Victoria Boyne

From: ResolutionProjectRecord
Subject: FW: FW: Draft Resolution Copper Project Science Tasks Workplan

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From: Magirl, Christopher <magirl@usgs.gov>
Sent: Monday, January 29, 2018 4:26 PM
To: Rasmussen, Mary C -FS <mcrasmussen@fs.fed.us>
Cc: Chris Garrett <cgarrett@swca.com>
Subject: Re: FW: Draft Resolution Copper Project Science Tasks Workplan

Hi Mary,

We understand completely and appreciate you getting back to us. Our slow, deliberate USGS approach is probably not the best match for this project. I've been tremendously impressed, however, with the professionalism and skill that you and Chris bring to the entire EIS task (I don't envy your job in the least).

Best of luck with the EIS review, and please don't hesitate to call or write if I can help with something.

Best regards,
-Chris

Christopher Magirl
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On Mon, Jan 29, 2018 at 3:43 PM, Rasmussen, Mary C -FS <mcrasmussen@fs.fed.us> wrote:

> Hello Chris Magirl and Happy New Year!
>
> We finally got a chance to review the details of the USGS response letter dated January 8, outlining your estimate of work for 4 tasks associated with the Resolution Copper Mine EIS.
>
> A formal letter from Neil is in the works – but I wanted you to know, informally and sooner, that we will not be pursuing an interagency agreement.
>
> The necessary timeframes and costs to complete the 4 tasks fall outside the scope and framework that that the Forest Service EIS project team is working under.

I hope you understand the our situation. We certainly appreciate the time and effort that you and your staff have expended up front to put together not only a response to the task proposal but also engaging and assisting with several of the ground water workgroup meetings held over the last 3 months.

I appreciate and respect the interest you've taken in helping both agencies to achieve our respective missions and project goals.

Sincerely, Mary

Mary C. Rasmussen
Project Manager - Resolution Copper Mine EIS
USDA Forest Service

Tonto National Forest, Supervisor's Office

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Caring for the land and serving people

From: Leenhouts, James [mailto:leenhout@usgs.gov]
Sent: Monday, January 8, 2018 4:56 PM
To: Bosworth, Neil -FS <nbosworth@fs.fed.us>
Cc: Rasmussen, Mary C -FS <mcrasmussen@fs.fed.us>; magirl@usgs.gov
Subject: Draft Resolution Copper Project Science Tasks Workplan

Dear Neil,

In response to your September, 6, 2017 invitation to contribute scientifically in Tonto National Forest's effort to complete the environmental review of the proposed Resolution Copper Mine, our USGS team prepared a draft scope-of-work detailing four of five proposed tasks (note that that the decision was made by the EIS team not to commence streamflow gaging this fiscal year).

Mary Rasmussen and Chris Magirl have been discussing the specifics behind each of the tasks. Unfortunately, due to the complexity of the proposed tasks, few of the items could be completed by September 2018. However, we outline tasks and sub-tasks that can be completed in the given time frame.

We look forward to addressing any questions you or your staff may have and will work with you to ensure work proposed addresses your needs as best possible. When the final workplan is agreed on, please have Mary work with Chris start the work toward an Interagency Agreement. The agreement process can be completed rapidly at the appropriate time.

Best Regards,

Jim

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James Leenhouts, Ph.D.

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Understanding the Regional Connectivity of Groundwater-Dependent Ecosystems and Groundwater-Supply Areas to the Regional Groundwater System near the Proposed Resolution Copper Project near Superior, Arizona

Summary and Statement of Work

Background

Resolution Cooper Mining, LLC, submitted to the US Department of Agriculture Tonto National Forest a proposed plan for development and operation of the large-scale Resolution Copper Mine, located near the Town of Superior, Arizona (USDA Tonto National Forest, 2017). Using the mining process called block caving, the Resolution Copper Project would create one of the largest copper mines in the United States with an estimated surface disturbance of 6,951 acres (approximately 11 square miles). It would also be one of the deepest mines in the United States, with mine workings extending 7,000 feet beneath the surface. Resolution Copper estimates that block-cave mining will create a surface subsidence feature between 700 and 1,000 feet deep (Resolution Copper, 2017).

The Resolution Copper Mine would be located at the former Magma Copper mine above the Apache Leap formation just east of Superior, AZ, on public lands exchanged with Resolution Copper for lands elsewhere in Arizona (USDA Tonto National Forest, 2017). The area is considered sacred ground by the San Carlos Apache Tribe. Tailings from the mining would be transported and deposited away from the mine on Tonto National Forest land (USDA Tonto National Forest, 2017). The impact of mining activities on nearby streams, including Queen Creek, Devil's Canyon, and Mineral Creek, is unknown. The impact of the tailings pile on surface-water drainages and groundwater resources is also unknown.

Problem

Tonto National Forest is focused on environmental review and administration of the land exchange and the proposed mine related activities that would occur on national forest lands. On September 6, 2017, Tonto National Forest invited the U.S. Geological Survey (USGS) to become a participating agency on the environmental review of the project. As a science organization in an independent and non-advocacy position, USGS does not typically participate in environmental reviews. However, the USGS as part of its mission may provide science support if its data and scientific expertise have direct relevance to proposed actions under the National Environmental Policy Act review, if funding were available. The National Forest also identified four potential tasks the USGS could be involved in to provide science support. Those four potential tasks are listed in sections below.

Objectives

Task #1— *Characterize Regional Connectivity of Groundwater-Dependent Ecosystems (GDEs) and Water Supplies:* The Forest Service identified several riparian areas that may be supported by groundwater. The Forest Service asked the USGS to characterize the most likely source of water to these GDEs.

The riparian areas that may be supported by groundwater, as well as several areas where water supplies are primarily supported by groundwater (fig. 1), include:

1. Intermittent reaches of Upper Queen Creek above the town of Superior
2. Groundwater supplies to Boyce-Thompson Arboretum
3. Perennial reaches of Devil's Canyon above Mineral Creek
4. Perennial reaches of Mineral Creek above Devil's Canyon
5. Groundwater supplies to JI Ranch
6. Shallow groundwater systems in Hackberry Canyon, Rio Rancho Canyon, and Oak Flat
7. Benson Spring
8. Bear Tank Spring
9. Groundwater supplies to the town of Superior

Task #2—Investigate Alternative Tailings Sites using Geophysical Methods: Tonto National Forest asked the USGS to use geophysical, geologic, and hydrogeologic data and interpretation to characterize the underlying geology, expected transmissivity of underlying geology, and occurrence of groundwater at depth of two potential tailings sites.

Task #3—Analyze Existing Baseline Surface-Water Data: While limited baseline data exist of the quantity of discharge in Queen Creek, Devil's Canyon, and Mineral Creek, no long-term gaging record exists for these important GDEs. In the absence of a gaging record, the Forest Service asked USGS to use limited field data and new stochastic methods to calculate baseline hydrologic flow (that is, surface-water flow before possible effects of the mine) with uncertainty bounds for these three intermittent streams.

At present, discharge in ungaged Forest Service streams is often determined using the stochastic methodologies of Moosburner (1970). Moosburner methods, however, have large uncertainties in regions of variable hydrogeology or limited spatial gaging-network coverage.

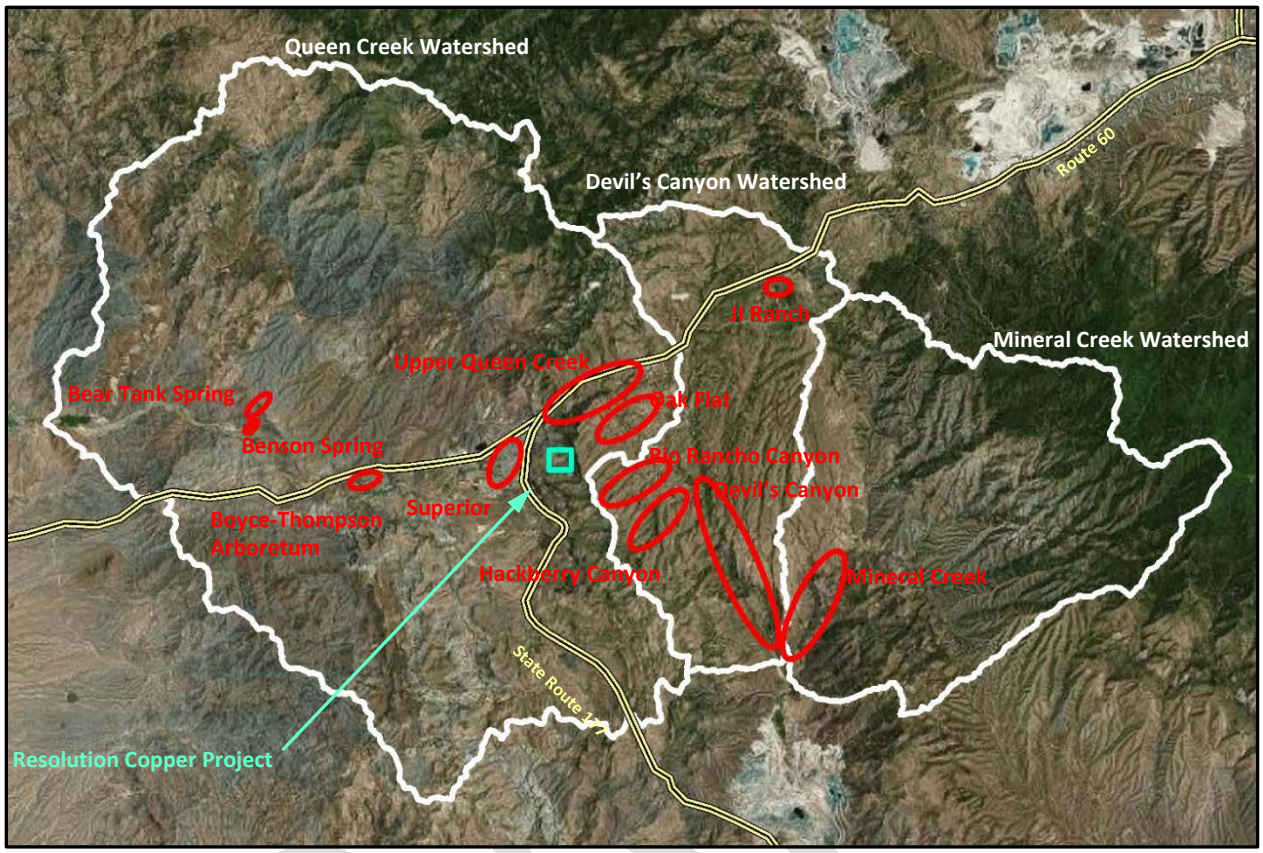

Figure 1. Map of location of Resolution Copper Project, approximate locations of potentially groundwater-dependent systems and groundwater supply areas, and locations of existing water-chemistry data.

Task #4—Assist with Groundwater Modeling Workgroup: Resolution Copper has prepared a numerical groundwater flow model to evaluate potential hydrologic impacts from mine operations. The Forest Service has established a multi-party Groundwater Modeling Workgroup in order to ensure that the model is acceptable for use in the analysis and to ensure that the limitations and uncertainties of the model are fully understood. The Forest Service invited the USGS to participate in the Groundwater Modeling Workgroup to assist the Forest Service and others in assessing and evaluating the groundwater model from Resolution Copper.

Approach

Task #1

Existing geochemical data collected by Resolution Mining Company and its consultants will be analyzed by USGS scientists to attempt to determine sources and connections of surface water and groundwater near the proposed mine. The existing water-chemistry data used in this assessment will include:

1. Groundwater samples from 55 wells
2. Groundwater samples from 20 springs
3. Surface-water samples from 26 locations

Each location was sampled by Montgomery & Associates multiple times between 2003 and 2015. Samples were analyzed for a variety of constituents, including field parameters, major ions, nutrients, trace elements, and bacteria indications. Many locations were also sampled for the isotopes of carbon-14 and -13, deuterium and oxygen-18, tritium, strontium 87/86, and sulfur-34; and the radionuclides of gross alpha and beta, radium 226 and 228, radon 222, uranium 234, 235, and 238, and uranium activity ratios. All data are available as part of the EIS data-gathering documents available at http://www.resolutionmineeis.us/eis-documents.

Several other existing datasets will be used in this assessment. Lithologic-chemistry data are available from 223 well-log samples describing 25 different types of lithologic alteration; these data were collected by Resolution Copper. Wet/dry mapping over multiple years is available for Devil's Canyon, Mineral Creek, Upper Queen Creek, and several other locations; these data were collected by Montgomery & Associates. Well data, including borehole logs, groundwater levels, and aquifer tests are also available from Montgomery & Associates. All of these data are also available as part of the EIS data-gathering documents at http://www.resolutionmineeis.us/eis-documents.

The available water-chemistry data will be used in conjunction with the available lithologic-chemistry data and groundwater levels to gain an enhanced understanding of the geochemical signatures of the different aquifers present in the study area and how they may contribute to the geochemical signatures of the 9 potentially groundwater-dependent systems and groundwater supplies. Some of the 9 areas may not have enough existing data to complete the geochemical assessment. In these cases, a modification to this work plan, and any potential agreement, will be proposed in 2018 in order to collect additional data in those areas.

Task #2

Geophysical methods will be used to determine the depth to bedrock and hydrogeology in areas where boreholes or wells are not available. The depth to bedrock and hydrogeology are important to understand near the Resolution Mine because of the potential interaction of tailings piles with the surface and groundwater systems. Two tailing sites near the Resolution mine are being considered by the Forest Service. The geophysical method Transient

ElectroMagnetics (TEM) will be used to profile the subsurface in the designated areas to determine the depth of alluvium to bedrock and hydrogeologic units.

Transient ElectroMagnetics (TEM), sometimes called Time Domain Electromagnetics (TDEM), is a geophysical method that can be used to detect variations in the electrical resistivity of the subsurface, which in turn can be related to variations in the physical and chemical properties of soil, rock, and pore fluids (fig. 2). A TEM sounding can be compared to a virtual borehole for investigating electrical resistivity in the subsurface. The depth of investigation can be tailored to the needs of the study area and maximum depths of about 3,000 ft are possible.

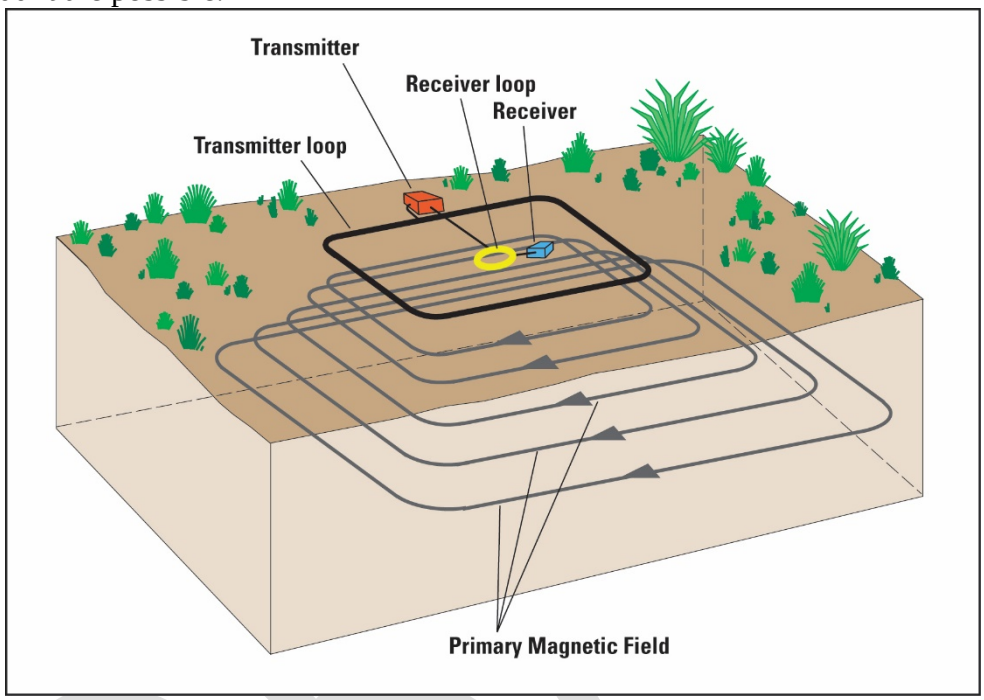

Figure 2. Diagram of TEM sounding (North Carolina Division of Natural Resources, 2004).

The TEM method uses a loop of wire laid on the ground to transmit short pulses of current, typically 1-3.5 amperes at 12-13 volts, through the closed-wire loop for brief periods of time (fig. 2). The current occurs only in the wire loop that is not grounded to the Earth; so no current goes into the ground. Rather, the current in the wire loop produces a short-term magnetic field that creates secondary decaying currents in the Earth. The technique is very safe and minimally impacts the land on which it's used. Since wires are merely laid on the ground and no holes are dug, the only impacts to the ground are the footprints that are made by walking the equipment into the field.

In both tailings location sites, TEM soundings will be performed over a three field-week period. TEM transects and individual TEM soundings will be collected at each alternative area. A field crew of 4 persons will acquire the data: one to run the transmitter, one to run the receiver, and 2 to set the receiver cables. The size of the TEM transmitter loop for this study will be 100 meters on a side with an expected depth of investigation of between 100 and 300 meters. TEM soundings will be modeled and analyzed following field collection efforts.

Products will be delivered in two phases. First, conductivity-depth sections along TEM transect will be delivered by September 30, 2018, as a non-interpretive ScienceBase Data Release. Second, a peer-reviewed USGS series interpretive report of these sections will be delivered 12 months after completion of the Interagency Agreement between USGS and Tonto National Forest. This report will include information, where determinable, on: 1) clay content of unconsolidated sediments; 2) depth of unconsolidated sediments over volcanic and igneous rock; 3) clay content of consolidated sedimentary rock; 4) depth to water table; 5) locations of faults and fracture in consolidated sedimentary rock, volcanic rock, and igneous rock; and 6) geologic contacts between rocks of differing resistivity.

Task #3

In 2015, the USGS completed a synoptic study of discrete discharge measurements at 530 ungaged streamflow sites in the Pacific Northwest in an attempt to characterize the hydrologic effects of severe regional drought. Konrad and Rumsey later developed a technique (2017, written communication of a journal article in preparation) to use data from the synoptic study and apply regional regressions and new stochastic techniques to estimate hydrologic characteristics of the ungaged sites.

The USGS will deploy 4 stage sensors in key study locations for 12 months. USGS will make 4 discrete discharge measurements at each site upon deployment, twice during the 12-month deployment, and during the retrieval of instrumentation. USGS will estimate an approximate low-flow stage-discharge relation for each site. These continuous stage data will be used to build a low-accuracy, 12-month record of low-flow discharge. In addition to the four pressure-transducer sites, synoptic discharge measurements would also be conducted at an additional eight sites, which would ultimately enable the hydrologic characterization of about a dozen perennial and intermittent streams in wilderness areas of interest.

Using a modified stochastic analytical approach of Konrad and Rumsey, all synoptic discharge data and continuous discharge data from the four pressure-transducer sites will be combined with regional streamflow-gaging data. This stochastic analysis will then enable the low-accuracy gaging data and additional synoptic discharge measurements to be related to the long-term regional streamflow-gaging record, thus allowing an estimate of hydrologic flow characteristics of the streams of interest. These data would be combined with peak-flow regression estimates (Paretti et al., 2014) to enable a characterization of the full hydrologic regime of the streams of interest, thus establishing a baseline assessment of hydrologic flows in Queen Creek, Devil's Canyon, and Mineral Creek before commencement of mining activities. Study results would produce hydrologic flow estimates from the stream with substantively greater accuracy than the Moosburner (1970) approach alone.

The methods and results of the study would be publish in a peer-reviewed scientific journal article or USGS series report and companion data releases.

Task #4

A team of USGS groundwater modeling scientists will participate in the Groundwater Modeling Workgroup meetings, read and assess reports and documents from the groundwater modelers, and provide professional modeling expertise and counsel to the Forest Service in a fashion consistent with USGS's Fundamental Science Practices (https://www2.usgs.gov/fsp/). The USGS Fundamental Science Practices bring forward a set of fundamental principles that underlie USGS science practices, uphold the Bureau's scientific reputation, and underscore its mandate to provide reliable science to address pressing societal issues. The USGS groundwater team will follow USGS guidelines for evaluating groundwater-flow models (Reilly and Harbaugh, 2004; Barlow and Leake, 2012). The evaluation team will run the groundwater model locally to evaluate model parameters and boundary conditions and assess the model results. Due to the limited time available under the Forest Service's environmental review process, no formal USGS series report will be generated.

Quality Assurance, Quality Control, and Data Management Plan

USGS policy requires that data on which interpretive products are based must be documented and published to describe 1) the methods or techniques used to collect, process, and analyze data, 2) the structure of the output, 3) data accuracy and precision, 4) standard metadata, and 5) the methods of quality assurance.

Task #1

The basis of this draft work plan is to use existing data collected by Resolution Copper and their consultants to address the proposed objective. All of the existing data is publically available as part of the EIS public record (http://www.resolutionmineeis.us/eis-documents). The USGS will be referencing these reports as the data sources, and will not be publishing the data nor archiving any data in USGS databases. The USGS will request quality assurance and quality control data for the water-quality data used in this analysis, and will conduct a data-quality assessment if possible. The USGS, however, is not ultimately responsible for assessing the quality of any of the furnished water-quality data.

Task #2

The geophysical methods used to support this study include ground-based electro-magnetic methods. Ground-based TEM data will be collected by USGS personnel and equipment consistent with USGS-defined technical specifications. Methods used will be consistent with published methods for the evaluation of subsurface geologic and hydrogeologic properties and methods. The data will initially reside in a project database while they are being checked, evaluated, processed, interpreted, reviewed, and approved. Once approved, all ground-based geophysical data, and metadata, will be published on the USGS ScienceBase (sciencebase.gov) database where it will be kept in its original format in

perpetuity. The data will be publically available and linked to a digital object identifier (DOI) number for access.

Task #3

Stage data will be collected with pressure transducers installed in locations of Queen Creek, Devil's Canyon, and Mineral Creek selected by USGS and Forest Service personnel. Stage data will be collected following standard USGS protocol. Surface-water discharge measurements will be made consistent with USGS standard practice (Rantz and others, 1982). All stage and discharge data will be published in USGS's National Water Information System, on online database that will make the data available publically in perpetuity. Simple one-dimensional step-backwater models of channel geometry at the temporary gaging sites will be used to estimate a coarse stage-discharge relation. Stochastic models will be developed to relate discharge data from the study area to the regional gaging network. All models and model results will be published on the USGS ScienceBase (sciencebase.gov) database where it will be kept in its original format in perpetuity. The data will be publically available and linked to a digital object identifier (DOI) number for access.

Task #4

No original data nor formal reports will be generated for this task. To assure quality of the professional judgement provided by USGS to the Forest Service, the USGS team will consists of a team of multiple USGS hydrologists will extensive groundwater modeling experience. As necessary, the USGS team will reach out to other USGS groundwater-modeling scientists to seek expertise and counsel. Any written communications from USGS to the Forest Service will be peer reviewed before delivery, consistent with USGS Fundamental Science Practices.

Relevance and Benefits

This study addresses the science of water quantity and quality within central Arizona. The study also supports Tonto National Forest's decision about the use of mineral resources on Federal lands. The study aims to develop a multidisciplinary approach to assess potential environmental effects of the Resolution Copper Mine, and the study contributes to the goals of the USGS strategic science directions "A Water Census of the United States" and "Energy and Minerals for America's Future," as identified and described in the Strategic Science Plan of the USGS (U.S. Geological Survey, 2007).

Products

Task #1:

USGS scientists will work closely with USFS and their consultants to ensure that the assessment is designed to address the USFS's informational needs. A peer-reviewed USGS Administrative Report or USGS series report detailing the preliminary assessment based on existing data will be completed 12 months after the complete of the Interagency Agreement.

Task #2:

Assuming the Interagency Agreement is signed by February 28, 2018, modeled geophysical data collected for Task #2 will be published as a USGS non-interpretive ScienceBase Data Release by September 2018. The final USGS series report describing the interpretive results of Task #2 will be delivered 12 months after the completion of the Interagency Agreement.

Task #3:

A peer-reviewed journal article or USGS series report describing the results and interpretive conclusions of Task #3 will be completed 24 months after completion of the Interagency Agreement. The surface-water data collected by USGS as part of Task #3 that is not published in the USGS National Water Information System will be publish as a USGS ScienceBase Data Release no later than 24 months after completion of the Interagency Agreement.

Task #4:

No formal USGS product will be released as part of Task #4. Instead USGS groundwater modeling personnel will participate in the Groundwater Modeling Workgroup meetings, review reports and documents prepared by Resolution Copper and their consultants, and meet regularly with Forest Service personnel to share technical insights and suggest questions to ask of the workgroup.

Timeline This timeline assumes the Interagency Agreement between the Forest Service and USGS is signed in the 2nd quarter of fiscal year 2018. Delays in the start of the Interagency Agency will result in a commensurate delay of the project timeline. USGS series product completion for a given task the in timeline is designated with an "**X**."

	YEAR 1 (FY18)			YEAR 2 (FY19)				(FY 20)	
	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr
Task 1A—Compile existing water-chemistry, lithologic-chemistry data, wet/dry mapping data, and well data									
Task 1B—Geochemical assessment of sources of water to 9 areas of interest									
Task 1C—Writing and publication of Administrative Report					X				
Task 1D—Archive project files									
Task 2A—Compile existing data									
Task 2B—Conduct ground-based geophysical data collection efforts									
Task 2C—Publish geophysical data in USGS ScienceBase			X						
Task 2D—Analysis and interpretation of geophysical data against study area geological data									
Task 2E—Publish interpretive USGS series final report					X				
Task 2F—Archive project files									
Task 3A—Select sites and deploy instrument in the field									
Task 3B—Collect discharge measurements and service field gages during deployment									
Task 3C—Retrieve instruments from the field; complete field work									
Task 3D—Analyze and publish all field data									
Task 3E—Stochastic analysis of field data and interpretation into regional gaging data									
Task 3F—Publish final report.								X	
Task 3G—Archive project files									
Task 4—Support Forest Service in Groundwater Modeling Workgroup									

Budget

Note: Tasks #1-3 are fixed cost; Task #4 is billed to expenses, not to exceed the total below.

	FY 18	FY 19	FY 20	Total
Task #1	$272,300	$13,000	-	**$285,300**
Task #2	$287,100	$117,600	-	**$404,700**
Task #3	$178,000	$179,000	$123,000	**$480,000**
Task #4	$222,300	-	-	**$222,300**
Yearly Totals	**$909,700**	**$279,600**	**$123,000**	**$1,392,300**

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