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W. Scott Ogden, PE, CFM
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Reed Blochberger, EIT
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TUCSON
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Ian Sharp, PE, CFM
Cyrus Miller, PE, CFM
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FLAGSTAFF
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PHOENIX
Jon Ahern, PE, CFM
Nathan Logan, PE, CFM

PRESCOTT
Nate Vaughan, PE

SILVER CITY, NM
Mary Evans, PE, CFM

8400 S Kyrene Road, Ste 201
Tempe Arizona 85284
480.752.2124

40 E Helen Street
Tucson, Arizona 85705
520.623.3112

323 North San Francisco Street
Suite 100
Flagstaff, Arizona 86001
928.214.0887

1 W Deer Valley Road, Ste 101
Phoenix, Arizona 85027
623.889.0166

1042 Willow Creek Rd – A101
#415
Prescott, Arizona, 86301
928.640.0778

2340 US Hwy East #130
Silver City, New Mexico, 88061
575.313.7650
www.jefuller.com

March 25th, 2016

Karen Riggs, PE
Cochise County Highway & Floodplain
1415 Melody Lane
Bisbee, AZ 85603

RE: Proposal – Ephemeral Streamflow Monitoring

Dear Karen:

Per your request, JE Fuller/Hydrology & Geomorphology (JEF) is providing you with this proposal for the referenced services. This proposal is based on the Scope of Work (SOW) dated March 25, 2016 (Attachment A) and is intended to be part of the Cochise County Board of Supervisors submittal package for the April 12th, 2016 meeting of the Board representing the Flood Control District Board. The following items are attached:

A. Cochise County and the Nature Conservancy Scope of Work, Ephemeral Streamflow Monitoring, dated March 25, 2016 (hereafter referred to as the Ephemeral Streamflow Monitoring SOW);
B. Summary Cost Sheet for the Ephemeral Streamflow Monitoring SOW;
C. JE Fuller narrative discussion (refinement to supplement Attachment A) of the Ephemeral Streamflow Monitoring SOW and JE Fuller cost estimate; and,
D. GSA narrative discussion of the Ephemeral Streamflow Monitoring SOW and GSA cost estimate.

JEF appreciates the opportunity to provide you with this proposal. You may indicate your acceptance of this proposal and provide notice to proceed by forwarding the applicable Professional Services Agreement (PSA) for signature. As always, please feel free to contact me by email (cyrus@jefuller.com) or by phone at 520-623-3112 if you have any questions regarding this proposal.

Sincerely,
JE Fuller/Hydrology & Geomorphology, Inc.

Cyrus D. Miller, P.E., CFM
Vice President

ATTACHMENT A

Cochise County and the Nature Conservancy Ephemeral Streamflow Monitoring Scope of Work Dated March 25, 2016

COCHISE COUNTY & THE NATURE CONSERVANCY
SCOPE OF WORK (SOW)
EPHEMERAL STREAMFLOW MONITORING
Date: March 25, 2016

Introduction

Following successful completion of the Palominas Flood Control and Recharge project construction and subsequent monitoring, and following Phase 1 investigations into the feasibility of conducting aquifer recharge activities on the Riverstone and Bella Vista Ranch properties, Cochise County (County) and The Nature Conservancy (TNC) will establish a network of surface flow monitoring stations at selected locations along ephemeral watercourses tributary to the Upper San Pedro River, at or near the project sites. Also included in the spatial scope of this proposed network is Horseshoe Draw on the Ladd family ranch located south of Highway 92, east of the San Pedro River.

The goal of establishing this network of monitoring stations is to estimate the natural surface water runoff flow depths, rates and volumes that are conveyed by the tributary watercourses on an annual basis in order to facilitate understanding of the rainfall/runoff characteristics of the subject watersheds, guiding improvements in potential future aquifer recharge facility design. The need for pre-project monitoring became evident following the measurement of relatively low runoff volumes reporting to the Palominas Flood Control and Recharge facility.

The data collected by this network of monitoring stations will provide the context within which future aquifer recharge projects will be conceptualized, designed, constructed and operated. It is intended that the results of these monitoring efforts will be combined with other metrics on groundwater elevations and gradients (separate scopes of work) to provide a comprehensive pre-project monitoring program to continue following project development, allowing for direct measurement of the effects of future recharge project implementation. It is also intended that the results of these monitoring efforts will be used to guide and refine modeling practices for estimating rainfall/runoff responses for future projects.

Project deliverables will include preliminary design of flow monitoring stations, installation of monitoring equipment at the selected stations, topographic survey of the monitoring stations, data collection and analysis, and reporting.

Consultants will perform the tasks listed in the SOW. The SOW includes participation in the regularly-scheduled monthly Cochise County Recharge Network Technical Team meetings for a calendar year following contract award. Contract administration will be conducted by the County.

Background

Stilling wells equipped with pressure transducers allow for remote sensing capabilities, measuring and recording water depths with respect to time. Applying the recorded water depths to the hydraulic characteristics of the stilling well installation sites allows for estimations of incremental discharge flow rates, and subsequently hydrograph flow volumes as the discharge rates are integrated over time.

A monitoring network using remote stilling well stations is proposed for several stream channels within the Sierra Vista Subwatershed of the Upper San Pedro River to monitor streamflow for a period of time prior to the design and construction of additional groundwater recharge facilities intended to capture stormwater runoff. This will allow for better estimation of streamflow characteristics in response to precipitation and improve predictions of potential available groundwater recharge volumes. The monitoring stations are presented in Figures 1, 2, and 3. All stream channels are located within Cochise County, within watersheds that originate in developed areas of the County and are subject to conveying urban enhanced runoff. Installation of equipment at the locations proposed is contingent upon obtaining permission for site access to install equipment and collect data for the duration of the project.

The continuous slope-area (CSA) method is an indirect method for calculating flow rates (instantaneous discharge) from ephemeral streams, and allows for estimation of stormwater runoff volumes and recharge potential (Smith et al. 2010). CSA monitoring using remote stilling wells provides advantages over traditional direct methods in that it does not require installation of costly stage gages, cableways/bridges with current meters, or mobilization to stream channels during runoff events to manually measure flow velocity. CSA monitoring stations will be analyzed following methods provided in Smith et al (2010). Calculation of the complete-event hydrograph of discharge will be automated by using the CSA2SAC computer program, adapted from the USGS Slope-Area Computation (SAC) program (Fulford 1994) by the Arizona Water Science Center (provided by S. Wiele, 2014).

Stage/discharge relationships using the U.S. Army Corps of Engineers HEC-RAS model in combination with remote stilling wells provide a method to estimate stormwater runoff volumes through development of rating curves for a range of discharge values, and application of the flow depths recorded by the remote sensors.

Standard methods for developing hydraulic ratings of roadway culvert crossings (FHWA, 2012) allow for development of rating curves correlating inlet flow depths with discharge rates passing through the culverts and/or overtopping roadways. Analysis of the recorded stilling well depth data after runoff events and applying the developed rating curves allows for estimations of runoff hydrograph volumes.

Proposed monitoring at each CSA station consists of four stilling wells installed at equal spacing along the channel reach equipped with datalogging pressure transducers (PT, Rugged TROLL 100, In-Situ, Inc, Fort Collins, CO). Proposed monitoring at each HEC-RAS station consists of two stilling wells installed at equal spacing along the channel reach equipped with the same type of PT. Proposed station configurations at the culvert inlet or roadway at-grade crossings consist of a single stilling well equipped with the same type of PT.

Two HEC-RAS streamflow monitoring stations are proposed in the Schoolhouse Wash in the Palominas watershed, and also proposed are two roadway crossing stations installed upstream of culverts in the King's Ranch subdivision (Figure 1). One roadway crossing station is proposed on the upstream side of Kings Ranch Road, to be analyzed using a broad-crested weir rating. One flowtography monitoring station will also be installed at the County parcel NW of the Palominas Flood Control and Recharge Facility to monitor the presence and extents of flow across the landscape in this undefined channel area.

One CSA monitoring station is proposed in Horseshoe Draw, downstream from the proposed detention basin/headcut mitigation project on the Ladd ranch property (Figure 1). Two CSA streamflow monitoring stations are proposed within the Bella Vista parcel, in Coyote Wash (Figure 3).

Pressure transducers that were previously installed on the Riverstone parcel have been collecting depth (flow, rainfall) data since November 19, 2014. Three PT sensors are located in the Carr Canyon channel, one sensor is located within a stock pond on Golden Acres Wash, one sensor is located within a stock pond on Ramsey Canyon Wash, and one sensor is located at the upstream side of the concrete drop structure (Ramsey Canyon Wash). Included in this SOW is cursory analysis of the historical sensor data collected at Riverstone, and continued data collection and analysis of the new and previously installed sensors at Riverstone.

It is understood that the intent of this monitoring network is to estimate annual runoff flow volumes, typically reporting to the stations under low-stage conditions. These monitoring installations are considered temporary, and damage to the installed stations may occur if the sites are subjected to large (high-stage) flows.

Descriptions of proposed work for each task are provided in the Scope of Work Outline, below.

Scope of Work Outline

The tasks listed below are the identified elements to this SOW.

Task 1: Project Management

The Consultant shall:

- Identify a project manager who will be responsible for managing the budget, schedule, and deliverables throughout the project, including the management of budget, schedule, and deliverables of any Subconsultants, as well as report directly to the County's project manager;
- Identify all Subconsultants who will be involved in the project;
- Schedule and coordinate field work, including equipment installation, data collection, and periodic data downloads;
- Participate in and/or lead (as appropriate) monthly conference calls/meetings for the duration of the contract, including the regularly-scheduled monthly Cochise Conservation and Recharge Network (CCRN) Technical Team Meetings;
- Assign roles and communication system for Consultant and Subconsultant project team members; and
- Identify key stakeholders groups, contacts for each group, and timing for project participation with assistance from the Project Team.

Deliverable 1: Monthly Reports and Invoices and Monthly Conference Calls/Meetings

Task 2: Monitoring Equipment Installation

Task 2a: Purchase and Preparation of Monitoring Equipment

Monitoring equipment will be purchased and prepared immediately in order to expedite installation for streamflow monitoring during the 2016 monsoon season. Information on equipment type, use, and quantities is provided in Table 1. Holsters for CSA gauge installation will be constructed from three foot sections of 2" schedule 40 stainless steel pipe sealed with locked 2" aluminum well caps. Three 3/8" holes will be drilled in each pipe to allow inflow of water into the pressure transducer housing. Precipitation gauges will be purchased for precipitation monitoring at Bella Vista and Horseshoe Draw, and three barometric pressure transducers will be purchased for installation at Bella Vista, Palominas and Horseshoe Draw. Barometric pressure transducers allow for atmospheric pressure compensation of datasets generated from absolute pressure transducers.

Table 1. Proposed monitoring equipment list for CSA streamflow monitoring.

Monitoring Equipment	Make/Model	Purpose	Quantity
Data Logging Pressure Transducer	In-Situ, Inc Rugged TROLL 100	CSA streamflow monitoring, HEC-RAS flow monitoring, roadway crossing flow monitoring	20
Data Logging Barometric Pressure Transducer	In-Situ, Inc Rugged Baro Troll	Barometric pressure compensation	3
Rain Gauge	Onset Comp Corp, RG3	Precipitation monitoring	2
Flowtography Camera	Moultrie, Game Spy M-900Ai	Flowtography monitoring	1
Staff Gauge	Ben Meadows, Style A	Flowtography water depth	2

Task 2b: Installation of Monitoring Equipment

Installation of monitoring equipment will occur concurrently with Task 3. PT sensor housings will be installed in channel bottoms by driving the pipe approximately two feet below ground surface at an angle of 45 degrees. Concrete will be used as needed to secure the housings in place. Pressure transducers will be suspended immediately at ground surface inside the pipe using stainless steel wire fixed to locking well caps. They will be programmed to record water level when a pressure change of greater than 5 mm is detected (event-based logging), with sensor readings checked at one-minute intervals. Installation methods will be identical for the three stilling wells installed immediately upstream of culverts in Kings Ranch and at the Kings Ranch Roadway crossing (Figure 1).

One additional sensor will be installed at the existing Carr Canyon station, in order to facilitate the use of the CSA method for analyzing flow depths.

A barometric pressure transducer will be installed at the fenced Liberty Utilities facility at Kings Ranch Estates, where a rain gauge is currently installed (Figure 1) as part of the Palominas Monitoring Network. A barometric pressure transducer and rain gauge will be installed along the established road near the proposed Hoseshoe Draw project site (Figure 1), outside the disturbance limits associated with the proposed detention basin project. A barometric pressure transducer and rain gauge will be installed in an open area near the ranch at Bella Vista (Figure 3). Both will be mounted to a steel post approximately five feet above ground surface. The rain gauge will be set to record temperature data hourly, in addition to instantaneous tip times. Barometric pressure transducers will record data every 15 minutes.

A flowtography camera will be installed in the county-owned parcel (Mansker tract or detention basin parcel) east of Miracle Valley, and mounted approximately 5 feet above ground surface on a steel post and set to record images every 30 minutes. Two 3.3 foot

staff gauges will be installed 15 and 30 feet from the camera to allow for documentation of surface water depth.

Table 2 below shows the stations and types of sensors that will be installed.

Table 2. Proposed monitoring equipment installation locations.

Station ID	Station Type	Description
KR C1	CULVERT	1 Pressure Transducer at Culvert Inlet
KR C2	CULVERT	1 Pressure Transducer at Culvert Inlet
KR 1	HEC-RAS	2 Pressure Transducers for HEC-RAS Analysis
KR 2	ROADWAY WEIR	1 Pressure Transducer at Roadway Crossing
MV 1	HEC-RAS	2 Pressure Transducers for HEC-RAS Analysis
KR P1	BAROMETRIC	1 Atmospheric Pressure Gauge
HD 1	CSA	4 Pressure Transducers for Continuous Slope-Area Analysis
HD P1	PRECIP/BARO	1 Precipitation Gauge and 1 Atmospheric Pressure Gauge
CA 1	CSA	1 Pressure Transducer for Continuous Slope-Area Analysis (3 are existing)
CY 1	CSA	4 Pressure Transducers for Continuous Slope-Area Analysis
CY 2	CSA	4 Pressure Transducers for Continuous Slope-Area Analysis
CY P1	PRECIP/BARO	1 Precipitation Gauge and 1 Atmospheric Pressure Gauge

The selected station locations have been chosen to maximize activities on County- or TNC-owned properties, however some are located on privately-owned land. Cochise County shall facilitate access for installation and data download activities where the stations are located on private property(ies).

Task 3: Survey of Monitored Channel Reaches/Stations

The survey data collection task will occur concurrently with Task 2b. Selection of suitable channel reaches is of great importance for successful application of the CSA method. Prior to installation of PT sensors, each of the proposed channel reaches will be visually assessed for straightness, uniformity, roughness, and accessibility. A Manning's n value will be assigned to each reach describing the channel/bank roughness and spatial variability of roughness across the cross section. Four channel cross section elevation profiles at each channel station will be surveyed using real-time kinematic (RTK) satellite positioning. Information gathered during site surveys will be used to modify monitoring sensor placement locations as needed, and to generate data necessary for input into the CSA2SAC computer model, the HEC-RAS files, and the roadway crossing analyses.

Survey data collected at the roadway crossing stations will consist of upstream and downstream culvert invert elevations (if present), culvert configurations including type, size, quantity (if present), and roadway overtopping elevation profiles.

For all survey work performed using RTK, a local benchmark (rebar pin, or wooden 2”x2”x24” stakes) will be driven into the ground and placed at the monitoring station. The local benchmarks will be flagged using survey flagging tape for recovery. All survey work will be relative to the installed benchmarks. County Surveyors will recover the installed local benchmarks and tie the benchmarks into the County survey network to provide horizontal (coordinate) and vertical (elevation) data on each benchmark.

Deliverables 2 and 3: Draft and Final Installation Reports detailing specifics on field work including: applicable dates of fieldwork, all sensors installed, installation methods, issues encountered during installations (if any), approaches taken to overcome the issues encountered (if any), survey information, and field observations relative to the expected analyses.

Task 4: Riverstone Data Analysis

Data from the CSA station (three sensors) gauges and three stilling wells installed at Riverstone Ranch will be reviewed to determine the need for sensor relocation, sensor repair/replacement, or additional instrumentation. The period of data reviewed for the CSA station in Carr Canyon wash will begin on November 19, 2014, when a vandalized gauge was replaced and data from the requisite number of gauges is therefore available. Streamflow events will be identified and the data reviewed for sensor functionality and suitability for CSA analysis. Figures of each event will be generated which show precipitation and measured water depth at each sensor location in the channel reach. Data from the three stilling wells installed inside retention basins in Ramsey Canyon and Golden Acres wash will be reviewed for continuity, and peak water levels will be identified and compared to measured rainfall amounts.

Deliverable 4: A brief summary of findings from the data review and analysis will be prepared and provided to the project team for discussion at one of the monthly meetings.

Task 5: Monitoring and Data Reporting

Task 5a: Quarterly Data Downloads

Data will be manually downloaded from all monitoring equipment at Bella Vista, Riverstone, Horseshow Draw and Palominas (Figures 1, 2, and 3) four times during the annual monitoring period. All pressure transducers, rain gauges, and the flowtography station will be assessed for functionality, battery life, and sensor and clock drift. Data

trends will be examined in the field to assure data quality, and any necessary adjustments will be made.

Task 5b: Equipment Maintenance

Flow events at the sensor stations may create the need to routinely clear vegetation and other debris from the sensors in order to allow for accurate measurement readings. Minor debris removal will occur coincidentally with the data downloads. Large flow events have the potential to scour channel bottoms and erode channel banks, which may necessitate adjustments to sensor installation locations and depths, as well as re-survey of channel cross sections and characteristics (roughness, uniformity, etc). Two additional site visits shall be assumed to allow for such maintenance, as changes may not be evident until data has been processed and analyzed.

Task 5c: Data Processing and Analysis

Data from the first year monitoring period at all CSA stations will be analyzed following methods provided in Smith et al (2010), and using HEC-RAS, depending on the station. Data for individual runoff events will be pre-processed and formatted as necessary for input into the CSA2SAC program developed by the USGS AZ Water Science Center (provided by Steven Wiele) or HEC-RAS. Output files provide instantaneous stream discharge estimates which will be used to develop complete event hydrographs of discharge.

Data from the first year of monitoring activities at roadway crossing stations will be analyzed following accepted engineering methods provided by the FHWA. At roadway crossing stations (Palominas watershed), culvert and/or roadway overtopping rating curves/tables will be generated to provide stage-discharge relationships to estimate flow volumes.

Data collected at the stock pond installations within the Riverstone property will be analyzed using the County's 2-foot contour resolution mapping, in order to develop a stage/storage relationship to translate recorded depths to volumes. The Ramsey drop structure data will be analyzed through the use of a broad-crested weir rating, to translate recorded flow depths to volumes.

Task 5d: Data Quality Assurance/Quality Control

Data will be reviewed to assure accuracy of data entry, processing, and analysis. A hydrologic engineer will also review all input parameters, results, and findings for accuracy. Any errors encountered will be remedied and documented in detail.

Task 5e: Reporting

Following analysis of monitoring data, an annual report will be generated which summarizes project findings. The following metrics will be calculated for each of the monitoring stations:

- Complete event hydrographs of discharge
- Total annual and individual event flow volumes (acre-feet)
- Peak channel discharge (cfs)
- Event flow durations (hours)

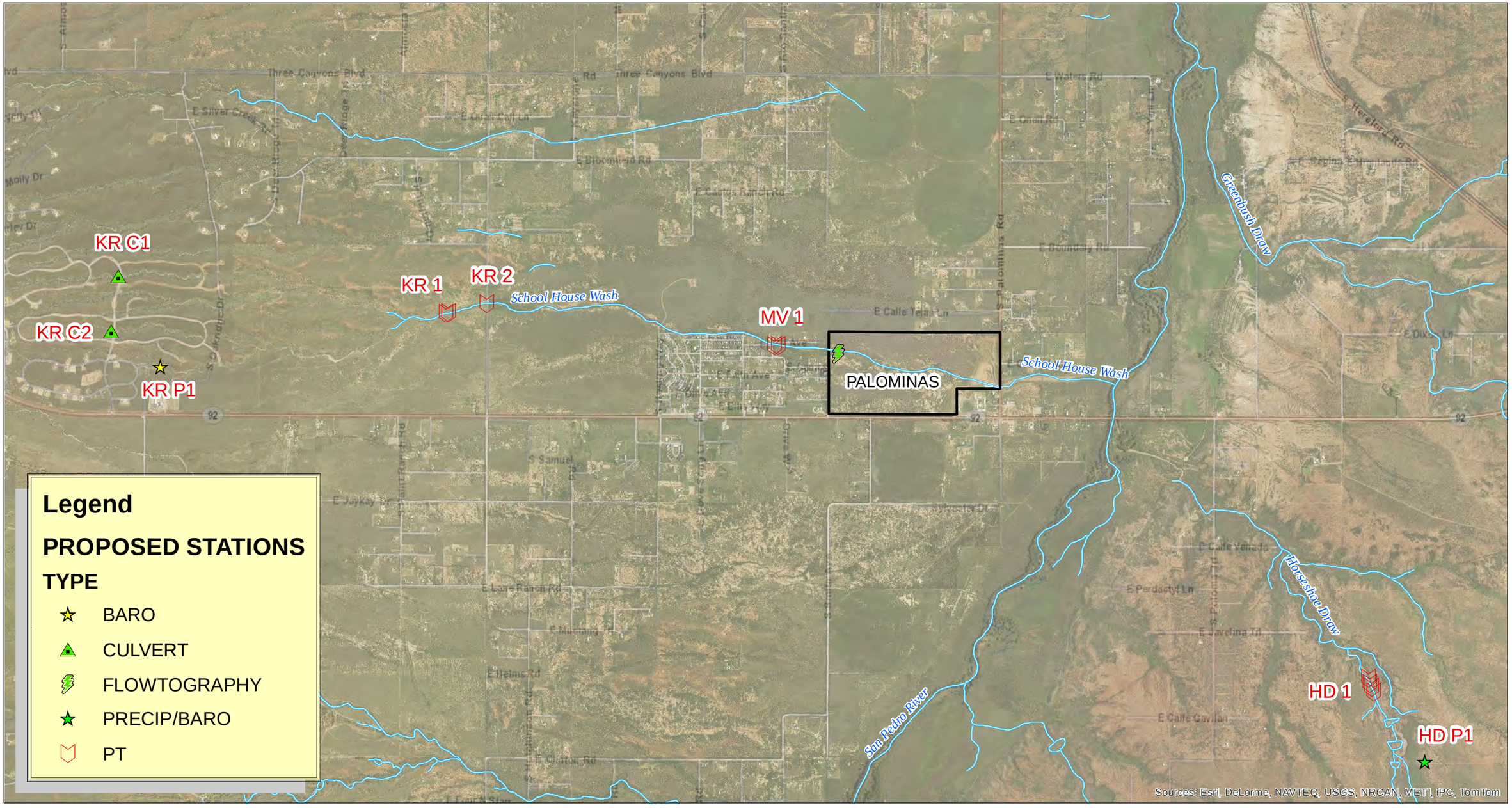
Data from the flowtography station will be summarized to provide estimates of water depth and extent during flow events.

Deliverables 5 and 6: A Draft Annual Report will be submitted to the project team at the end of the one year monitoring period. A Final Annual Report will be submitted within one month of receipt of comments from the project team. All project activities will be clearly documented, including data interpretation and analysis. All associated data will be provided in electronic format, as an appendix to the final report.

Schedule

It is anticipated that the contract will be awarded during the month of March, 2016. The Consultant shall work closely with the County's project manager to develop a schedule for review and approval by the Project Team within 10 days of contract award.

A proposed schedule is to complete Tasks 2 and 3 by June 15, 2016, to prevent loss of streamflow data during summer rains. Manual data downloads (Task 5a) will occur at the end of August 2016, November 2016, February 2017, and May 2016. Data analysis and QA/QC (Tasks 5c and 5d) will begin following the preliminary download in August 2016, and will continue following each of the subsequent site visits.



Legend

PROPOSED STATIONS

TYPE

- BARO
- CULVERT
- FLOWTOGRAPHY
- PRECIP/BARO
- PT

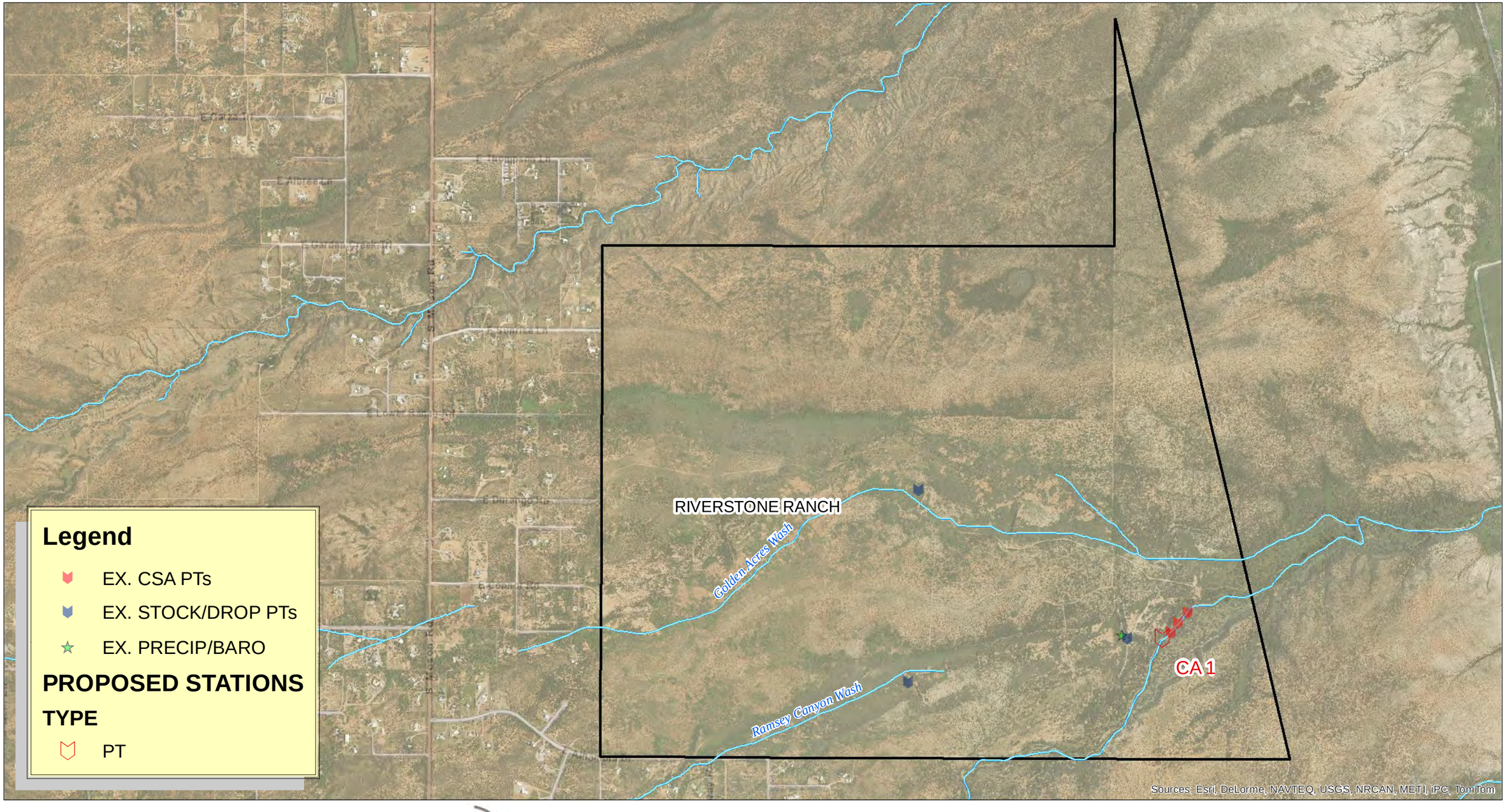
JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

GSA GeoSystems Analysis, Inc. Innovations in Hydrology

0 1,500 3,000 6,000 9,000 12,000 Feet

APPROX. SCALE: 1"=3,000 FT.

FIGURE 1
PROPOSED STATIONS
PALOMINAS AREA



Legend

- EX. CSA PTs
- EX. STOCK/DROP PTs
- EX. PRECIP/BARO

PROPOSED STATIONS

TYPE

- PT

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

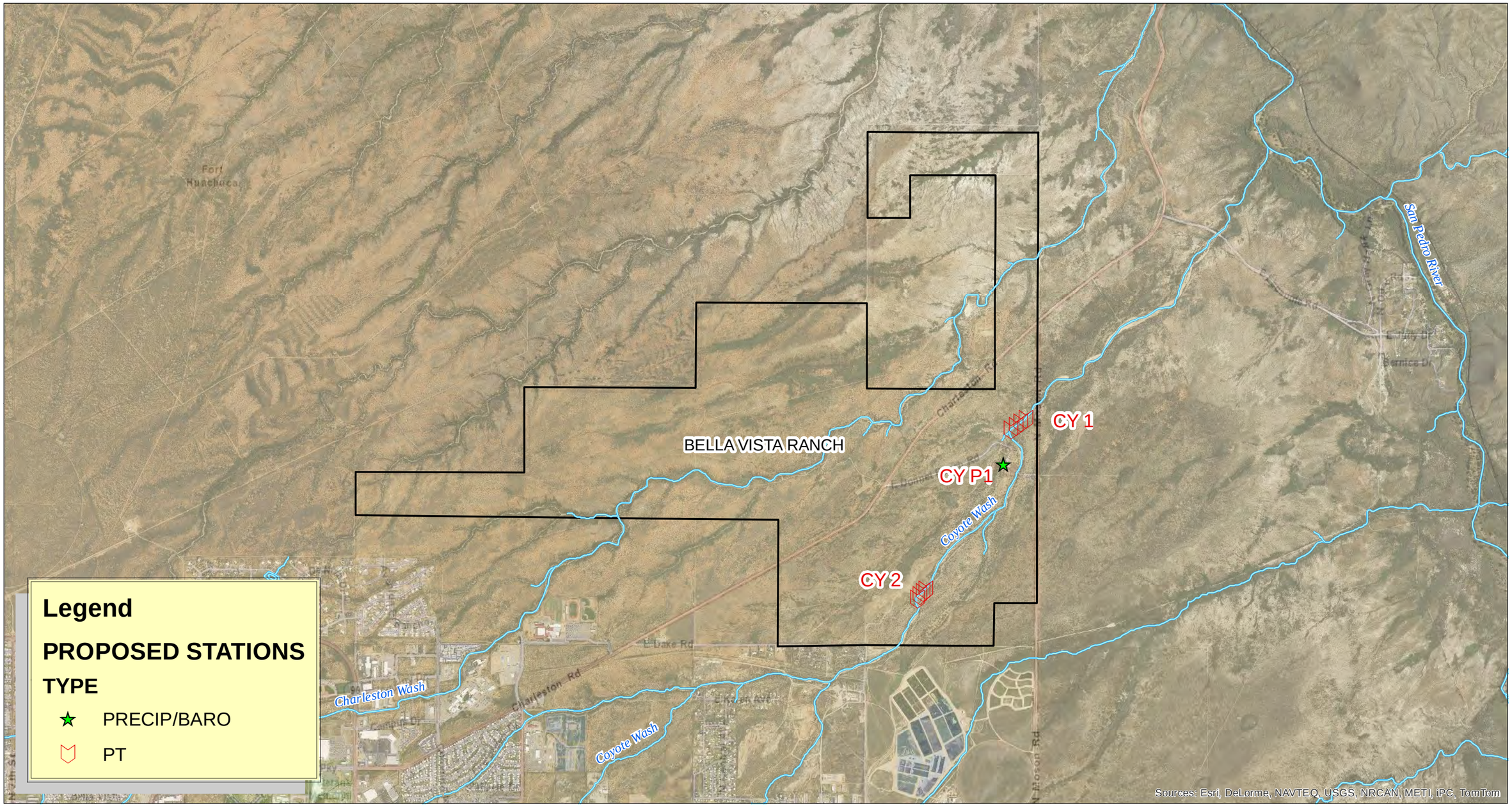
GSA GeoSystems Analysis, Inc. Innovations in Hydrology

0 700 1,400 2,800 4,200 5,600 Feet

APPROX. SCALE: 1"=1,500 FT.

N

FIGURE 2
EXISTING & PROPOSED STATIONS
RIVERSTONE SITE



JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

GSA GeoSystems Analysis, Inc. Innovations in Hydrology

0 1,500 3,000 6,000 9,000 12,000 Feet

APPROX. SCALE: 1"=3,000 FT.

FIGURE 3
PROPOSED STATIONS
BELLA VISTA SITE

ATTACHMENT B
Summary Cost Sheet for the Ephemeral Streamflow Monitoring SOW

PROJ: Cochise County/Ephemeral Streamflow Monitoring Project
DETAIL: Total Project Cost Calculation
DATE: March 8, 2016
Prepared by: JE Fuller/Hydrology & Geomorphology (JE Fuller)

ATTACHMENT B - Summary Cost Sheet for the Ephemeral Streamflow Monitoring SOW

Task	Title	Deliverable (see SOW for task details)	Costs		
			JE Fuller	GSA	TOTAL
1	Project Management	Deliverable 1: Monthly Reports and Invoices and Monthly Meetings/Conference Calls	$13,397	$11,748	**$25,145**
2a	Purchase and Preparation of Monitoring Equipment	Deliverables 2 and 3: Draft and Final Installation Reports detailing specifics on field work including: applicable dates of fieldwork, all sensors installed, installation methods, issues encountered during installations (if any), approaches taken to overcome the issues encountered (if any), survey information, and field observations relative to the expected analyses.	$724	$14,476	**$15,200**
2b	Installation of Monitoring Equipment		$398	$7,960	**$8,358**
3	Survey of Monitored Channel Reaches/Stations		$5,875	$0	**$5,875**
4	Riverstone Data Analysis	Deliverable 4: A brief summary of findings from the data review and analysis will be prepared and provided to the project team for discussion at one of the monthly meetings.	$62	$1,248	**$1,310**
5a	Quarterly Data Downloads	Deliverables 5 and 6: A Draft Annual Report will be submitted to the project team at the end of the one year monitoring period. A Final Annual Report will be submitted within one month of receipt of comments from the project team. All project activities will be clearly documented, including data interpretation and analysis. All associated data will be provided in electronic format, as an appendix to the final report.	$306	$6,113	**$6,419**
5b	Equipment Maintenance		$1,058	$2,862	**$3,920**
5c	Data Processing and Analysis		$8,937	$9,134	**$18,071**
5d	Data Quality Assurance/Quality Control		$1,260	$0	**$1,260**
5e	Reporting		$5,115	$6,292	**$11,407**
		TOTALS	**$37,132**	**$59,833**	**$96,965**

Notes:
5.00% Subconsultant markup included in JE Fuller Cost
All fee estimates are approximate.
The total fee is a not-to-exceed (NTE) amount and individual task fees may vary within the total NTE.
Where needed tasks may be performed concurrently or out of the sequence indicated above.

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ATTACHMENT C
JE Fuller Scope of Work & Fee Estimate

Task 1: Project Management

JE Fuller will provide project management services in coordination with subconsultants Geosystems Analysis (GSA) as needed. Cyrus Miller, PE, CFM, will serve as the project manager for JE Fuller. John Wallace, PE, CFM will provide technical oversight and assistance as needed. JE Fuller will provide the monthly reports and invoices called for under this task.

Task 2: Monitoring Equipment Installation

GSA will perform the work called for under this task (see Attachment D). JE Fuller will coordinate with GSA as needed to facilitate performance of this task and administer their contract. GSA will assist JE Fuller in preparation of the Deliverables 2 and 3 (Draft and Final Installation Reports) associated with this task.

Task 3: Survey of Monitored Channel Reaches/Stations

JE Fuller will provide the channel cross section and culvert/weir topographic survey using RTK surveying equipment provided by JE Fuller for this task. Local benchmarks (2"x2"x24" wooden stakes or 18" rebar pins) will be placed to establish local benchmarks, as well as the end points of the surveyed cross sections (as applicable). Existing benchmarks discovered during the field survey will be used to the extent practical. JE Fuller will collect channel/bank roughness information for use in the HEC-RAS analyses, and will provide that information to GSA for use in the CSA analyses.

Benchmark data for each station, consisting of points collected with hand-held GPS units will be forwarded to the County for recovery by County Survey crews after the topographic survey has been performed.

JE Fuller, in coordination with GSA, will prepare Deliverables 2 and 3 associated with this task.

Task 4: Riverstone Data Analysis

GSA will perform the work called for under this task (see Attachment D). JE Fuller will coordinate with GSA as needed to facilitate performance of this task and administer their contract. GSA will prepare Deliverable 4 (Data Summary) associated with this task.

Task 5: Monitoring and Data Reporting

GSA will perform the work called for under Task 5a (see Attachment D).

JE Fuller will perform one (1) post-installation trip to one (1) of the stations in order to perform equipment maintenance and re-survey.

JE Fuller will perform the Task 5c data analyses for the stations analyzed using the following methods: HEC-RAS, culvert crossing, weir (roadway and drop structure) and stock pond, given recorded flow depth data collected by GSA and provided to JE Fuller. Discharge rating tables based on flow depths will be created, and complete event hydrographs will be developed for all recorded flow data. Total runoff volumes will be calculated by integrating the flow rates over time.

JE Fuller will perform Task 5d.

JE Fuller will formulate and deliver the Draft and Final Annual Monitoring Reports (Deliverables 5 and 6), in coordination with and given input from GSA.

The page which follows provides an estimate of the work effort by JE Fuller (only) to provide the foregoing services. A separate cost estimate for the entire project is provided separately in Attachment B.

PROJ: Cochise County/Ephemeral Streamflow Monitoring Project
DETAIL: JEF Cost Calculation
DATE: March 8, 2016
Prepared by: JE Fuller/Hydrology & Geomorphology (JE Fuller)

Task	Title	Deliverable (see SOW for task details)	JE Fuller Hours		JE Fuller Labor Cost	JE Fuller Direct Costs	JE Fuller Total Cost
			PM II	PE II			
			$125.00	$105.00			
1	Project Management	**Deliverable 1:** Monthly Reports and Invoices and Monthly Meetings/Conference Calls	6	112	$12,510	$300	**$12,810**
2a	Purchase and Preparation of Monitoring Equipment	**Deliverables 2 and 3:** Draft and Final Installation Reports detailing specifics on field work including: applicable dates of fieldwork, all sensors installed, installation methods, issues encountered during installations (if any), approaches taken to overcome the issues encountered (if any), survey information, and field observations relative to the expected analyses.	0	0	$0	$0	**$0**
2b	Installation of Monitoring Equipment		0	0	$0	$0	**$0**
3	Survey of Monitored Channel Reaches/Stations		0	52	$5,460	$415	**$5,875**
4	Riverstone Data Analysis	**Deliverable 4:** A brief summary of findings from the data review and analysis will be prepared and provided to the project team for discussion at one of the monthly meetings.	0	0	$0	$0	**$0**
5a	Quarterly Data Downloads	**Deliverables 5 and 6:** A Draft Annual Report will be submitted to the project team at the end of the one year monitoring period. A Final Annual Report will be submitted within one month of receipt of comments from the project team. All project activities will be clearly documented, including data interpretation and analysis. All associated data will be provided in electronic format, as an appendix to the final report.	0	0	$0	$0	**$0**
5b	Equipment Maintenance		0	8	$840	$75	**$915**
5c	Data Processing and Analysis		4	76	$8,480	$0	**$8,480**
5d	Data Quality Assurance/Quality Control		0	12	$1,260	$0	**$1,260**
5e	Reporting		4	40	$4,700	$100	**$4,800**
		TOTALS	**14**	**300**	**$33,250**	**$890**	**$34,140**

Notes:
All fee estimates are approximate.
The total fee is a not-to-exceed (NTE) amount and individual task fees may vary within the total NTE.
Where needed tasks may be performed concurrently or out of the sequence indicated above.

ATTACHMENT D
GSA Scope of Work & Fee Estimate

GeoSystems Analysis, Inc.
Innovations and Solutions

Proposed Scope of Work for Ephemeral Streamflow Monitoring

The Section headings in this Scope of Work (SOW) are consistent with the task numbers used in the JE Fuller Site Investigation Scope of Work Outline Ephemeral Streamflow Monitoring through Task 5. Only the tasks requiring work by GSA are included in this document, thus Task 3 is excluded.

1.0 PROJECT MANAGEMENT

GSA will work closely with JEF and the Project Team to manage the budget, schedule, and deliverables and to report to the County's project manager. Mike Milczarek, the GSA project manager will prepare and provide monthly reports and invoices to JEF, and participate in monthly conference calls and meetings (deliverable 1). In addition, Mike Milczarek will provide technical oversight and be available to assist as needed.

2.0 MONITORING EQUIPMENT INSTALLATION

GSA will be responsible for the purchase and preparation of monitoring equipment (subtask 2a), and installation of all monitoring equipment (subtask 2b). The installation of monitoring equipment will occur concurrently with JEF's completion of Task 3. Installation locations and details will be carefully documented for inclusion in a draft and final installation report (subtask 2c, deliverables 2 and 3).

4.0 RIVERSTONE DATA ANALYSIS

Data from a CSA station installed in 2014 at the Riverstone Ranch will be reviewed to determine the suitability of data collected for CSA analysis and need for additional instrumentation. Streamflow events will be plotted relative to rainfall amounts, and data will be summarized and presented to the CCRN technical team during a data discussion meeting (subtask 4b, deliverable 4).

5.0 MONITORING AND DATA REPORTING

The ephemeral streamflow monitoring network will be visited quarterly for data downloads (subtask 5a). An additional equipment maintenance visit is included to facilitate rapid replacement in the event of instrumentation malfunction or loss (subtask 5b). GSA will be responsible for analyzing all major streamflow events at CSA stations following established methods and using the CSA2SAC program developed by USGS (subtask 5c). Instantaneous stream discharge estimates generated from CSA analysis will be used to develop complete

event hydrographs. Additionally, GSA will summarize precipitation data to be utilized in reviewing watershed rainfall-runoff relationships, and review flowtography station data to provide estimates of water depth and lateral spreading during runoff events. Data from the annual monitoring period will be summarized in a draft and final annual monitoring report (subtask 5d, deliverables 5 and 6). Findings from this report will be integrated by JEF into a unified project report for submittal to Cochise County and The Nature Conservancy.

6.0 ESTIMATED BUDGET

The estimated budget for Tasks 1 through 5 is summarized in Table 1; detailed estimated costs are provided in Table 2.

San Pedro CSA Monitoring

1520 - JE Fuller

March 02, 2016

Table 1 - Cost Summary By Task

	Total Costs
1 - Project Management	**$11,748**
1a - Project Coordination and Management	$2,942
1b - Monthly CCRN Technical Team Meetings	$8,806
2 - Monitoring Equipment Installation	**$22,436**
2a - Purchase and Preparation of Monitoring Equipment	$14,476
2b - Installation of Monitoring Equipment	$6,564
2c - Installation Report	$1,396
4 - Riverstone Data Analysis	**$1,248**
4a - Process and Analyze Data	$879
4b - Data Discussion Meeting	$369
5 - Monitoring and Reporting	**$24,401**
5a - Quarterly Data Downloads	$6,113
5b - Equipment Maintenance	$2,862
5c - Data Processing and Analysis	$9,134
5e - Reporting	$6,292
Proposal Grand Total	**$59,833**

San Pedro CSA Monitoring
Table 2 - Detailed Costs

Task: 1 - Project Management

		Quantity	Unit Cost	Shipping	Total Cost
Personnel Costs					
Subtask: 1a - Project Coordination and Management					
Program Director	Milczarek	8	$145	NA	1160
Staff Hydrologist	Bunting	16	$85	NA	1360
Clerical Staff	Torres	4	$65	NA	260
			Subtask Total:		*$2,780*
Subtask: 1b - Monthly CCRN Technical Team Meetings					
Program Director	Milczarek	42	$145	NA	6090
Staff Hydrologist	Bunting	24	$85	NA	2040
			Subtask Total:		*$8,130*
Other Direct Costs					
Subtask: 1a - Project Coordination and Management					
Miscellaneous		2	$50	NA	100
Communications		1	$50	NA	50
			Subtask Total:		*$162*
Subtask: 1b - Monthly CCRN Technical Team Meetings					
Miscellaneous		2	$50	NA	100
Communications		4	$50	NA	200
Reproduction		2	$50	NA	100
2WD Transportation		400	$1	NA	226
			Subtask Total:		*$676*
	8.00% Overhead: $62.08		**Task Total**		**$11,748**

San Pedro CSA Monitoring
Table 2 - Detailed Costs

Task: 2 - Monitoring Equipment Installation

	Quantity	Unit Cost	Shipping	Total Cost
Personnel Costs				
Subtask: 2a - Purchase and Preparation of Monitoring Equipment				
Program Director Milczarek	0.5	$145	NA	72.5
Staff Hydrologist Bunting	4	$85	NA	340
Technician Heydorn	8	$65	NA	520
		Subtask Total:		*$933*
Subtask: 2b - Installation of Monitoring Equipment				
Program Director Milczarek	0.5	$145	NA	72.5
Staff Hydrologist Bunting	36	$85	NA	3060
Technician Heydorn	36	$65	NA	2340
		Subtask Total:		*$5,473*
Subtask: 2c - Installation Report				
Program Director Milczarek	1	$145	NA	145
Staff Hydrologist Bunting	12	$85	NA	1020
AutoCAD/GIS Buchanan	2	$75	NA	150
		Subtask Total:		*$1,315*
Other Direct Costs				
Subtask: 2a - Purchase and Preparation of Monitoring Equipment				
Hobo Rain Gauge	2	$420	NA	840
In-Situ Rugged Baro Troll	2	$380	NA	760
In-Situ Rugged Troll 100	20	$380	NA	7600
Flowtography Locked Enclosure	3	$200	NA	600
Flowtography Camera	3	$150	NA	450
Stainless Steel Pipe	8	$100	NA	800
Shipping	2	$50	NA	100
Miscellaneous Items	5	$50	NA	250
Staff Gage	6	$35	NA	210
2" locking well cap	20	$20	NA	400
PT suspension cable	20	$15	NA	300
Padlock	23	$10	NA	230
		Subtask Total:		*$13,543*
Subtask: 2b - Installation of Monitoring Equipment				
Lodging	4	$85	NA	340
Miscellaneous Items	4	$50	NA	200
Subsistence	6	$46	NA	276
4WD Truck	300	$1	NA	195

San Pedro CSA Monitoring
Table 2 - Detailed Costs

			Subtask Total:		*$1,092*
Subtask: 2c - Installation Report					
Reproduction		0.5	$50	NA	25
Communications		1	$50	NA	50
			Subtask Total:		*$81*
	8.00% Overhead: $1090.08		**Task Total**		**$22,436**

San Pedro CSA Monitoring
Table 2 - Detailed Costs

Task: 4 - Riverstone Data Analysis

		Quantity	Unit Cost	Shipping	Total Cost
Personnel Costs					
Subtask: 4a - Process and Analyze Data					
Program Director	Milczarek	1	$145	NA	145
Staff Hydrologist	Bunting	8	$85	NA	680
			Subtask Total:		*$825*
Subtask: 4b - Data Discussion Meeting					
Program Director	Milczarek	1	$145	NA	145
Staff Hydrologist	Bunting	2	$85	NA	170
			Subtask Total:		*$315*
Other Direct Costs					
Subtask: 4a - Process and Analyze Data					
Communications		1	$50	NA	50
			Subtask Total:		*$54*
Subtask: 4b - Data Discussion Meeting					
Communications		1	$50	NA	50
			Subtask Total:		*$54*
	8.00% Overhead: $8.00		**Task Total**		**$1,248**

San Pedro CSA Monitoring
Table 2 - Detailed Costs

Task: 5 - Monitoring and Reporting

		Quantity	Unit Cost	Shipping	Total Cost
Personnel Costs					
Subtask: 5a - Quarterly Data Downloads					
Program Director	Milczarek	2	$145	NA	290
Staff Hydrologist	Bunting	12	$85	NA	1020
Hydrologist 1	Calabrese	48	$75	NA	3600
			Subtask Total:		*$4,910*
Subtask: 5b - Equipment Maintenance					
Program Director	Milczarek	1	$145	NA	145
Staff Hydrologist	Bunting	12	$85	NA	1020
			Subtask Total:		*$1,165*
Subtask: 5c - Data Processing and Analysis					
Program Director	Milczarek	4	$145	NA	580
Staff Hydrologist	Bunting	100	$85	NA	8500
			Subtask Total:		*$9,080*
Subtask: 5e - Reporting					
Program Director	Milczarek	4	$145	NA	580
Staff Hydrologist	Bunting	60	$85	NA	5100
AutoCAD/GIS	Buchanan	6	$75	NA	450
			Subtask Total:		*$6,130*
Other Direct Costs					
Subtask: 5a - Quarterly Data Downloads					
Miscellaneous		2	$50	NA	100
Communications		1	$50	NA	50
Subsistence		4	$46	NA	184
4WD Truck		1200	$1	NA	780
			Subtask Total:		*$1,203*
Subtask: 5b - Equipment Maintenance					
Hobo Rain Gauge		1	$420	NA	420
In-Situ Rugged Troll 100		2	$380	NA	760
Communications		1	$50	NA	50
Miscellaneous		2	$50	NA	100
Subsistence		1	$46	NA	46
4WD Truck		300	$1	NA	195
			Subtask Total:		*$1,697*
Subtask: 5c - Data Processing and Analysis					
Communications		1	$50	NA	50
			Subtask Total:		*$54*
Subtask: 5e - Reporting					

San Pedro CSA Monitoring
Table 2 - Detailed Costs

Communications		1	$50	NA	50
Reproduction		2	$50	NA	100
			Subtask Total:		*$162*
	8.00% Overhead: $230.80		**Task Total**		**$24,401**
			PROPOSAL GRAND TOTAL:		**$59,833**