United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Arizona Water Science Center
520 North Park
Tucson, AZ 85719

January 23, 2020

Ms. Erin Young
Water Resource Manager
City of Flagstaff
2323 Walgreens St. Suite 1
Flagstaff, AZ 86004

Dear Ms. Young:

Enclosed are two signed originals of our standard joint-funding agreement for the project(s) Arizona Water Science Center Water Resources Investigations, during the period July 1, 2020 through September 30, 2024 in the amount of $99,100 from your agency. U.S. Geological Survey contributions for this agreement are $55,250 for a combined total of $154,350. Please sign and return one fully-executed original to Autumn Henson at the address above.

Federal law requires that we have a signed agreement before we start or continue work. Please return the signed agreement by **July 1, 2020**. If, for any reason, the agreement cannot be signed and returned by the date shown above, please contact Kurt Schonauer by phone number (928) 556-7223 or email schonaue@usgs.gov to make alternative arrangements.

This is a fixed cost agreement to be billed quarterly via Down Payment Request (automated Form DI-1040). Please allow 30-days from the end of the billing period for issuance of the bill. If you experience any problems with your invoice(s), please contact Rebecca Ramirez at phone number (520) 670-3345 or email at rramirez@usgs.gov.

The results of all work performed under this agreement will be available for publication by the U.S. Geological Survey. We look forward to continuing this and future cooperative efforts in these mutually beneficial water resources studies.

Sincerely,

JAMES LEENHOUTS

Digitally signed by JAMES LEENHOUTS
Date: 2020.01.28 08:42:04 -07'00'

James M Leenhouts
Director

Enclosure
20ZFJFA2200 (2)

Form 9-1366
(May 2018)

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

Customer #: 6000000790
Agreement #: 20ZFJFA2200
Project #: ZF00H6R
TIN #: 86-6000244

Fixed Cost Agreement YES[X] NO[ ]

THIS AGREEMENT is entered into as of the July 1, 2020, 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 Flagstaff, 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) $55,250 by the party of the first part during the period July 1, 2020 to September 30, 2024

(b) $99,100 by the party of the second part during the period July 1, 2020 to September 30, 2024

(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://www.usgs.gov/about/organization/science-support/science-quality-and-integrity/fundamental-science-practices).

Form 9-1366
(May 2018)

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

Customer #: 6000000790
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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.

USGS Technical Point of Contact

Name:	Kurt Schonauer
	Hydrologist
Address:	2255 North Gemini Drive
	Flagstaff, AZ 86001
Telephone:	(928) 556-7223
Fax:	
Email:	schonaue@usgs.gov

Customer Technical Point of Contact

Name:	Erin Young
	Water Resource Manager
Address:	2323 Walgreens St. Suite 1
	Flagstaff, AZ 86004
Telephone:	(928) 213-2405
Fax:	
Email:	eyoung@flagstaffaz.gov

USGS Billing Point of Contact

Name:	Rebecca Ramirez
	Budget Analyst
Address:	520 N. Park Ave
	Tucson, AZ 85719
Telephone:	(520) 670-3345
Fax:	(520) 670-5592
Email:	rramirez@usgs.gov

Customer Billing Point of Contact

Name:	Stacy Brechler-Knaggs
	Grants & Contracts Mgr.
Address:	211 W. Aspen Ave.
	Flagstaff, AZ 86001
Telephone:	(928) 213-2227
Fax:	
Email:	Sknaggs@flagstaffaz.gov

U.S. Geological Survey
United States
Department of Interior

Signature

By_____ **Date: 01/23/2020**
JAMES LEENHOUTS Digitally signed by JAMES LEENHOUTS Date: 2020.01.28 08:52:14 -07'00'

Name: James M Leenhouts

Title: Director

City of Flagstaff

Signatures

By_____ **Date:** _____
Name:
Title:

By_____ **Date:** _____
Name:
Title:

By_____ **Date:** _____
Name:
Title:

Scope of Work for the City of Flagstaff and the U.S. Geological Survey Cooperative Program

Surface-Water Gaging Network and Collection of Hydrologic Data

Work Plan and Budget
7/1/2020 – 9/30/2024

A. Purpose

This Scope of Work describes installation of a turbidity sensor at a U.S. Geological Survey (USGS) streamflow gage. Also described is the operation and maintenance of the streamflow gage and automated suspended sediment sampler, and record analysis of suspended sediment and turbidity in Newman Canyon above Upper Lake Mary. If all aspects are funded, the gaging station can be used to document short and long-term changes in streamflow, flood frequency, and changes in turbidity and suspended sediment concentration and loads.

B. Background

Upper Lake Mary serves as an important water source for the City of Flagstaff. To monitor and understand the volume, timing and quality of surface-water inflow into the lake from surrounding forested areas, the USGS in cooperation with the City of Flagstaff, will continue to operate a gaging station in Newman Canyon. The gaging station will collect rainfall, and streamflow data continuously at 15-minute intervals and store the data in the USGS National Water Information System (NWIS). These data will also be available on the internet. The gaging station will also collect intermittent suspended sediment samples using an automatic pump sampler, and *in situ* samples when technicians are present.

C. Description of Work and Budget

By means of this Agreement, the City of Flagstaff is providing funds to the USGS Arizona Water Science Center (AzWSC) to help support the operation, and maintenance of the streamflow gage. The gage covered is Newman Canyon above Upper Lake Mary (station number 09400815). Stage data collected from the gage will be used to calculate streamflow discharge. Visits to the gage and discharge measurements will occur at least six times annually. Discharge computations will be produced by the USGS AzWSC and made available on the National Water Information System web page. Suspended sediment samples will be collected and sent the Cascades Volcano Observatory for analysis. After analysis a suspended sediment concentration record will be calculated annually providing concentration and load data for all days of flow. Frequency of sample collection and total samples collected will be determined based on requirements for record analysis. A turbidity sensor provided by the City of Flagstaff will be installed and maintenance costs paid by the City of Flagstaff. The turbidity data will be logged at

the site and not stored in the USGS National Water Information System. Data will be downloaded and provided to the City on a quarterly basis. Biannual communication with the City of Flagstaff and USGS will take place to discuss operations for the next water year and winter operations (September), and to discuss the record analysis for sediment (April). In addition, email communication will take place with the City of Flagstaff regarding changes to equipment. Costs for the site are estimated below under the "Work Tasks" table. If it is determined that adjustments need to be made those can be made at the beginning of each year after an agreement by both parties.

Work Tasks **Costs**

		Operation and maintenance of streamflow gage and rain gage	Operation and maintenance of automatic pump sampler*	Analysis of annual sediment	Installation of turbidity sensor	Annual turbidity sensor calibration and data transfer	**Total**
2020	City of Flagstaff Cost	$2,300	$1,125	$1,500	$175	$500	**$5,600**
	USGS Contribution	$2,200	$1,050	-----	-----	-----	**$3,250**
2021	City of Flagstaff Cost	$9,476	$4,634	$6,180	-----	$2,060	**$22,350**
	USGS Contribution	$8,800	$4,200	-----	-----	-----	**$13,000**
2022	City of Flagstaff Cost	$9,760	$4,773	$6,365	-----	$2,122	**$23,020**
	USGS Contribution	$8,800	$4,200	-----	-----	-----	**$13,000**
2023	City of Flagstaff Cost	$10,052	$4,917	$6,556	-----	$2,185	**$23,710**
	USGS Contribution	$8,800	$4,200	-----	-----	-----	**$13,000**
2024	City of Flagstaff Cost	$10,351	$5,065	$6,753	-----	$2,251	**$24,420**
	USGS Contribution	$8,800	$4,200	-----	-----	-----	**$13,000**

Total Agreement for 2020-2024

City of Flagstaff	$99,100
USGS	$55,250
TOTAL	$154,350

Tasks associated with a continuous-record, real-time USGS streamflow gage

Field

1) 6 routine trips to the site.
2) Additional trips may occur when necessary:
    - During high-flow events to measure discharge or check DCP performance.
    - If equipment failure occurs when reviewing transmissions and NWIS at the office. If gage repairs cannot be completed in one trip a back up sensor will be deployed to minimize lost data.
    - Verification of elevation change relating to equipment movement (levels).
    - If changes to the control affecting the stage-discharge relationship are suspected.
3) Equipment maintenance:
    - Data-collection platform check.
    - Power system check.
    - Orifice line cleaned if required.
4) Discharge measurement made. Check measurements when needed.
5) Control structure maintenance – debris removal.
6) Measuring section maintenance.
7) Point of zero flow measurement.
8) Photo documentation of flow.
9) Vehicle costs.
10) Travel costs.
11) Routine gage maintenance, i.e. painting, gage removal, vegetation removal…

Office

1) Discharge measurement notes checked.
2) Provisional record of discharge computed to current.
3) Checking of provisional discharge record.
4) Review of quarterly and final discharge record and the preparation of station manuscripts.
5) Triannual technical review of surface-water data program.
6) Entering and updating of descriptions, analysis, levels, and manuscripts in SIMS.
7) NWIS posting of provisional and finalized data (gage height, discharge, other parameters measured at the site such as precipitation).
8) Web site maintenance.
9) Field equipment maintenance.
10) Complete pages for annual web report.

Equipment

1) Bench testing of Data Collection Platforms.
2) Bench testing of other equipment – transducers, radar units, sonar, etc.

3) Equipment replacement due to failure that can be caused by electrical malfunction, aging, vandalism, or upgrading to newest technology.
4) Purchasing of measuring equipment including:
    - Wading rods.
    - Acoustic doppler meters
    - Acoustic doppler current profilers
    - Cup meters (AA and Pygmy)
    - Trucks
    - Safety equipment.
    - Cell phones and satellite phones for remote areas.
    - Data collection platforms and satellite uplink/downlink communications.

Tasks associated with automatic suspended sediment sampler

Field

1) Check ISCO program sampling report.
   Use ISCO Field Guide: an.data\Sediment Collection Information\Sediment Sampler Manuals and Docs
   - Record bottle number, date and time on form (electronic or hard copy).
   - Collect bottles, secure lids, tape lids, and number bottle or label.
   - If bottle did not fill notate which bottle number on form.
2) Ensure ISCO orifice and liquid level actuator are clear and clean.
3) Clear the orifice line with clean water.
4) If there are any problems with the ISCO make changes to program, test system to ensure functionality, record changes on XXXXXXXX_ISCO_program_parameters form in gage house folder.
5) Restock empty bottles at site (ISCO bottles, 1 litter and 3 litter collection bottles).
6) Bring all samples back to office.
7) Make seasonal adjustments. In the summer (April) lower orifice and change gage height threshold to collect samples during lower flow. In the winter (October) set orifice and threshold to begin sampling at higher flows.
8) Ensure sampler is functional prior to departure and ready for next event.
9) Visits may occur outside of routine visits to collect samples and ensure ISCO has capacity for future events.
10) Attempt to collect at least one replicate sample each year. If at site during flow above ISCO threshold collect two manual ISCO samples sequentially and record second sample as a replicate with the time one minute after the first sample.

Office

1) Fill out sediment tracking Excel spreadsheet for water year (located in: an.data\XXXXXXXX\WY20XX\Sediment\XXXXXXXX ISCO sample data 20XX).
2) Record any changes to ISCO program on form in: an.data\XXXXXXXX\WY20XX\Sediment\XXXXXXXX_ISCO_program_parameters.
3) If it has been determined not to send in select samples record which sample and why on tracking Spreadsheet.*
4) Log samples into QW Data Transfer System (QWDX). Save a copy of the SLAR in an.data\XXXXXXXX\WY20XX\Sediment\09XXXXXX_SLAR_DATE (of SLAR).
5) Ship samples promptly.
6) Follow up to make sure samples are loaded into database within 3 months – if not follow up with Cascades Volcano Observatory (CVO).

*Reasons for not sending in a sample:

- Sample quality has been compromised (i.e. cracked bottle, spilled sample, volume not consistent with other samples or sampling volume setup, other).
- ISCO malfunction.
- Gage height surging near liquid level actuator resulting in multiple samples with unnecessary frequency. Samples should be evaluated based on hydrograph to identify if they would be useful, if so, then send into lab.

Tasks associated with a continuous sediment record

This is in addition to the tasks associated with the automatic suspended sediment sampler.

Field

1) Collect Equal Width Increment (EWI) samples when flow is present using a DH-81 sampler. The EWI needs to be completed at a cross section with relatively uniform depth and water velocity. All EWI samples must be collected within the isokinetic range of the sampler because EWI samples are discharge-weighted samples.
2) The EWI cannot be used at cross sections at which all or large parts of the sampling cross section have velocities of less than about 1.5ft/s.
3) Reference the USGS National Field Manual for collection techniques: https://water.usgs.gov/owq/FieldManual/
4) Use of the DH-81 sampler using the Equal-Width-Increment (EWI) method requires the user to maintain a consistent transit rate in every vertical in the stream cross-section. The user should determine the mean stream velocity and the deepest sampling depth in the cross-section. Determine the transit rate for the container and nozzle being used based on the velocity and depth information
5) The sampler should be held away from the body and as far upstream as possible. The wading rod should be held vertically with the sampler nozzle horizontal and pointing upstream. Begin the transit with the sampler above the surface of the stream using the predetermined transit rate. Maintain the transit rate until the sampler container touches bottom, then immediately reverse the direction of the transit and maintain the transit rate until the sampler clears the surface. Care should be taken when touching the stream bottom so as not to disturb loose sediment and bias the sample. Once the sampler clears the surface, the user should be careful not to tilt the sampler forward so that the nozzle tilts down. If the container is nearly full, water could run out of the container back through the nozzle and bias the sample.
6) Upon completion of sampling with a container, remove it by firmly holding the cap with one hand and removing the container with the other hand.
7) Cap and label the container. Each sample container label should contain adequate information. For sediment sampling, the following information should be included:
    - Name of stream
    - Location of cross-section
    - Location of vertical
    - Stream depth covered by sample
    - Stage of stream
    - Date
    - Time
    - Identification of personnel
    - Sampling time

Office

1) Processing and Analysis of Sediment Data
   - Data processing of periodic measurements consists of four steps: tabulation, evaluation, editing, and verification.
2) Compilation of Data
   - Analyses are performed on samples by the Cascades Volcano Observatory.
3) Analysis of Data
   - Sediment data and records are compiled by using procedures described in TWRI Computation of Fluvial Sediment Discharge (Porterfield, 1972). Computations are made by using the Graphical Constituent Loading Analysis System (GCLAS).
   - All electronic files used in the computation of the sediment record should be placed in the appropriate folder for the year and the station in the sediment records folder on the WSC data documents file server.
   - The manuscript for the annual data report must be completed.
   - The sediment-station analysis should be started at the beginning of the computation processes and added to during the whole process of computing and analyzing the sediment record.
4) Sediment Station Analysis
   - A sediment-station analysis is written for sediment station each water year. The sediment station analysis is a summary of the sediment activities at the station for a given year. The analysis describes the coverage of sampling, the types of samples and sampling, changes that might affect sediment transport or the record, and the methods and reasoning used to compute the record. Information included in the sediment-station analysis is presented in a thorough manner so that the checker and the reviewer can determine from the analysis the adequacy of the activities in defining the record and in accomplishing the objectives defined for the station.

     Elements included in each sediment-station analysis are as follows:

     - sampling program: establishment and history
     - equipment
     - sediment samples: number of each type of samples collected
     - water discharge record
     - sediment load computations
     - analysis of daily point samples; if a sample was not used then an explanation is needed
     - analysis of cross-section samples; if a sample was not used then an explanation is needed
     - cross-section coefficients
     - an explanation of how well the sample cross-sections relate to pump samples
     - estimated concentration and load
     - remarks

5) Quality-Assurance Review of Sediment Records
    - All sediment records computed will have at least one review before they are approved for publication. After the computation of the sediment record is completed, personnel will set the record to “analyzed” in the Records Management System (RMS). Personnel familiar with sediment-record computation will check electronic data files and GCLAS to ensure that the computations and analysis of the record are complete and are hydrologically correct. After the approver has set the record as “approved” in RMS, the record will be provided to the office supervisor.

Porterfield, G., 1972, Computation of fluvial sediment discharge: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C3, 66p.

Tasks associated with a continuous turbidity sensor

Field

- On a quarterly basis download turbidity data from the site and bring back to the field.
- Annual calibration of the turbidity sensor will be completed by FTS with the costs of the calibration and shipping being covered by the AzWSC.
- Any replacement parts or if the sensor is damaged beyond repair will be covered by the City of Flagstaff.
- There is an estimated 4 to 6 weeks turnaround time on the calibration at FTS so it will be necessary to use the City of Flagstaff's backup sensor during that time for deployment at the site.

Office

- Compile data and email to City of Flagstaff quarterly.
- Store data in an.data for the specific water year.
- Data will not be entered into the NWIS database since it does not follow USGS continuous sensor data collection protocols and should not be used as USGS approved data for analysis or presentation.

Tasks associated with a precipitation gage

Field

1) The sensor is calibrated annually, and three additional inspections are required at different times of the year. The purpose of the additional inspections is to identify that the sensor is logging to the datalogger, that the funnel is neither clogged nor affected by debris, and that the area above the sensor is clear of vegetation.

Office

1) Data acquired from the precipitation sensor are considered temporary and will be removed from public accessibility after a 120-day display period. This temporary data will not be published nor will they be distributed to anyone outside of the USGS after the 120-day display period.

Tasks associated with automatic suspended sediment sampler

Field

1) Check ISCO program sampling report.
   Use ISCO Field Guide: an.data\Sediment Collection Information\Sediment Sampler Manuals and Docs
   - Record bottle number, date and time on form (electronic or hard copy).
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2) Ensure ISCO orifice and liquid level actuator are clear and clean.
3) Clear the orifice line with clean water.
4) If there are any problems with the ISCO make changes to program, test system to ensure functionality, record changes on XXXXXXXX_ISCO_program_parameters form in gage house folder.
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