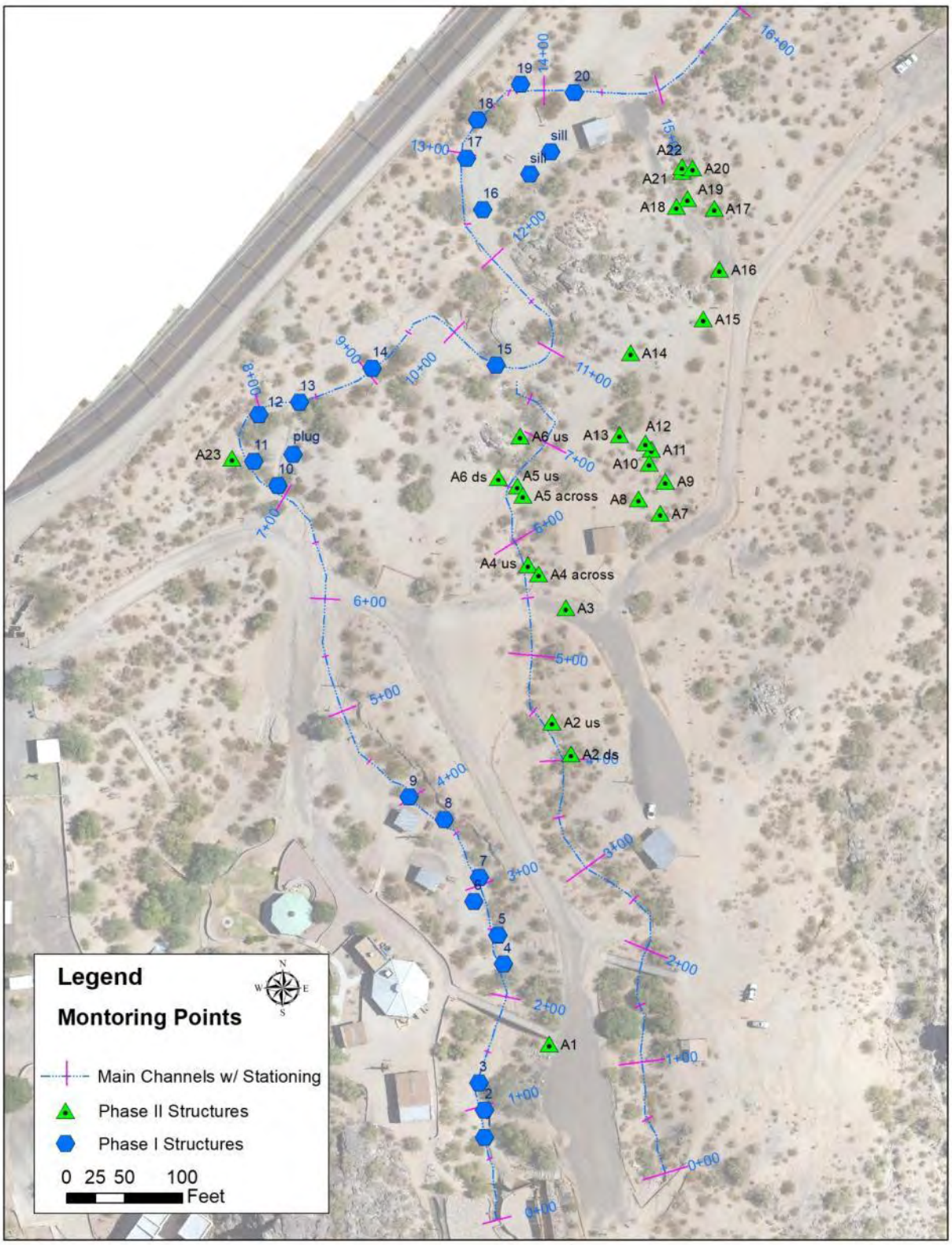

Figure 2. Structure Locations and photo points.

HYDROLOGY AND STRUCTURE DESIGN

The project area was divided into reaches to help estimate the amount of rock needed at each location, since the channel width varied going downstream. These reaches were based on average bed slope and/or the presence of significant incoming tributaries. Within these separate reaches, spacing of structures was determined by calculating length needed to reduce the channel bed slope between structures by at least 50% of the overall reach slope. This resulted in a minimum numbers of structures needed per reach. Actual locations were then field located taking into account the presence of headcuts, scour or vegetation.

The watershed area at the upper end of the project was calculated to be approximately 51 acres. Incoming tributaries increase the total watershed area to 65 acres at the end of the project reach, which is the area used to calculate the return interval discharge amounts.

To estimate flow magnitudes down the channels, the NSS (National Streamflow Statistics) Program was used. The site is located in Flood Region 5 in Arizona, and based on the watershed size estimates discharge quantity was calculated for a range of return intervals (Table 1). The stream channel and geomorphic floodplain is created and maintained by moderate, frequent flood events with return intervals in Arizona in the range of one to two years with the average being a 1.5 yr event (Moody et al 2003). Bankfull discharge is defined as the flow associated with the elevation of the geomorphic floodplain. We estimated that bankfull flows are between 12 and 15 cfs and the 2 yr flows to be around 20 cfs.

Table 1. Estimated Discharge for Different Return Intervals

NSS - WS area = 65 acres	Return Interval (year)	Q (cfs)
	1.5	14
	2	20
	5	41
	10	60
	25	90
	50	113
	100	136

Due to the shallow channel shape, GCS's were designed so that the height of the structures would encourage sediment deposition and water retention, and protect channel banks while maintaining a minimum channel capacity of the 2-yr flow. Several cross sections through the project area were analyzed using a cross-section hydraulic analyzer spreadsheet, (developed by the NRCS Water Quality and Quantity Technology Development Team) to ensure that after increasing bed elevation the channel still had the capacity to hold at least the 2-year flow before spreading out over the floodplain. Due to the sandy soils, we also wanted to reduce the likelihood

of bed scour which might occur if the structures were built too tall. It was determined that the height of structures in the bed would be installed at 0.5 ft above the existing channel bed.

Rock size for the structures was calculated by following the Shields relation and modified using field data from Rosgen (Watershed Assessment of River Stability and Sediment Supply, 2009). We used the 25 year return interval (approx 90 cfs) for use in sizing the rock. Within the project reaches, the highest slope measured was 5.7% and this slope was used to calculate the shear stress, which is an input in the rock sizing calculation. An approximate 12 inch diameter rock was needed to withstand the 25 year flow event. We specified that rock sized between 12 and 16 inches (14 inch D_{50}) be utilized for the top rock of the weir portion of all the structures.

The design of the structures was based on the One Rock Dam, but was modified to provide for channel stability in a functioning stream channel. The implemented grade control structures utilize components of a cross-vane weir design developed by Dave Rosgen as the main structure (Figure 3). The weir arms, (labeled as vane arms in figure 3), are shorter than a typical rock weir design and there is an additional pad of rock downstream, similar to the one rock dam design, which will help prevent bed scour. This design utilizes less rock than a traditional one rock dam and the weir shape helps to reduce bank scour while focusing stream energy towards the center of the channel.

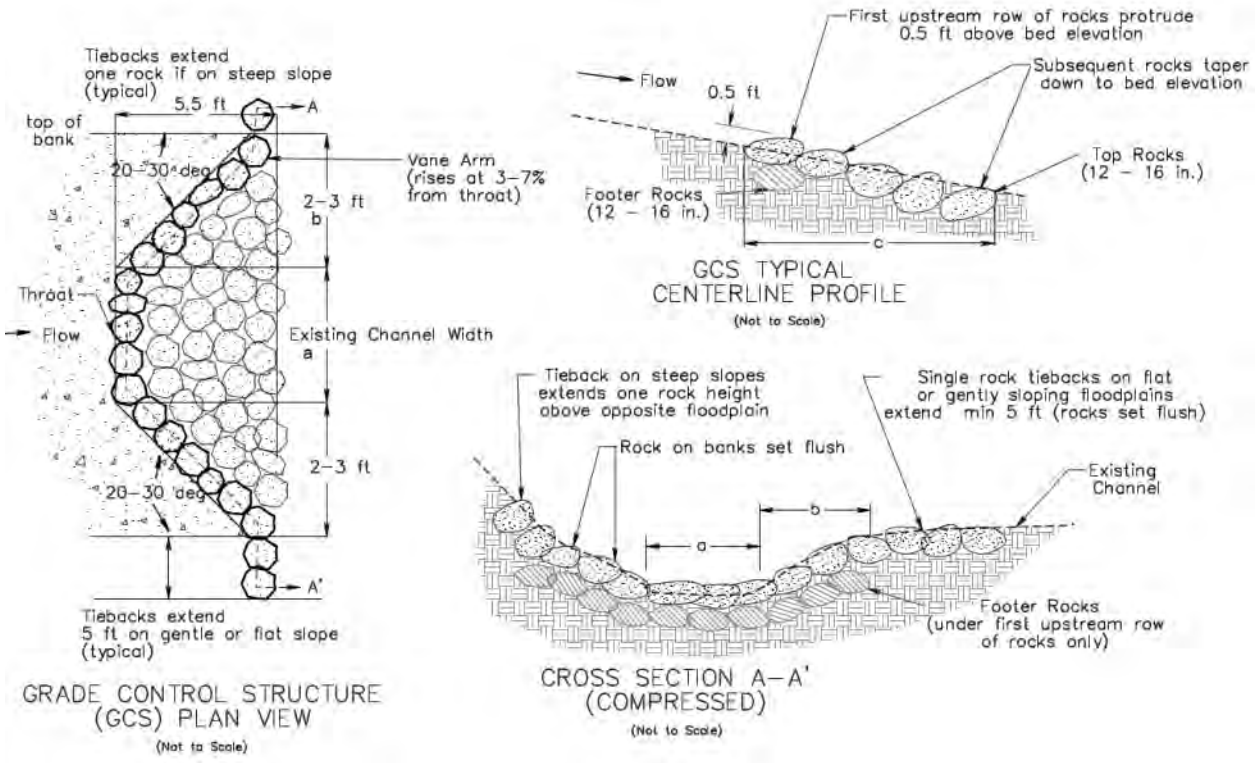

Figure 3. Rock grade control structure design

INSTALLATION

Installation of the grade control structures began on November 13th, 2018. A 4 person ACE crew with a supervisor provided labor for installation. Actual installation locations were laid out prior to the crews' arrival. On the first day, crew hand excavated earth in preparation for the rock structures. The vane arm and throat portion was excavated down approximately 1.5 feet below bed elevation to help prevent undercutting scour. Two structures were excavated the first day.

Figure 4. Excavating for structure placement.

Approximately 20 tons of rock was delivered the following day (Figure 5). With the rock gradation, approximately 2/3rd of the rock delivered was usable for the actual structure, with the smaller rock used for infill.

Figure 5. Truck delivering rock on site.

Rock installation began with setting in footer rocks under the throat and setting the vane arm portions of the structure. The footers help keep the top rocks stable and prevent scour from undermining the structure. The downstream row of rocks was also installed, being buried to existing ground level (Figure 6). The center of the structure was excavated enough to allow a smooth drop of infill rocks (Figure 7).

Figure 6. Grade control structure with weir and downstream rocks installed.

Figure 7. Placing rocks in the interior of the structure.

Figure 8. Completed structure, including tiebacks.

Smaller mini-one rock dams were installed over several very small channels created from concentrated road runoff. These small structures were spread out in these channels to help encourage sediment deposition and reduce channel incision. Photos of these structures are shown in Appendix A.

Work to complete all structures continued over a total of three work periods, ending January 18, 2019.

ZUNI BOWL

A Zuni bowl was installed at the downstream end of the road leading to the camping sites (Figures 9-12). The road crossed the east tributary and continual maintenance was required whenever the channel flows. A Zuni bowl is a structure that is constructed at a small headcut and it armors the cut, allowing water to fall to the lower elevation while dissipating the energy within the bowl.

Figure 9. Site of the Zuni Bowl.

Figure 10. Excavating for Zuni Bowl installation.

Figure 11. Placing rock into Zuni Bowl

Figure 12. Completed structure.

ROCK PLUGS

Three rock plugs were installed in an overflow channel at station 7+00 of the main channel (Figure 2) that was threatening to capture the flow of the main channel. Rock was placed in the gully to plug the overflow channel. The plugs were keyed into the surrounding banks to help prevent scour around the plugs. Plugs were placed lower than the surrounding floodplain to prevent them from acting as an obstruction on the floodplain. Remaining rock not needed for grade control structures was placed in the gully between the plug during site cleanup.

ROCK SILLS

Rock sills were installed at Stations 1+50 and 13+00 of the main channel. The rock sills are simply a row of rock that runs perpendicular to the channel, across the floodplain. Rock sills can either be a single row of larger rock, or as was installed at the site, a rubble trench which uses smaller fractured rock that is compacted together. The top of the sill is set to existing ground level. This structure helps disperse water flowing over the floodplain, which minimizes downcutting. At 13+00, there is a trail that directs foot traffic across a broad floodplain ending at a covered ramada that threatenes to capture flood flows and which could potentially cause downcutting. At this site, three sills were installed, each approximately 25 feet long and spaced approximately 20 feet apart. At Station 1+50, three rock sills were placed into a short section of wide and shallow channel bed where flows are slower and the channel deposits sediment. These structures will help maintain a large width/depth ratio, lower velocities and keep encouraging sediment deposition.

MONITORING

All installed structures were photographed immediately after installation in January 2019. It was hoped that a significant storm runoff event would occur at the site to test the integrity of the structures and to see if any change in ground water could be detected. However, due to an unusually dry monsoon season, there was no large flow down the channels this season. Local runoff from the roads did create for some minor flows in the channels which smoothed the sand and created some mud deposits. Monitoring of all the sites occurred on September 12th and all structures were re-photographed. The comparative photos are displayed in Appendix A.

All structures are intact and functioning as intended. There is no need for repair or maintenance at this time. Additional rock has been stockpiled on site at the request of the Boy Scouts. This material can be used to install additional structures in the future if needed.

MAINTENANCE

Little maintenance should be necessary for the structures. Rock was sized to remain in place up to a 25 year flow event. As flows deposit sediment upstream and over the structures, they will become less noticeable. However, due to the sandy bed conditions, larger flow events could cause some rocks to roll out of place. Monitoring after heavy rainfall that produces extreme amounts of runoff should be done to ensure the structures remain intact and functioning and that no unintended scour or erosion has taken place.

Excessive sediment deposition and larger flood events could cause the stream to find an alternate path around a structure. If this is the case, the new path should be plugged and the throat of the original structure can be lowered slightly by adjusting the weir throat elevation to increase channel capacity.

BSA personnel were informed of the concepts for building these types of structure, and several cubic yards of suitable rock has been left on site. Additional rock grade control structures can be built by BSA volunteers that can improve the road ditch and trail drainage. The location of any future installations should be recorded.

REFERENCES

Moody, T, M.Wirtanen , S.Yard, 2003. Regional Relationships for Bankfull Stage in Natural Channels of the Arid Southwest. Natural Channel Design, Flagstaff, Az

Rosgen, D. 2006. Watershed Assessment of River Stability and Sediment Supply (WARSS). Wildland Hydrology, Fort Collins, Colorado

Appendix A
Monitoring Photos

Structure 1

Structure 1. Looking Upstream January 2019

Structure 1. September 2019

Structure 1. Looking across from right bank, January 2019

Structure 1. September 2019.

There has been some sediment accumulation upstream of structure.

Structure 2

Structure 2. Looking upstream, January 2019

Structure 2. September 2019

Structure 2. Looking across from right bank, January 2019

Structure 2. September 2019

Structure 3

Structure 3. Looking upstream, January 2019

Structure 3. September 2019

Structure 3. Looking across from left bank, January 2019

Structure 3. September 2019

Structure 4

Structure 4. Looking upstream, January 2019

Structure 4. September 2019

Structure 4. Looking across from right bank, January 2019

Structure 4. September 2019

Structure 5

Structure 5. Looking upstream, January 2019

Structure 5. September 2019

Structure 5. Looking across from right bank, January 2019

Structure 5. September 2019

Structure 6

Structure 5. Looking upstream, January 2019

Structure 6. September 2019

Structure 6. Looking across from left bank, January 2019

Structure 6. September 2019

Structure 7

Structure 6. Looking upstream, January 2019

Structure 7. September 2019

Structure 7. Looking across from left bank, January 2019

Structure 7. September 2019

Structure 8

Structure 7. Looking upstream, January 2019

Structure 8. September 2019

Structure 8. Looking across from left bank, January 2019

Structure 8. September 2019

Structure 9

Structure 8. Looking upstream, January 2019

,

Structure 9. September 2019

Structure 9. Looking across from left bank, January 2019

Structure 9. September 2019

Structure 10

Structure 10. Looking upstream, January 2019

Structure 9. September 2019

Structure 10. Looking across from left bank, January 2019

Structure 10. September 2019

Structure 11

Structure 10. Looking upstream, January 2019

Structure 11 September 2019

Structure 11. Looking across from left bank, January 2019

Structure 11. September 2019

Structure 12

Structure 11. Looking upstream, January 2019

Structure 12. September 2019

Structure 12. Looking across from right bank, January 2019

Structure 12. September 2019

Structure 13

Structure 12. Looking upstream, January 2019

Structure 13. September 2019

Structure 13. Looking across from left bank, January 2019

Structure 13. September 2019

Structure 14

Structure 13. Looking upstream, January 2019

Structure 14. September 2019

Structure 14. Looking across from left bank, January 2019

Structure 14. September 2019

Structure 15

Structure 14. Looking upstream, January 2019

Structure 15. September 2019

Structure 15. Looking across from right bank, January 2019

Structure 15. September 2019

Structure 16

Structure 15. Looking upstream, January 2019

Structure 16. September 2019

Structure 16. Looking across from right bank, January 2019

Structure 16. September 2019

Structure 17

Structure 17. Looking upstream, January 2019

Structure 16. September 2019

Structure 17. Looking across from right bank, January 2019

Structure 17. September 2019

Structure 18

Structure 17. Looking upstream, January 2019

Structure 18. September 2019

Structure 18. Looking across from right bank, January 2019

Structure 18. September 2019

Structure 19

Structure 18. Looking upstream, January 2019

Structure 19. September 2019

Structure 19. Looking across from right bank, January 2019

Structure 19. September 2019

Structure 20

Structure 19. Looking upstream, January 2019

Structure 20. September 2019

Structure 20. Looking across from right bank, January 2019

Structure 20. September 2019

Rock Plugs

Rock Plugs. Looking downstream, January 2019

Rock Plugs. September 2019

Rock Sills – Station 13+00

Rock Sill – on floodplain at end of reach, January 2019

Rock Sill - September 2019

The sills are buried and can no longer be seen on the floodplain.

Rock Sills – Structure A1

Structure A1. Three rock sills, January 2019

Structure A1. September 2019

Structure A2

Structure A2, Looking upstream, January 2019

Structure A2, September 2019

Structures A3

Structures A3. Looking upstream, January 2019

Structures A3, September 2019

There are four rock dams in the roadside ditch

Structure A4

Structure A4. Zuni Bowl looking across from right bank, January 2019

Structure A4. September 2019

Structure A4. Looking upstream, January 2019

Structure A4. September 2019

Structure A5

Structure A5. Looking upstream, January 2019

Structure A5. September 2019

Structure A5. Looking across from right bank, January 2019

Structure A5. September 2019

Structure A6

Structure A6. Looking downstream, January 2019

Structure A6. September 2019

Structure A6. Looking upstream, January 2019

Structure A6. September 2019

Structure A7

Structure A7. Looking across from right bank, January 2019

Structure A7. September 2019

Structure A8

Structure A8. Looking downstream at two structures, January 2019

Structure A8, September 2019

Structure A9

Structure A9. Looking downstream, January 2019

Structure A9. September 2019

Structure A10

Structure A10. Looking across from right bank, January 2019

Structure A10. September 2019

Structure A11

Structure A11. Looking downstream, January 2019

Structure A11. September 2019

Structure A12

Structure A12. Looking across from right bank, January 2019

Structure A12. September 2019

Structure A13

Structure A13. Looking downstream, January 2019

Structure A13, September 2019

Structure A14

Structure A14. Looking upstream at three structures, January 2019

Structure A14. September 2019

Structure A15

Structure A15. Looking downstream at two structures, January 2019

Structure 15. September 2019

Structure A16

Structure A16. Looking downstream, January 2019

Structure A16, September 2019

Structure A17

Structure A17. Looking upstream, January 2019

Structure A17, September 2019

Structure A18

Structure A18. Looking downstream, January 2019

Structure A18, September 2019

Structure A19

Structure A19. Looking upstream, January 2019

Structure A19, September 2019

Structure A20

Structure A20, Looking downstream, January 2019

Structure A20, September 2019

Structure A21

Structure A21. Looking upstream, January 2019

Structure A21. September 2019

Structure A22

Structure A22. Looking upstream, January 2019

Structure A22, September 2019

Structure A23

Structure A23 Looking upstream, two structures, January 2019

Structure A23. September 2019

Appendix 12. Photos of Grade Control Structures Looking Upstream, Downstream, Left Bank and Right Bank on March 13, 2020

GCS #1

Photo 1: GCS #1 Looking downstream

Photo 2: GCS #1 Looking upstream

Photo 3: GCS #1 Looking at left bank

Photo 4: GCS #1 Looking at right bank

GCS #2 Photos

Photo 5: GCS #2 Looking downstream

Photo 6: GCS #2 Looking upstream

Photo 7: GCS #2 Looking at left bank

Photo 8: GCS #2 Looking at right bank

GCS #3 Photos

Photo 9: GCS #3 Looking downstream

Photo 10: GCS #3 Looking upstream

Photo 11: GCS #3 Looking left bank

Photo 12: GCS #3 Looking right bank

GCS #4

Photo 13: GCS #4 Looking downstream

Photo 14: GCS #4 Looking upstream

Photo 15: GCS #4 Looking left bank

Photo 16: GCS #4 Looking right bank

GCS #5

Photo 17: GCS #5 Looking downstream

Photo 18: GCS #5 Looking upstream

GCS #5

Photo 19: GCS #5 Looking left bank

Photo 20: GCS #5 Looking right bank

GCS #6

Photo 21: GCS #6 Looking downstream

Photo 22: GCS #6 Looking upstream

Photo 23: GCS #6 Looking left bank

Photo 24: GCS #6 Looking right bank

GCS #7

Photo 25: GCS #7 Looking downstream

Photo 26: GCS #7 Looking upstream

GCS #7

Photo 27: GCS #7 Looking left bank

Photo 28: GCS #7 Looking right bank

GCS #8

Photo 29: GCS #8 Looking downstream

Photo 30: GCS #8 Looking upstream

GCS #8

Photo 31: GCS #8 Looking left bank

Photo 32: GCS #8 Looking right bank

GCS #9

Photo 33: GCS #9 Looking downstream

Photo 34: GCS #9 Looking upstream

GCS #9

Photo 35: GCS #9 Looking left bank

Photo 36: GCS #9 Looking right bank

GCS #10

Photo 37: GCS #10 Looking downstream

Photo 38: GCS #10 Looking upstream

GCS #10

Photo 39: GCS #10 Looking left bank

Photo 40: GCS #10 Looking right bank

GCS #11

Photo 41: GCS #11 Looking downstream

Photo 42: GCS #11 Looking upstream

GCS #11

Photo 43: GCS #11 Looking left bank

Photo 44: GCS #11 Looking right bank

GCS #12

Photo 45: GCS #12 Looking downstream

Photo 46: GCS #12 Looking upstream

GCS #12

Photo 47: GCS #12 Looking left bank

Photo 48: GCS #12 Looking right bank

GCS #13

Photo 49: GCS #13 Looking downstream

Photo 50: GCS #13 Looking upstream

GCS #13

Photo 51: GCS #13 Looking left bank

Photo 52: GCS #13 Looking right bank

GCS #14

Photo 53: GCS #14 Looking downstream

Photo 54: GCS #14 Looking upstream

GCS #14

Photo 55: GCS #14 Looking left bank

Photo 56: GCS #14 Looking right bank

GCS #15

Photo 57: GCS #15 Looking downstream

Photo 58: GCS #15 Looking upstream

GCS #15

Photo 59: GCS #15 Looking left bank

Photo 60: GCS #15 Looking right bank

GCS #16

Photo 61: GCS #16 Looking downstream

Photo 62: GCS #16 Looking upstream

GCS #16

Photo 63: GCS #16 Looking left bank

Photo 64: GCS #16 Looking right bank

GCS #17

Photo 65: GCS #17 Looking downstream

Photo 66: GCS #17 Looking upstream

GCS #17

Photo 67: GCS #17 Looking left bank

Photo 68: GCS #17 Looking right bank

GCS #18

Photo 69: GCS #18 Looking downstream

Photo 70: GCS #18 Looking upstream

GCS #18

Photo 71: GCS #18 Looking left bank

Photo 72: GCS #18 Looking right bank

GCS #19

Photo 73: GCS #19 Looking downstream

Photo 74: GCS #19 Looking upstream

GCS #19

Photo 75: GCS #19 Looking left bank

Photo 76: GCS #19 Looking right bank

GCS #20

Photo 77: GCS #20 Looking downstream

Photo 78: GCS #20 Looking upstream

GCS #20

Photo 79: GCS #20 Looking left bank

Photo 80: GCS #20 Looking right bank