2014-160A3

Form 9-1366
(May 2018)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resource Investigations

Customer #: 6000004118
Agreement #: 18ZFJFA0100
Project #: ZF00FMN
TIN #: 86-6000257

Fixed Cost Agreement YES[X] NO[ ]

THIS AGREEMENT is entered into as of the July 1, 2018, by the U.S. GEOLOGICAL SURVEY, Arizona Water Science Center, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the City of Prescott party of the second part.

1. The parties hereto agree that subject to the availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation Water Resource Investigations (per attachment), herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50, and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) include In-Kind-Services in the amount of $0.00

(a) $60,175 by the party of the first part during the period July 1, 2018 to September 30, 2021

(b) $94,850 by the party of the second part during the period July 1, 2018 to September 30, 2021

(c) Contributions are provided by the party of the first part through other USGS regional or national programs, in the amount of: $0

Description of the USGS regional/national program:

(d) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

(e) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program, and if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at cost, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records or reports published by either party shall contain a statement of the cooperative relations between the parties. The Parties acknowledge that scientific information and data developed as a result of the Scope of Work (SOW) are subject to applicable USGS review, approval, and release requirements, which are available on the USGS Fundamental Science Practices website (https://www2.usgs.gov/fsp/).

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9. Billing for this agreement will be rendered **quarterly**. Invoices not paid within 60 days from the billing date will bear Interest, Penalties, and Administrative cost at the annual rate pursuant the Debt Collection Act of 1982, (codified at 31 U.S.C. § 3717) established by the U.S. Treasury.

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U.S. Geological Survey
United States
Department of Interior

Signature

By Christopher Mazza [ACTING] Date: 06/25/2018
Name: James M Leenhouts
Title: Director

City of Prescott

Signatures

By _____ Date: 1/24/2018
Name: GREG MENGARELLI
Title: MAYOR

By _____ Date: 7/30/18
Name: JOH PALADINI
Title: CITY ATTORNEY

By Maureen Scott Date: 7/30/18
Name: MAUREEN SCOTT
Title: CITY

Workplan for groundwater-level and groundwater-storage data collection in the Big Chino Sub-basin, central Arizona

Prepared by: Jeff Kennedy, USGS Arizona Water Science Center
Date: June 20th, 2018

Problem

Water users and managers who rely on the Verde River system and its aquifers for water supplies have an intrinsic interest in monitoring changes in groundwater storage in the Big Chino sub-basin aquifer, the source of much of the baseflow to the Verde River. A group of these managers and their technical staff (hence termed the "Cooperators") have requested this workplan from the USGS to continue groundwater-storage monitoring in the Big Chino sub-basin (fig. 1; use of "sub-basin" consistent with Arizona Department of Water Resources nomenclature). Initial groundwater monitoring began in 2013, with the establishment of a groundwater-level monitoring network and a repeat microgravity monitoring network. At present, continuous and discrete groundwater levels are measured at 5 sites in the Big Chino sub-basin, and discrete groundwater levels only are measured at an additional 8 sites. Groundwater-storage change is measured at 32 sites; 4 of these sites were newly established in 2017.

Communities upstream of the Verde River headwaters, including Prescott and Prescott Valley, are currently considering augmenting their water supplies by using groundwater withdrawals from the Big Chino sub-basin. Downstream users of Verde River flows, including greater Phoenix water provider Salt River Project, are concerned that Big Chino sub-basin groundwater withdrawals will eventually reduce the flow in the Verde River and their water availability. Given the current understanding of aquifer properties, the period of time to affect the Verde River flows could be on the order of years to a century or more. In addition, variable recharge rates result from infiltration of periodic flows in major ephemeral stream channels in the region. Decreases in recharge rates could exacerbate the effects of groundwater withdrawals on Verde River flow, while increases in recharge rates could help counter the effects of the withdrawals. Further data collection and monitoring of the hydrologic system in the Big Chino sub-basin are proposed here for the purpose of improving definition of the important aquifer properties and understanding variations and locations of ephemeral channel recharge.

Objectives

The objective of this project is to collect groundwater and streamflow data for the Big Chino sub-basin that will improve understanding of the hydrogeologic system and the predictive capabilities of groundwater-flow models. Groundwater monitoring will include aquifer-storage monitoring to estimate storage change and aquifer-storage properties at several locations. Many of the storage monitoring stations are co-located at wells where co-incident water-level data will be collected. Streamflow monitoring consists of a single streamgage on Williamson Valley Wash (USGS station 09502800), which has 16 years of record.

Relevance and Benefits

The results of this monitoring will provide improved knowledge of the hydrogeologic system of the Big Chino sub-basin and information about the effect of present and future groundwater pumping in the sub-basin. Stakeholders will have a better understanding of aquifer-storage properties provided by repeat microgravity data. Accordingly, the water resource planning capabilities of federal, state, and local governmental agencies and offices with a stake in the upper and middle Verde area will benefit. The content of the work is consistent with and supports USGS Bureau Science Strategy *A Water Census of the United States: Quantifying, Forecasting, and Securing Freshwater for America's Future* in USGS Circular 1309: Facing Tomorrow's Challenges—U.S. Geological Survey Science in the Decade 2007-2017.

Approach

Improved understanding of the response of the Big Chino aquifer system to groundwater withdrawals and variations in ephemeral channel recharge will be accomplished by monitoring groundwater levels and aquifer-storage change.

Task 1. Groundwater-level monitoring

Groundwater-level monitoring will be carried out at 4 sites that were established under the previous cooperative agreement, and are currently monitored (Table 1 and Fig. 1). One site included under the previous agreement will no longer be monitored (Big Chino, site 30); groundwater levels at this site are largely similar to others in the area (sites 20, 23, and 25). Continuous measurements at sites 23 and 25 will be discontinued after 2018; the 2018 record is considered useful as a record of the extremely dry conditions during winter 2017-2018.

Continuous monitoring will be achieved using submersible pressure transducers. Sites will be visited quarterly and data made available online through the USGS National Water Information System within 60 days of each site visit. Data will be collected and analyzed using standard USGS quality-control procedures.

Table 1. Existing continuous groundwater-level monitoring sites

Site name	Map ID	Data URL
Wineglass Ranch	11	https://waterdata.usgs.gov/nwis/dv/?site_no=345518112332701
WMW3	20	https://waterdata.usgs.gov/nwis/dv/?site_no=350232112404901
WMW2	25	https://waterdata.usgs.gov/nwis/dv/?site_no=350427112414701
B-19-04 05ABA1	23	https://waterdata.usgs.gov/nwis/dv/?site_no=350403112421801
Big Chino	30	https://waterdata.usgs.gov/nwis/dv/?site_no=350616112435601

At the remaining 12 sites where groundwater levels are currently monitored with discrete measurements (Fig. 1), data will continue to be collected, but on an annual basis (discrete groundwater levels at non-continuous sites were collected 3 times per year under the previous agreement). The primary purpose of these measurements is to compare the change in groundwater-level with the change in aquifer storage measured using repeat microgravity. These discrete groundwater levels will be collected simultaneously with the repeat microgravity surveys.

In addition to the sites in Table 1 and the newly installed monitoring wells, USGS will equip one of the wells monitored under the previous agreement as a real-time groundwater monitoring site (site 14 on Fig. 1). This site will transmit continuous data via satellite, to be made available online within approximately 15 minutes of the time of measurement. This monitoring, outside the scope of this workplan, is part of the USGS Climate Response Network (https://groundwaterwatch.usgs.gov/net/ogwnetwork.asp?ncd=crn).

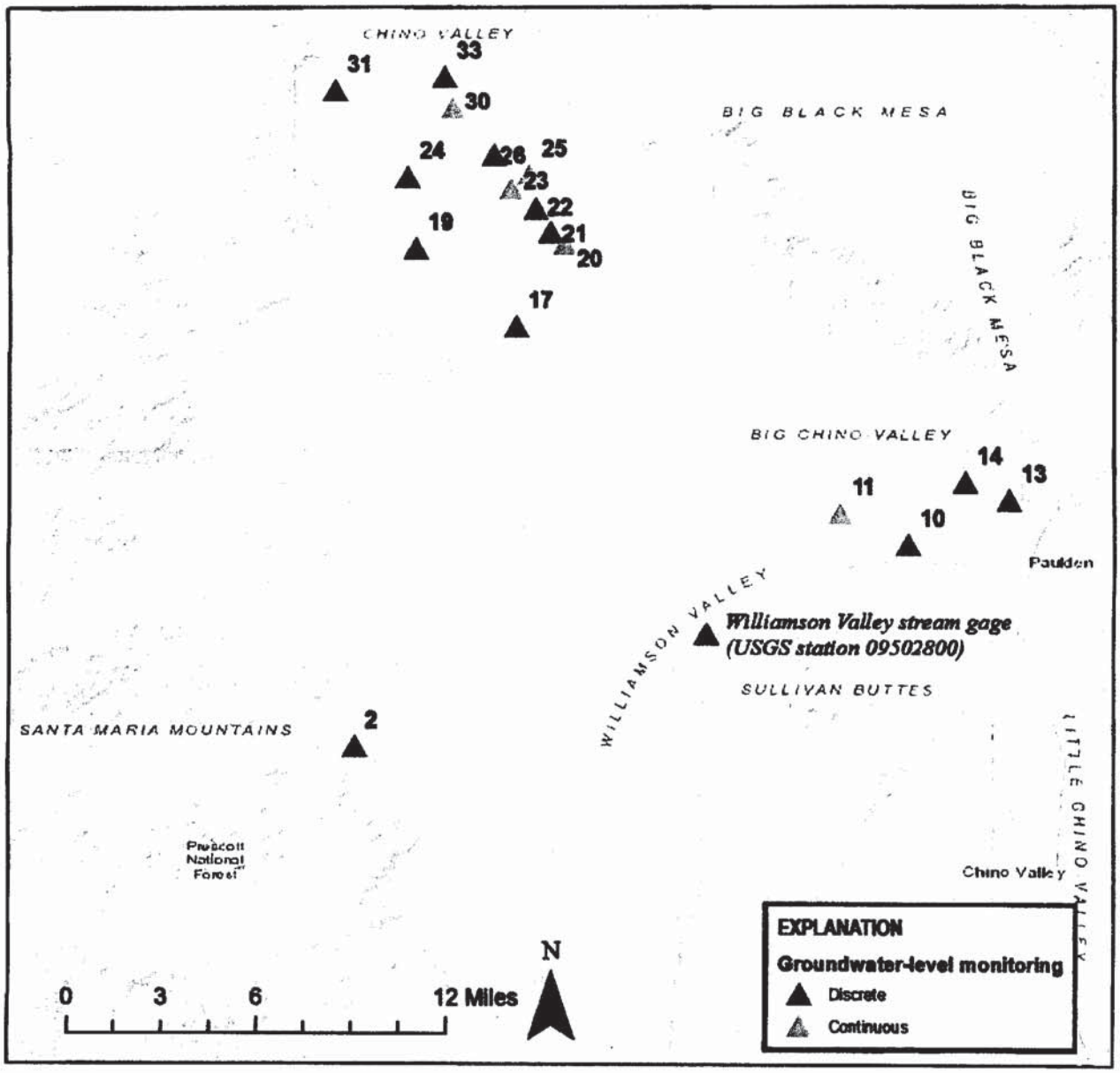

Figure 1. Groundwater-level monitoring network as of 2017 and location of the Williamson Valley streamgaging station in the Big Chino Sub-basin.

Task 2. Aquifer storage-change monitoring

Repeat microgravity (measuring small changes in acceleration due to Earth's gravitational potential) will be used to monitor aquifer-storage change. This method is useful because it provides a direct, quantitative measurement of changes in aquifer-storage that is independent of aquifer porosity or depth to groundwater. The method is used for two purposes. First, it will provide refined estimates of aquifer-storage properties at several well sites (initial estimates of storage properties will be provided in a 2018 report prepared under the previous cooperative agreement). The accuracy of the storage-property estimates generally increases with a longer period of record, as greater extremes in groundwater levels are recorded. Aquifer-storage properties are a poorly constrained, but highly important variable that have a direct effect on the predicted timing of changes in stream base flow due to groundwater pumping. Second, the estimates of aquifer-storage changes can be used directly to measure changes in the volume of water stored in the aquifer. If new production wells are drilled in the Big Chino sub-basin, ongoing microgravity measurements will provide information about where water is being removed from the aquifer.

There are currently 13 wells within the study area that are monitored by USGS for both seasonal changes in groundwater storage (microgravity) and groundwater levels under the previous monitoring agreement (Fig. 2). An additional 15 locations are monitored for groundwater-storage changes without accompanying water-level measurements. Most of these sites have been measured three times per year for 3 to 5 years, and little additional information will be gained by continued seasonal monitoring, unless there is a significant recharge event during the study period. However, the existing network is valuable for establishing baseline conditions prior to the onset of additional pumping. Therefore, the current workplan provides for one gravity survey per year at up to 15 stations, to be carried out in spring when groundwater levels are typically at a maximum. The stations to be monitored will be identified after discussing the pending report on 2010-2017 monitoring.

In 2017, storage-change monitoring began at 4 new stations located on the K4 Ranch west of the Big Chino Wash (sites 17, 19, 24, and 31 on Fig. 2). Groundwater-level measurements at these wells have historically been measured by ADWR. Because of the short period of record at these sites, three-times-per-year monitoring will continue for the duration of this workplan. In addition, a fifth new station (site 18 on Fig. 2) has been permitted by Yavapai County along Williamson Valley Road, but not yet constructed. This station will be added to the monitoring network for a total of 5 stations to be measured 3 times per year.

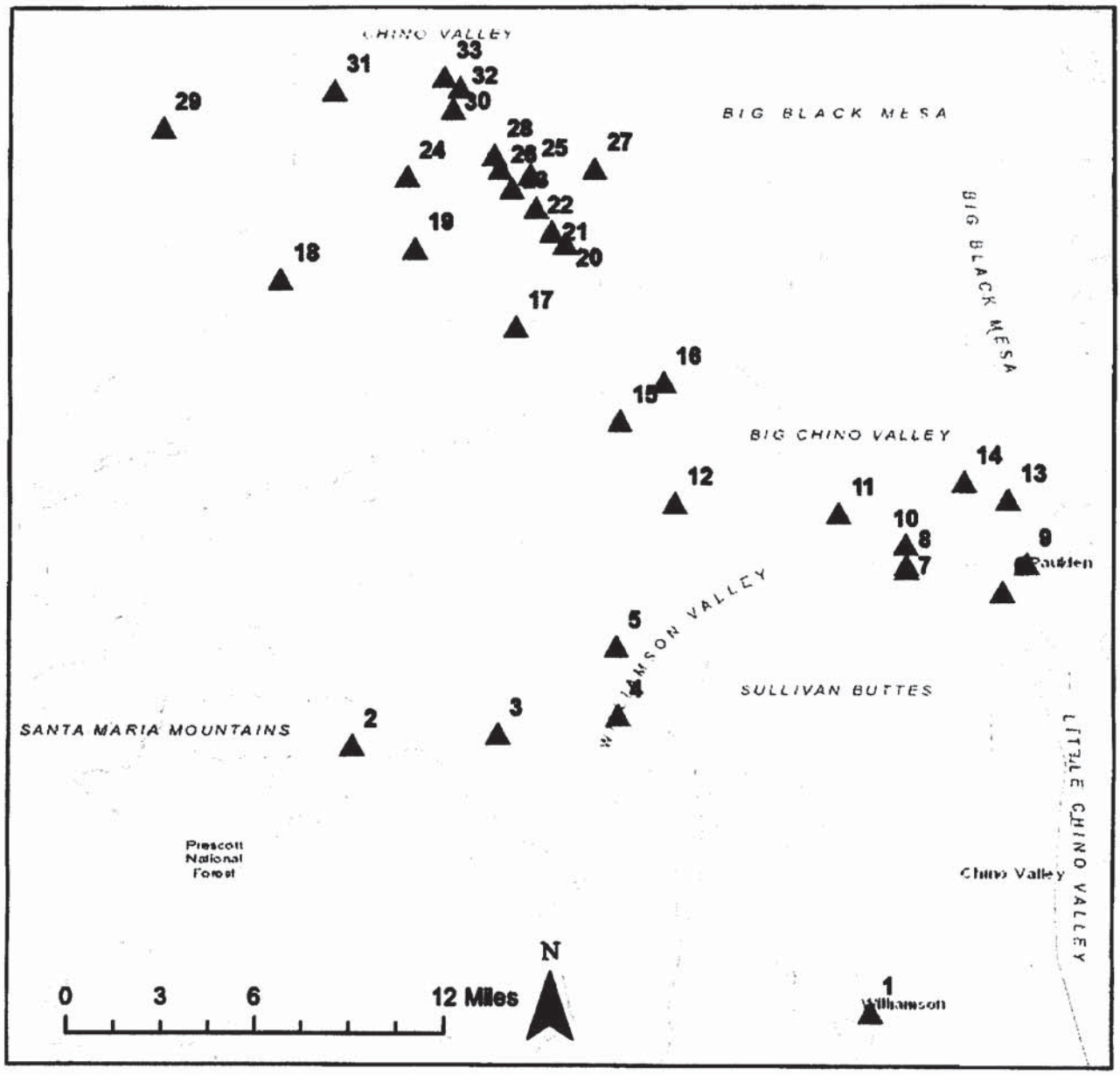

Figure 2. Locations of aquifer-storage monitoring sites as of 2017. Under the current proposed workplan, three-times-per-year monitoring will continue at stations 17, 18, 19, 24, and 31. Of the remaining stations, up to 15 will be identified for continued annual monitoring.

Task 3. Continuous monitoring of flow at the existing stream gage at Williamson Valley Wash

Continued monitoring of streamflow, including base flows, at the existing stream gage on Williamson Valley Wash will augment new streamflow monitoring established by the Parties. This task will help monitor groundwater budgets and runoff in the upstream area and place limits on recharge through stream-channel infiltration between the gage and the newly installed downstream gage established by the Parties. Operation of gage will also allow a historical perspective for the interpretation of streamflow data from the newly installed stream gages.

Communications and Deliverables

Communications between the cooperators and USGS will be accomplished through informal and formal communications. Informal communications will be via telephone and email and will include exchange of provisional data, clarification of previous work products, discussion of details regarding data collection methods and siting, and other similar topics as necessary. Informal cooperator interaction will be welcomed throughout the project. Formal communications will include progress updates and reports for each task, as described below.

- **Project progress updates**

The USGS will hold meetings with the cooperators as needed, up to quarterly in frequency, and in person or via remote-communication technology in order to regularly update progress made, and just as importantly, to seek input and guidance from the cooperators. Anticipated information exchanged in update meetings includes:

  - Status of aquifer-storage monitoring station installation
  - Status and issues regarding planning of USGS-conducted field-data collection
  - Collected data
  - Feedback from USGS to the cooperators regarding the planning and implementation of cooperator-conducted field-data collection

When feasible, material to be presented at update meetings will be furnished to the cooperators at least one week in advance of the meeting.

- **Reports publication**

Results of the monitoring will be formally published in year 4 as a USGS-series report and (or) journal article(s) and become publicly available upon release. Planned release is by June 2021. In addition, through the meetings described previously, the cooperators will be engaged in the process throughout the investigation and will be aware of findings. In addition to cooperator courtesy reviews, report products will have at least two independent colleague reviews. Until final USGS approval of the report(s), results cannot be publicly released. Groundwater-level data will be published on NWISWeb including relevant data collected by ADWR. All gravity data will be archived in the AzWSC Gravity Database and published as online data releases. All data collected will follow applicable USGS standard field methods and quality-control procedures.

Budget, Personnel, and Billing

The project budget for each task is presented by year of funding in Table 3. Workplan budgeting includes a project chief plus field support from students, hydrologic technicians, and hydrologists as needed.

Total costs are apportioned among USGS and the Parties by Federal Fiscal Year in Table 4.

Table 3. Federal Fiscal Year Budget for Tasks 1 and 2 "Monitor groundwater-levels and aquifer-storage changes" and report task by Federal Fiscal year.

		Federal Fiscal Year			
Task	**2018**	**2019**	**2020**	**2021**	**Total**
Continuous groundwater-level monitoring at 4 stations in 2018 and 2 stations in 2019-20; Discrete monitoring at 12 stations.	$20,000	$10,300	$10,600	$0	$40,900
Once per year aquifer-storage monitoring at up to 15 stations; 3 times per year monitoring at 5 stations in 2019-2020.		$24,200	$24,950	$0	$49,150
Continuous streamgaging station operation		$17,300	$17,500	$0	$34,800
Report including publication			$15,175	$15,000	$30,175
Total	$20,000	$51,800	$68,225	$15,000	$155,025

Table 4. Total budget and funding split between the Cooperators and USGS by Federal Fiscal Year. Cooperative Match Funding is subject to congressional appropriations

Funding Entity		**Federal Fiscal Year**			
	2018	**2019**	**2020**	**2021**	**Total**
The Cooperators	$10,000	$36,800	$48,050	$0	$94,850
USGS Cooperative Match Program	$10,000	$15,000	$20,175	$15,000	$60,175
Total	$20,000	$51,800	$68,225	$15,000	$155,025

Data Management Plan

USGS Fundamental Science Practices require that data collected for publication in databases or information products, regardless of the manner in which they are published (such as USGS reports, journal articles, and Web pages), must be documented to describe 1) the methods or techniques used to collect, process, and analyze data, 2) the structure of the output, 3) a description of accuracy and precision, 4) standards for metadata, and 5) the methods of quality assurance.

Groundwater-level data will be collected following procedures outline in USGS Techniques and Methods Report 1–A1 (Groundwater technical procedures of the U.S. Geological Survey; available online at available only online at https://pubs.usgs.gov/tm/1a1/). Sites will be visited 4 times per year. Discrete (tape-down) groundwater-level measurements will be made during each site visit. Sites will be located using survey-grade GPS and inventoried in the USGS Groundwater Site Inventory (GWSI) database. Groundwater-level data will be reviewed and approved by qualified personnel prior to publication online in the USGS National Water Information System (NWIS) database. Groundwater-level data will be published online within 90 days of each site visit, and within 180 days of the time of data collection.

Gravity data for the project will be collected with a Micro-g Lacoste A-10 absolute gravimeter using techniques consistent with the USGS Arizona Water Science Center Absolute Gravity Quality Assurance and Quality Control Plan (available at https://www.sciencebase.gov/catalog/item/5637db90e4b0d6133fe72e90). All data collected will be published in a publicly available database to be kept in perpetuity. The USGS ScienceBase (sciencebase.gov) repository is a likely publication outlet. A digital object identifier (DOI) will be generated for the published dataset.

All gravity data for the project will be collected, processed, reviewed, approved, and published by trained USGS personnel. Gravity data will be processed by USGS personnel in the office within 3 months of data collection. An experienced reviewer will review and check the data for accuracy, then the project chief will release the data as a published ScienceBase data release. All metadata will be documented in the ScienceBase data release. Once published, the data will be fully accessible to anyone inside or outside the USGS.