

Web-based Hydrologic Information Portal for the Upper San Pedro Basin: The WHIP

A Proposal to the U.S. Bureau of Reclamation, WaterSMART Applied Science (BOR-DO-19-F012)

October 30, 2019

The WHIP: *A web-based hydrologic information portal designed to make the wealth of hydrologic information gathered from the Upper San Pedro Basin of southeast Arizona readily accessible and useful to the decision-makers, project managers, scientists, and general public who need it and in formats they can use.*



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TECHNICAL PROPOSAL AND EVALUATION CRITERIA

A. Executive Summary

On October 30, 2019, the City of Sierra Vista, in Cochise County, Arizona, acting as fiscal agent for and in cooperation with the [Upper San Pedro Partnership \(USPP; uppersanpedropartnership.org\)](http://uppersanpedropartnership.org), submits this proposal to the U.S. Bureau of Reclamation WaterSMART Applied Science grant program. We propose to create an interactive web-based tool—the **Web-based Hydrologic Information Portal—Upper San Pedro Basin (WHIP)** – to improve access to and use of water resources data to increase water supply reliability in the Arizona portion of the Upper San Pedro Basin (USPB) of southeast Arizona, which includes the San Pedro Riparian National Conservation Area (SPRNCA; Fig. 1). The goal of the 21-member USPP is to “ensure an adequate long-term groundwater supply is available to meet the reasonable needs of both the area’s residents and property owners (current and future) and the SPRNCA.” Throughout its existence, the USPP has funded numerous studies and over 20 years of continuous groundwater and surface water monitoring within the USPB with a primary focus on the Sierra Vista Subwatershed. Communities in the USPB, the U.S. Army installation at Fort Huachuca, and the SPRNCA all rely on groundwater as their sole, shared source of water. Thus, the goal of the WHIP is to improve management and reliability of that groundwater resource by turning the wealth of USPB hydrologic data into understandable and useful information through the use of the geospatial tools that will be provided on the WHIP platform. The WHIP will also ensure that these data and information are fully and easily accessible to water managers, researchers, decision makers, and the general public.

The WHIP will have three main functions. First, it will provide **readily accessible, geospatially accessed, hydrologic information** to water managers, decision makers, researchers, and the public through the synthesis of raw hydrologic data sets. Direct access to the raw data sets will also be available via direct web links. Second, it will provide **data visualization tools** allowing users to graphically view single data sets, side-by-side data-set comparisons, data overlays, and basic statistical analyses which are keyed to a map interface. And, third, it will ensure the **ready and timely availability of future Upper San Pedro Basin monitoring data via a report-out template including information needed by water managers**. In all cases data will be made available on the WHIP platform as soon as possible following data publication. The U.S. Bureau of Reclamation Applied Science grant will fund contractors to work in synch with the project team to plan, develop and disseminate the WHIP over a 2-year timeline. A 7-month **planning phase** (\$33,000), will be led by the project team and a contracted facilitator who will convene a series of focus groups, designed to work with water managers and the public, to determine the ultimate layout and data formats delivered via WHIP and the annual hydrologic report template. This phase will be iterative and may continue into the subsequent development phase to ensure that stakeholder input meaningfully informs the WHIP development. The 15-month **development phase** (\$100,000 for web contractor, \$65,000 for USGS Technical Lead) will follow the planning phase, during which the WHIP will be developed, constructed, and

tested. The final months of the development phase will overlap with the 5-month **dissemination phase**, during which we will make the WHIP publicly available and offer training on its use (this phase will engage the planning phase contractor and is included in the planning phase budget listed above).

The proposed project is not located on a Federal facility. However, both the 76,000-acre Department of Defense Fort Huachuca Army installation and 55,990-acre Bureau of Land Management managed SPRNCA are within the Upper San Pedro Basin, adjacent to the City of Sierra Vista, and will benefit from the WHIP.

B. Technical Project Description and Milestones

The City of Sierra Vista, Arizona, a Category A applicant, submits this application with the support and shared-leadership of the Upper San Pedro Partnership (USPP), and will co-fund the Web-based Hydrologic Information Portal (WHIP) with USPP partners Cochise County, The Nature Conservancy (TNC), and Arizona Department of Water Resources (ADWR). The USPP's focus for much of its 21-year existence has been developing the science to understand and thus achieve *sustainable yield*¹ of the finite groundwater resource shared between local communities and the San Pedro River and riparian area. The San Pedro River is a binational, interrupted-perennial stream whose baseflow is dependent upon the same groundwater needed by local communities and Federal installations within the Upper San Pedro Basin (USPB) (Fig. 1). In 1988, the United States Congress recognized the river's unique and important riparian forest by designating 47 U.S. river miles as the San Pedro Riparian National Conservation Area (SPRNCA; Public Law 100-696). The U.S. Bureau of Land Management (BLM)-managed SPRNCA was designated to conserve, protect, and enhance the riparian area and the aquatic, wildlife, archeological, paleontological, scientific, cultural, educational, and recreational resources inherent within. The U.S. Army Fort Huachuca, also located in the USPB, requires water for its missions and community, and manages important environmental resources. The Fort Huachuca 2014 Programmatic Biological Assessment issued by the U.S. Fish and Wildlife Service, addresses threatened and endangered species protection for a number of federally listed species dependent on the habitat provided by the San Pedro River or its adjacent groundwater-dependent cottonwood-willow and mesquite forests.

USPP members (local, state and federal government agencies, and private-sector non-profit organizations) have pooled their resources each year for the past two decades to establish and maintain a robust regional hydrologic monitoring program. The annual monitoring budget is currently between \$300,00 and \$400,000. Other long-term datasets are also established within the USPB, including those of the Agricultural Research Service's (ARS) Walnut Gulch Experimental Watershed. As a result, the USPB enjoys a wealth of various datasets with long

¹ Based on the definition of Alley and others (1999), the USPP agreed *sustainable yield* means the *development and use of groundwater in a manner that can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences* .

periods (20+ years) of record. The WHIP will provide the long-needed tool to provide ready access to these data, a means to understand, synthesize, and interpret them, and thus assistance in making decisions based on them in order to adaptively manage water in the Arizona portions of the USBP.

The goal of the WHIP then is to improve management of and increase the reliability of groundwater—the sole water source in the USBP—by taking the existing robust hydrologic data set established by the USPP membership and making it available to all in a format that is understandable, useful, and easily accessible. Through an interactive map and geo-based tools provided on the WHIP platform, this information can be more simply and fully utilized to increase water availability for local communities and natural systems. Users will have access to the Arizona USBP hydrologic monitoring data sets of their choice: groundwater, surface water, managed recharge, geophysics, water quality/water chemistry, precipitation, and (or) evapotranspiration. Data type, location, and time range will be determined by user input via a water resources dashboard and a geospatial platform.

B.1. Project Type: The WHIP (Eligible Project Type #4) will make available in readily digestible graphical formats previously difficult to obtain and (or) understand water resources data from the USBP of southeast Arizona. While not a decision support tool per se, the WHIP will be designed and developed to increase the ease of obtaining, analyzing, and understanding hydrologic data while adding spatial and temporal context, and to recognize potential relationships between different hydrologic data sets that will facilitate and improve water related decision-making. The purpose of the WHIP is specifically to improve USBP water data availability and delivery to those who want it, need it, and will use it to manage reliable water supplies for people and nature. The WHIP will make quality controlled and quality assured water data and water-data derived information available to a much broader audience.

Web-based platforms designed to disseminate hydrologic data and related information are now relatively common, which ensures that development of the WHIP for the USBP will be based on mature technologies and will not require new or novel methods. A few examples of web platforms with characteristics similar to the conceptual WHIP product include The Nature Conservancy's TX Water Explorer (<http://www.texaswaterexplorer.tnc.org/>), CA's Groundwater Exchange, (<https://groundwaterexchange.org/>) and CO's Decision Support Systems (<https://www.colorado.gov/cdss>).

B.2. Water Management Objectives Project will Achieve: Once complete, the WHIP will improve access to and use of water resources data for jurisdictional decision makers, water managers, researchers, and the interested general public, and thus achieve the following water management objectives for the USBP: improve (1) water supply reliability, (2) drought management, and (3) water conservation; (4) assist watershed management and improve watershed health; (5) assist in meeting current and future endangered species requirements; (6) facilitate water rights administration. The WHIP will achieve these objectives by providing access to data and continuously tracking partner efforts in the USBP that affect sustainable

groundwater use. The annual hydrologic report generated from the WHIP will deliver key information on whether and where conditions have improved, stayed the same, or declined.

B.3. Technical Project Description: *Please refer to Sections E.1.3. “Project Implementation” for a detailed breakdown and justification of the objectives, and the methodology and resulting deliverables from the three phases of the project.*

To ensure that the WHIP meets the needs of stakeholders, the project will kick-off with a facilitated **planning phase** for stakeholders that will precede WHIP web development. The planning phase will determine the tools and web-based data interaction methods that decision makers, water managers, researchers, and the interested general public (“stakeholders”) feel will be most valuable in advance of website construction. This will ensure the scope and goals of WHIP tool development are clear heading into the **development phase**, and that the final product will be tied directly to the stated needs of those most likely to benefit from its creation. The **dissemination phase** will ensure the tool is made widely available, delivered with user-friendly instructions, and is immediately put to use by all classes of stakeholders.

The **Planning Phase** will span the first 7 months of the project and involve 6 tasks: (1) a kick-off meeting, (2) focus group facilitator procurement, (3) planning, (4) convening focus groups 1 and 2, (5) website development contractor (WDC) procurement, (6) a coordination meeting between the focus group facilitator and the WDC. The resulting deliverables will include two procured contracts, a two-year project schedule chart, two focus groups and memos.

The **Development Phase** will span 15 months and 10 tasks, advancing the WHIP from conceptual model to wireframe to proto-type application to final web site launch: (1) incorporation of focus group input, (2) analysis of WHIP website and data server requirements and server selection, (3) determination of data ownership, (4) establishment of hydrologic data locations and development of a local data base (if needed), (5) data processing (automatic data loading from external sources), (6) building website wireframes, (7) designing the WHIP web application, (8) incorporating Focus Group 2 prototype feedback and finalizing the web application, (9) initial loading and final review of WHIP, (10) loading to server and final launch. Deliverables will include a WHIP Flow chart, database of hydrologic data-served, wireframe, server contract, annual Hydrologic State of the USBP Report template, and a launched WHIP.

The **Dissemination Phase** will span 5 months (overlapping the final 3 months of the Development Phase) and include 3 tasks: (1) the compilation of a quick-start guide to help users perform the most typical WHIP activities, (2) WHIP website roll-out, (3) development of a plan and budget for annual updates to WHIP (website maintenance, improvements to interface, loading new data). Deliverables will include a quick-start guide, two press releases, a maintenance plan, and a U.S. Bureau of Reclamation webinar.

B.4. Preliminary Project Schedule: *Please refer to section E.1.3.4. Preliminary Project Schedule for the project timeline and preliminary schedule.*

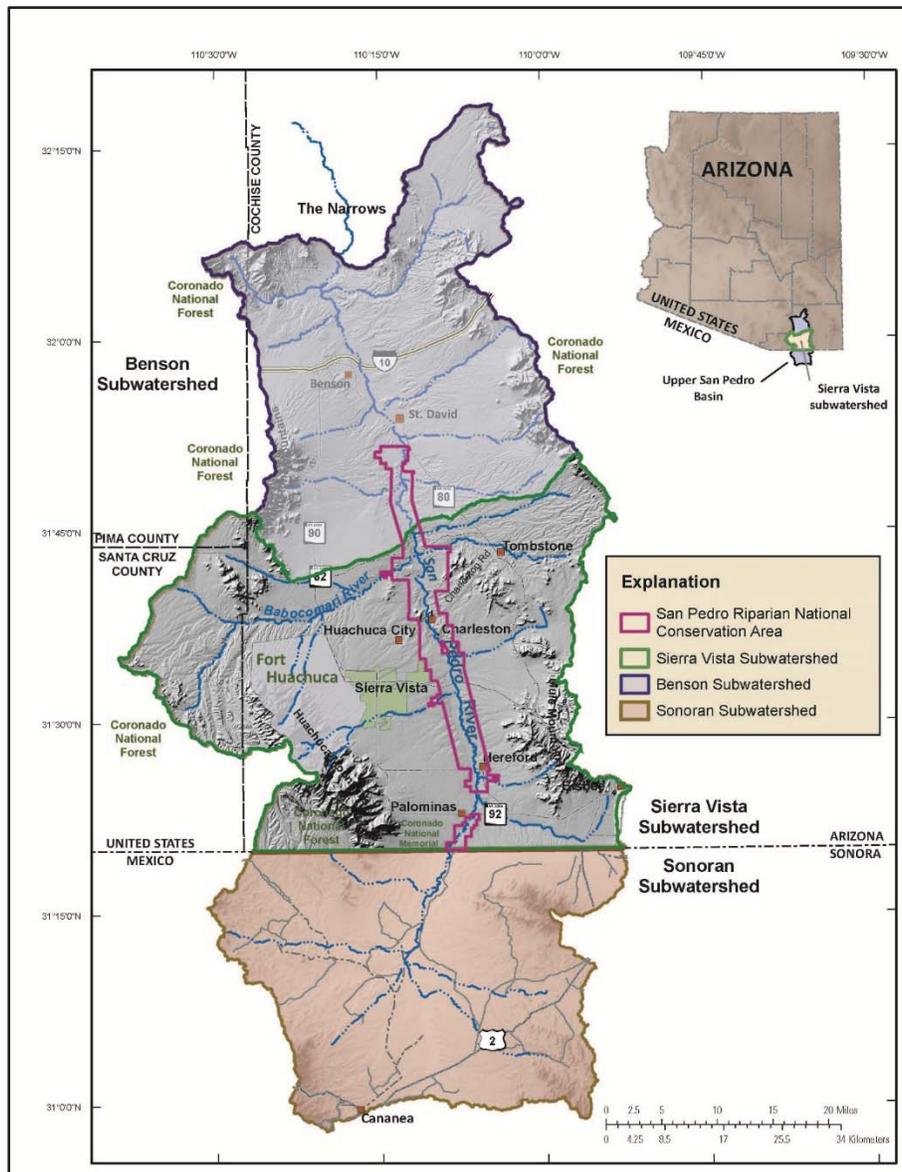


Figure 1. Upper San Pedro Basin. The geographic extent of the WHIP framework is the part of the Basin in Arizona and will focus primarily on data from the Sierra Vista Subwatershed.

C. Project Location: The geographic area of focus is the Upper San Pedro Basin of southeastern Arizona and is primarily but not exclusively on the Sierra Vista Subwatershed (Fig. 1).

D. Data Management Practices: The WHIP data management practices will largely be defined by the technical design features that are built into the tool, which will be established in the WHIP Development Phase. However, it is likely the tool will align with USGS data management practices. Appropriate hardware, software, and staff resources will be accounted for in the Development Phase, and later in the maintenance plan. A plan and roles for routine data and server backups will be addressed to ensure that data are backed up regularly and with multiple redundancy. Data are and will continue to be stored in NWIS as a quality assured dataset,

including all associated metadata. Data that are not applicable to the NWIS processing are and will continue to be stored in ScienceBase, a national open-source catalog and repository that ensures full data management and metadata processing. Once data are in the USGS NWIS or ScienceBase database and available on that website they are fully available to the public and thus available for display on and use by the WHIP platform (one function of the WHIP will be to streamline USGS data availability.)

E. Evaluation Criteria

E.1.1. Evaluation Criteria A- Benefits to Water Supply Reliability

E.1.1.1. The proposed Web-based Hydrologic Information Portal for the Upper San Pedro Basin (WHIP) will be an essential tool for water management. It will take extensive, 20+ year datasets and make them publicly accessible for a river basin with limited groundwater supplies during an extended period of drought. The diverse and sometimes competing water needs of the basin include both urban and rural communities, a U.S. Army installation, and the first National Riparian Conservation Area established in the nation. Reliable water supplies are essential for both people and nature to persist and thrive in this arid setting.

The San Pedro River is an interrupted-perennial stream whose baseflow is dependent upon the same groundwater needed by the communities within the Upper San Pedro Basin (USPB) in southeastern Arizona (USPB; Fig. 1). The river flows north, from Cananea, Sonora to its confluence with the Gila River near Winkelman, Arizona, and is an important migratory flyway with about half of all of the bird species of North America having been observed there (Steintz, 2003). A number of threatened and endangered species are likewise dependent on the aquatic habitat provided by the San Pedro River (and thus the groundwater discharged from the USPB regional aquifer) and its adjacent groundwater-dependent cottonwood-willow and mesquite forests. The U.S. Army 76,000-acre Fort Huachuca is also located in the USPB, and requires water for its missions, residential community, and the environmental resources it manages. The concentration of federal installations and areas of hemispheric ecological importance in the USPB have created a challenging suite of water management issues.

Since the initiation of groundwater pumping in the 20th Century, more water has been removed from the USPB aquifer than has been recharged. The vast majority of the groundwater pumped in the region has come from the Sierra Vista-Fort Huachuca area (see Fig. 1) and from agricultural pumping along the San Pedro River. This amounts to the removal of over 100,000 acre-ft of water from aquifer storage over an area about 10 mi on the westside of the San Pedro River in just the past 18 years. The total volume of groundwater removed from storage since groundwater pumping commenced in the first half of the 1900s could be as much as 500,000 acre-ft (Gungle, personal comm.). The United States Geological Survey (USGS), the Arizona Department of Water Resources (ADWR), and numerous university researchers have reported on the decades-long regional overdraft of groundwater from the aquifer and development of the cone of depression that has led to water supply uncertainty within the

USPB (for example, Pool and Coes, 1999; Goode and Madock, 2000; Leenhouts and others, 2006; Pool and Dickinson, 2007; Schmerge and others, 2009; Gungle and others, 2016). But those reports did little to inform where hydrologic protections would be the most effective, by when, and for how long.

The annual water budget and groundwater deficit number reported in the Congressionally-mandated “Water Management of the Regional Aquifer in the Sierra Vista Subwatershed, Arizona- Report to Congress,” or [“321 Reports”](#) from 2004 to 2011 provided an extremely crude analysis of conditions across a large area, with that one number being used to characterize groundwater conditions across the 950 mi² Sierra Vista Subwatershed (U.S. Department of the Interior, 2005- 2014). Over those years, water budget tracking reported that the groundwater deficit was reduced from 10,800 acre-feet to about 5,000 acre-feet. A more robust analytical tool such as the WHIP is needed to facilitate spatial and temporal understanding of the USPB groundwater system so that we can adaptively manage that system into the future.

The human population of the USPB is solely dependent on groundwater for drinking, bathing, and economic activity. Baseflow in the San Pedro River is dependent on this same groundwater. The groundwater found in the USPB regional aquifers originates as precipitation falling on the surrounding mountains, enters the aquifer at the mountain fronts and through ephemeral stream channels, then moves through the subsurface and discharges to the San Pedro River as baseflow. The production wells of many USPB communities are located between these areas of mountain-front recharge and the San Pedro River, resulting in the interception of groundwater and the creation of cones of depression centered on the Sierra Vista and Fort Huachuca pumping centers. Over time these serve to capture groundwater discharge from the riparian area and the river (Pool and Coes, 1999; Leake and others, 2008; Schmerge and others, 2009). Water levels in the regional aquifer on Fort Huachuca have declined by as much as 30 feet since the early 1970s and declines in San Pedro River baseflow have also been observed (Gungle and others, 2016). Water levels southeast of Sierra Vista are likewise in decline as residential development throughout the region continues. On the other hand, groundwater pumping on a per-capita basis began to come down in about 2005 and has dropped steadily through at least 2012 (the last year for which data are available). Nonetheless, beginning in about 2007 the groundwater overdraft, which had been declining since 2002, plateaued at around 5,000 acre-ft per year and has remained there through at least 2012 (Gungle and others, 2016). Continued development and population expansion in the basin create uncertainty about the groundwater future of the USPB. In addition to groundwater pumping, climate change models project decreasing natural recharge rates due to a hotter and drier climate (Garfin et al., 2013; Niraula et al., 2017). Additionally, the USPB is in a multidecadal drought—thus there is less water available for natural recharge of the regional groundwater aquifer, such that even regional groundwater levels unimpacted by pumping have been in decline, further reducing the water available to all users.

As the last unimpounded river in the southwestern United States with significant perennial reaches, the San Pedro is a critical North American flyway for migratory birds (Steintz, 2003). The USPB provides habitat for 409 bird species, 84 species of mammal, and 53 reptile and amphibian species (Krueper 1999, BLM 2019, Rosen 2005). Within the SPRNCA, there are 7 federally listed threatened or endangered species that depend on San Pedro River baseflow or spring discharge, or on the riparian vegetation supported by that baseflow and near-surface groundwater: Huachuca Water Umbel, Yellow-billed cuckoo, Southwestern Willow Flycatcher, Northern Mexican garter snake, Gila topminnow, desert pupfish, and Chiricahua leopard frog. Of the 13 historically documented native fish species in the Upper San Pedro River only 2 remain (Minckley 1987), but given sufficient streamflow, their habitat could be restored. The SPRNCA, fully located within the geographic focus of the WHIP, has an explicit Federal Reserved Water Right to maintain the riparian and aquatic habitat, which is currently being adjudicated in federal court. As is often the case where endangered species are present and dependent upon habitat potentially threatened by human development, a number of lawsuits have been filed by conservation groups to protect habitat at the federal nexus of the SPRNCA and Fort Huachuca. This has resulted in restricting groundwater pumping on Fort Huachuca (to reduce impacts to groundwater discharge to the river) and crafting a number of draft Biological Opinions, one of which was at last accepted by the court in 2014 after several years of litigation, in 2014.

Human water consumption thus competes with the environmental water needs of the San Pedro River and its attendant riparian system and aquatic habitat. This has led to conflicts throughout the USPB since at least the early 1990s when Cochise County first began to publicly address the issue of declining flows. However, competing water demands led to “dueling hydrologists” (hired by different factions) who provided widely varying opinions about the fate of the San Pedro River and the long-term availability of groundwater. The [Upper San Pedro Partnership \(uppersanpedropartnership.org\)](http://uppersanpedropartnership.org) (USPP) was created in 1998 through ADWR’s Rural Watershed Initiative (see section E.1.2. for additional detail). In the decades since its creation, the USPP has done much to defuse the tension among the residents of the Sierra Vista Subwatershed in particular by providing a platform for discussion and resolution of water conflicts through open dialogue and unbiased, impartial hydrologic monitoring and research on which to base water resource management decisions. In addition, the US Congress officially recognized the USPP in 2004 and charged it with achieving sustainable groundwater use (see E.1.2. for more detail).

E.1.1.2. For over 20 years, the USPP and other land management entities have worked cooperatively toward achieving groundwater reliability and sustainable use for the region’s human populations, Fort Huachuca, and the SPRNCA. Since at least 1999, the USPP has supported a comprehensive hydrologic monitoring program, with its partners investing \$300,000 to \$400,000 annually to collect, quality control, quality assure, and publish hydrologic monitoring data. Nonetheless, ready access to and effective use of these data remains elusive due to the vagaries and incompatibility of, and lack of intuitive interfaces for, these data bases. Compatibility of data and ease of access to the wealth of USPB-related hydrologic data are

desperately needed; this is extremely important for the effective management of groundwater as the USPP continues toward its goal to achieve sustainable groundwater use.

Beginning in 2004, the USPB monitoring network supplied water data for the U.S. Congress-mandated water-budget and groundwater sustainability reporting requirements that were part of the Defense Authorization Act of 2004 (Public Law 108-136, Section 321). The congressionally mandated [321 Reports](#) reported on the state of the regional aquifer from 2002 to 2011 (U.S. Department of Interior 2005-2014). These reports served as the analog version of a data-portal for that era of the USPP but took significant time and funding to generate. After the mandate expired, the USPP and individual USPP members continued to provide annual financial support to ensure hydrologic monitoring in the Sierra Vista Subwatershed continued uninterrupted.

Subsequently, a more spatially and temporally relevant framework was established and anchored around 14 indicators of groundwater sustainability. The USPP-funded hydrologic monitoring data were used to evaluate progress toward the goal of sustainable groundwater use from 2004 to 2012. The USPP funded the resulting publication, “Hydrological Conditions and Evaluation of Sustainable Groundwater Use in the Sierra Vista Subwatershed, Upper San Pedro Basin, Southeastern, AZ” (Gungle and others, 2016), the “sustainability report”. The sustainability indicator framework there established now serves as the outline for the WHIP. A funded WHIP will turn these indicators into tools that can be readily used to evaluate hydrologic trends through time.

Each of the water management issues identified will be addressed in part by the WHIP in essentially the same way: by providing those with a stake in the issues ready access to all USPB data and information they need to understand the state of the USPB and to make water-related decisions and manage water supplies. Specific monitoring data accessible via WHIP will, for example, be applied to the following issues:

Competing demands for groundwater—WHIP will utilize the 14 metrics of sustainability, previously described, along with other key metrics, to resolve competing demands. This will be achieved by enabling the evaluation, in space and time, of the performance of the many specific water management strategies that are underway at the regional scale, by public agencies and private partner organizations. Various water management practices and infrastructure projects (for example, water conservation and the managed recharge of treated effluent and stormwater), municipal and county water policy advancements, and ongoing climate and population trends, cumulatively affect groundwater availability. Yet, without readily accessible, regional scale monitoring data, the cumulative result of all these interacting factors is difficult, if not impossible to comprehend.

Endangered species requirements— Access to alluvial aquifer water level trends over time will indicate whether groundwater levels are stable enough to sustain cottonwood and willow forests and sacaton grasslands and continue to provide high quality habitat. Pairing USGS

stream gage, annual streamflow permanence, and summer dry-season water presence data (“wet-dry mapping”) will indicate where aquatic habitat is suitable to support fish and amphibian species.

The regional aquifer overdraft and cone of depression lead to long-term water supply uncertainty for both local communities and the San Pedro River. WHIP will ensure that all interested parties can more easily track the annual groundwater overdraft, the extent of the cone of depression, annual groundwater budget data, and the effects of water management projects. While the groundwater deficit is a crude approximation of subwatershed conditions, it is one that the public easily understands and provides a means to connect with the other important issues such as pumping location and water recharge, as well as competing water demands, endangered species water needs, drought, and the potential impacts of climate change.

The WHIP project will ensure that hydrologic data and information from the basin remains readily available, unbiased, and impartial and thus help to make water management and water-use decision making transparent. While there will continue to be competing demands for USBP groundwater into the foreseeable future, and some associated uncertainty for stakeholders (due to overlying actions such as the Gila River adjudication), the WHIP project will help to ensure that groundwater use decisions are based on the best available science.

E.1.1.3. The WHIP will support water managers as they work to build resiliency into their water management systems. It will help them to make informed decisions in order to optimize the limited water resources of the USBP. For example, the WHIP will provide tools to evaluate water spatial and temporal water use and water supply trends in both the groundwater and river systems. It will allow managers to determine where to direct additional resources so that they will have the most potential to build resiliency into the system. For example, a better understanding of the performance of the existing managed aquifer recharge projects within the [Cochise Conservation and Recharge Network \(CCRN\) \(ccrnsanpedro.org\)](http://ccrnsanpedro.org) could help to guide the prioritization of additional projects, or the need to direct more water to existing projects. The success of these near stream recharge efforts is particularly important to the riparian obligate species associated with extensive cottonwood-willow forest, dense mesquite bosques, and springs and wetlands along the San Pedro River, including the federally listed threatened and endangered species.

E.1.1.4. The WHIP will not duplicate any local efforts, particularly because nearly all water managers in the USBP (and all in the Sierra Vista Subwatershed) are involved in the USPP and in its development. Section **E.1.2.2.c.** explains how the WHIP may compliment the Fort Huachuca Sentinel Landscape and the Transboundary Aquifer Assessment Program (TAAP) data management goals in the future. As detailed in **E.1.2.2.a.**, the WHIP will add value to the CCRN projects, enabling adaptive management of these projects, by providing data that describes the ambient conditions of the basin and the cumulative benefits of the many projects already implemented.

E.1.2. Evaluation Criteria B- Need for Project and Applicability of Project Results

E.1.2.1 In 2019, based on the progress made moving from a water-budget to sustainability-indicator framework for water management (detailed in **E.1.1.2.**), the USPP prioritized development of the WHIP as a means to meet the real science information needs of the members' work on the ground in the USPB. One example is the CCRN whose objective is to protect and enhance near stream groundwater levels that sustain San Pedro River baseflows through a network of stormwater and effluent recharge projects. Other specific examples from many individual partners are described in **E.1.2.2.a**. In addition, the WHIP will serve to anchor an **annual science summit** for the USPP aimed at helping to **adaptively manage water** in the region and will also be used to produce an annual "Hydrologic state of the Basin" or "Subwatershed" report.

E.1.2.2. Due to the past two decades of USPP investment in developing what has become the foundational science and framework for the WHIP, there is great confidence the product will result in an applied science tool that is readily applicable to, and highly likely to be used by, water resource managers in the USPB. The WHIP's three main functions will be to provide readily accessible, geospatially accessed, hydrologic information; provide data visualization tools for individual or comparative data and basic statistical analyses; and to ensure timely delivery of needed future USPB monitoring data via a reporting feature. The WHIP will provide decision-makers and water managers with the hydrologic information and analysis tools they need to manage water supplies sustainably, ensuring reliable water supplies for the human population of the region while also meeting the environmental water needs outlined in section **E.1.1**, even in times of drought.

The USPP resources invested and the information already compiled by the USGS within the "sustainability report" (Gungle and others, 2016) greatly leverage the ability to develop and launch the tool within the 2-year timeframe (see **E.1.1.2**). Lead author and USGS Hydrologist Bruce Gungle, possesses a unique knowledge and familiarity with the data sets that will be the backbone of the WHIP and he continues to manage the hydrologic monitoring program. Gungle has already cataloged the source-data locations with links to the raw data sources (Appendix B), a critical step to the WHIP development. To ensure the data delivered by WHIP align with USGS' high QA/QC standards, grant funds will be used to directly contract Gungle as the project Technical Lead, while observing Federal and Sierra Vista city sole source procurement rules. Additionally, the WHIP project team will be a USPP Technical Committee (TC) workgroup, with project progress being reviewed at [monthly meetings](#). The USPP TC have reviewed the Sustainability Report and all the indicators at length, which enhances their expertise related to the WHIP.

Letters of support are included from the BLM, CCRN, and Town of Huachuca City, in addition to letters of funding support from Cochise County (\$23K), the City of Sierra Vista (\$23K), TNC (\$20K) and ADWR (\$33K). As the USPP TC Chair, TNC's Water Projects Coordinator will be contributing significant staff time over the two-year project as the WHIP Project Manager. The

BLM Hydrologist will also contribute staff time as a key WHIP project team member. The members of the USPP TC will commit time at their monthly meetings to advise the WHIP's progress and development [USPP TC membership includes Cochise County, Sierra Vista, BLM, USGS, USDA-ARS, Huachuca City, Friends of the San Pedro River, TNC, ADWR, AZ Department of Environmental Quality (ADEQ), Ft. Huachuca, and Audubon Arizona].

E.1.2.2.a. Many USPP members have expressed their immediate, intended uses for the WHIP.

The **BLM** seeks to use the WHIP to identify where to locate projects within the SPRNCA to meet management targets, as well as to understand what impacts from outside of SPRNCA may be leading to changes within SPRNCA. WHIP outputs may provide data to support the following Approved Resource Management Plan (ARMP) Soil/Watershed/Water management actions on lands inside SPRNCA: Monitoring groundwater levels near recharge enhancements, and where the data indicates, modify the size, location and/or type of enhancement, or designing groundwater pumping for BLM-authorized actions to reduce impacts on base flows, such as seasonally restricting pumping.

The **CCRN** depends on timely and accessible groundwater and surface water data to design the most effective aquifer recharge projects in locations where the San Pedro River needs the most support. The WHIP will serve as a vital tool for the CCRN, providing this critical information as the projects come online and are monitored for their impacts over time, using stream gage, alluvial groundwater level, and isotope monitoring data delivered by the WHIP. The CCRN performs extensive site-specific groundwater and surface water monitoring at project locations, but the WHIP will provide easy access to information and data at a higher regional scale, providing essential context as to ambient hydrologic conditions in the subwatershed, as well as showing how the projects are collectively impacting groundwater levels and San Pedro River baseflows. The CCRN also anticipates the USPP annual science summit will deliver the annual hydrologic report and help inform where future CCRN projects are needed and what kinds of groundwater projects will be the most effective (e.g. reduced or precluded pumping or managed aquifer recharge).

As a member of the CCRN, **Cochise County** will be able to readily access data to support the engineering and design of future recharge projects. Moreover, easy access to the monitoring data associated with the CCRN's projects through the WHIP will help support the County's outreach efforts to the public and foster substantive dialogue between elected officials, staff and County stakeholders about existing and future recharge projects. In addition, the **Cochise County Flood Control District**, administered by the Engineering and Natural Resources Department, will likewise use the data sets available through the WHIP to support the engineering and design of flood control projects throughout the watershed.

The **USPP** will use the WHIP to prioritize annual monitoring, research, and project needs at their science summit, and evaluate and determine the most critical needs and support the partners

in adaptively managing water resources. The WHIP is the key to the USPP achieving a long-standing goal of building spatial and temporal information about how much water is needed, and where, to support local groundwater and river base flow reliability.

In general, WHIP will provide **researchers** with up to date, comprehensive, readily accessible data in a single location, making their research efforts more efficient and more effective. The **general public** will obtain a source of open and transparent information about local water availability issues of their concern.

E.1.2.2.b. The WHIP will inform water resource management actions and decisions immediately upon completion of the project. In addition to being available to various users on a daily basis, the results will also be used to anchor the USPP annual science summit. As described in the next section, the WHIP is being designed to be dynamic and will expand as additional data and information become available, as functionality is added, and the WHIP's value is demonstrated. There have been repeated requests of the USPP to provide annual reporting on the state of the watershed and track progress towards sustainable yield; the WHIP will quickly meet this need. Managers, residents and officials in the USPB have repeatedly requested to see these data in a timely manner, especially given their long-term commitment to funding the data collection efforts and so that timely water management decisions can be made based on their data collection investments.

E.1.2.2.c. While the WHIP will serve data from the Arizona portions of the USPB, the initial focus will be on the Sierra Vista Subwatershed (Figure 1). This should allow for a smooth, effective, and potentially leveraged expansion of the WHIP to the adjacent Benson and Sonoran Subwatersheds as data and other funding become available. There have also been initial discussions between the USGS sponsored Trans-Boundary Aquifer Assessment program and the USPP about serving their data on the WHIP. Additionally, the Fort Huachuca Sentinel Landscape, a partnership between the U.S. Departments of Interior, Defense, and Agriculture and whose geographic reach fully includes the Sierra Vista and Benson Subwatersheds, has also expressed interest in the WHIP for the purpose of land protection and other objectives outlined in their Fort Huachuca Strategic Plan (December 2018). The USGS is also interested in the results of the WHIP development and use to determine its applicability in other watersheds where they work.

E.1.2.2.d. In addition to grant applicant Sierra Vista, many other entities including the general public will benefit from development of the WHIP. The WHIP project team will be housed within the USPP Technical Committee, with the Committee Chair serving as the project manager. It is anticipated that during the Planning Phase, the proposed focus groups will more clearly define the specific information needs of the public, and these data needs will later be incorporated into the ultimate design of the WHIP.

E.1.3. Evaluation Criteria C- Project Implementation

The WHIP project's Planning, Development, and Dissemination phases will be supported by contractors and directed by the WHIP project team. The project team includes the City of Sierra Vista Procurement staff and the USPP TC Web-portal work group. TNC's Water Projects Coordinator will serve as the WHIP Project Manager. She will directly coordinate with Sierra Vista Procurement staff, ensuring adherence to procurement rules, key milestones, and Reclamation reporting, as well as the hired contractors to ensure alignment with scopes of work and timelines. The Web-portal work group will also include the USGS Technical Lead, Bruce Gungle, whose involvement will be funded by the grant, and the BLM Hydrologist. Community stakeholders will be engaged at key decision points but are not considered formal project team members. To ensure meaningful incorporation of stakeholder input, the Planning and Development phases will be iterative. However, the timelines provide a broad understanding of the total time required to complete the phases as they are spread through the 24-month project timeline.

E.1.3.1. The *WHIP Planning Phase*. Length: 7 months. Deliverables: 2 Procured contracts, 2-year project schedule chart, and 2 Focus Groups and memos.

Task 1. Kick Off Meeting (Month 1): At the kick-off meeting, the WHIP project team will develop the Focus Group Facilitator scope of work (SOW) and refine the project timeline (phases, duration, major tasks, milestones and deliverable dates). A recurring team meeting schedule will be established.

Task 2. Focus Group Facilitator Procurement (Month 2): WHIP Project Manager and Sierra Vista Procurement coordinate to hire the Focus Group Facilitator (FCF).

Task 3. Plan and Convene Focus Group 1 (Month 3): FCF and WHIP project team will plan and convene Focus Group 1 in two sessions: one each for the general public and water managers. Direct invitations may be sent to agencies, local jurisdictions, academic institutions, scientists and researchers, media, and interested citizens. The deliverable-memo will outline the input on who needs the tool and for what purposes, retrospective on past information/data delivery efforts; and what data will the WHIP need to deliver and how it will function.

Task 4. Develop Website Development Contractor (WDC) Procurement (Month 4 – 5): WHIP Project Manager and Sierra Vista Procurement coordinate to hire the WDC. Refine SOW based on Focus Group 1 memo.

Task 5. Team Meeting with Web Design Contractor (Month 6): WHIP project team and WDC will review Focus Group 1 memo and develop WHIP conceptual model/mock-up. WDC will advise on technical aspects, such as ArcGIS platform and need for custom widgets.

Task 6. Plan and Convene Focus Group 2: (Month 9) FGF, WDC and WHIP project team will plan and convene Focus Group 2, possibly in two sessions, one for the general public and one for water managers, using the same invitation list as for Focus Group 1. WHIP mock-up will be

test-driven and feedback gathered, and input gathered on what data will be delivered via the annual hydrologic report template. FCF and WDC will work together to compile input into a memo suitable for WDC and project team to make WHIP finalization decisions.

E.1.3.2. The *WHIP Web Development Phase*. Length: 15 months. Deliverables: WHIP Flow chart, Database of Hydrologic Data-Served, Wireframe, Server contract, Annual Hydrologic State of the USBP Report Template, and Launched WHIP.

Task 1. Prepare Hydrologic Data: (Month 6-8) The USGS Technical Lead (TL) will gather the quality assured/quality-controlled WHIP data from required sources (Appendix B), organize, and deliver the hydrologic database to the WDC, and provide support as the data is built into the WHIP and as WHIP plans are refined based on Focus Group 1. The TL serves as the project advisor with regard to determining the time and resources required to connect to, harvest, and serve the variety of data types. The TL will also advise on the best format for data presentation (static, georeferenced, weblinks) and on the suitability of including various non-standard data.

Several categories of data require varying levels of effort by the WDC to incorporate into the WHIP. These efforts entail obtaining or creating plug-ins that enable periodic or automatic harvesting of data from the [USGS National Water Information System](#) (NWIS) and potentially other permanent, stable, web-accessible data bases such as ADWR's Ground Water Site Inventory (GWSI). A full list of these data can be found in Appendix B. Some NWIS data in standardized formats will require minimal manipulation (e.g. groundwater levels; stream flow, baseflow, spring discharge; surface water stable isotope; water quality). USDA Agricultural Research Service standardized data includes precipitation and vegetation flux/evaporation data. Non-standard format data will require some manipulation by the WDC (e.g. microgravity/aquifer storage change; recharge projects; stream-flow permanence and presence; geophysical soundings). The WHIP team will also develop a method for annually funding the compilation of groundwater pumping data.

Focus Group 1 facilitator will present these data options and elicit input from stakeholders and the public on which data are their top priorities and explore user-friendly data delivery options. The project team and the WDC will use this input in the Development Phase to create the WHIP mock up, and later present it back to the stakeholders during Focus Group 2. The WDC will establish stubs within the WHIP for creation of links in the future to additional data locations not included in this initial development project. These might include data from the ADWR, ADEQ, BLM, Arizona State University and University of Arizona, aerial electromagnetic survey data, and the Environmental Protection Agency.

Task 2. WHIP Functionality Decision Point Meeting: (Month 7) Based on the Focus Group 1 input memo, the WDC will issue recommendations on which platform functions are within project budget. At a project team meeting, WDC will review recommendations and decide on final content and conceptual model of the WHIP. These recommendations may include various ways to access data (GUI, geospatially) and data subsets, perform simple statistical

manipulations, visualize data schemes (tables, graphs, charts), compare data sets (side by side, insets, overlays), export WHIP data (KMZ, Excel, csv, pdf), provide access to the raw, root data (USGS NWIS data base), and provide text-based explanations of geography, geology, hydrology, history, and climate of the USPB.

At a decision point meeting, the WDC will address these specifications and update the WHIP project team on the feasibility of providing the desired products, and what technical difficulties the WDC expects to face. Discussions may include content, visualization, and flow hierarchy, and feasibility of desired activities (what WHIP will do and what that will look like to the user). Decisions will be made about the activities and flow paths required on the WHIP platform to achieve the specific requested functionalities, as well as determining which functionalities are not possible at the current time.

Task 3. Data Processing: (Month 8 - 9) After WHIP functionality decision are made, WDC will work with the TL to determine the technical requirements necessary to access the data (either find or create necessary plug-ins and if needed, create a local data base), regularly harvest from the web (no less than every 3 months) those data sets that are frequently updated, create a local data base if necessary to serve similar data from dissimilar data bases, provide the user with access to spatial- and (or) temporal-based data subsets, present the selected data subset in the format requested by the user (plot, chart, contours), provide multiple data subset types for comparisons as requested by the user, and provide an exportable product if requested by the user. The WDC will also be responsible for evaluating the geospatial compatibility of the various data sets. For this initial WHIP development project, USGS NWIS data will provide the standard to which other data sets will need to be compatible. Non-compatible data sets may be eliminated from this initial development project after WDC and WHIP Team evaluation. This task will also include selection of a server to house the WHIP.

Task 4. Build WHIP Wireframes and Web Applications: (Month 6 - 9) WDC builds the website wireframe*, incorporates the database organized by the Technical Lead, and designs and tests the WHIP web application prototype. The development of the WHIP wireframe will take the general concepts fleshed out in the previous sections of the Development Phase and wire them together. It is expected that the design and functionality input from Focus Groups 1 and 2 may not be possible or require creative solutions during wireframe construction, and thus there will need to be close communication between the WDC and the WHIP project team, so roadblocks are resolved efficiently to stay on schedule.

**Wireframe—a skeletal layout of a website and includes page layout and arrangement, website content, interface elements, navigational systems, and an understanding and explanation of how they all work together.*

Task 5. Finalize WHIP Based on Focus Group 2 and USPP Input: (Month 10 - 12) Based on Planning Phase, Task 6. (Plan and Convene Focus Group 2, Month 9) Project Team will convene

a final decision point meeting, to agree on the final changes to the prototype. WDC, with support from TL as needed, will finalize the WHIP with final revisions.

Task 6. Load, Test, Final WHIP Refinements: (Month 13 - 14) Upload to designated server, test and review final version; USPP Technical Committee serves as final test, with WHIP project team guidance.

Task 7. Hydrologic State of the Upper San Pedro Basin (USPB) Report Template: (Month 15-16) The WDC will develop a template for a short annual analysis of the Hydrologic State of the Upper San Pedro Basin, and the WHIP project team generate the first report and deliver it at the USPP science summit. A standard scientific publication may also be produced.

Task 8. Launch WHIP: (Month 17-18) See Dissemination Phase.

E.1.3.3. The *WHIP Dissemination Phase*. Please refer to **E.1.4.** for the detailed tasks leading to effective WHIP dissemination, as well as the development of, distribution to, and training of users on the Quick Start Guide.

E.1.3.4. Preliminary Project Schedule (based on 24-month WHIP timeline). *Please refer to E.1.4. for the WHIP Dissemination Phase details.*

Phase/Task (Lead: Project Team/PT, Facilitator/F, Technical Lead/TL, Web Design Contractor/WDC)	Start Month	End Month
<i>WHIP Planning Phase</i>		
Task 1. Kick-off Meeting (PT)	1	2
Task 2. Focus Group Facilitator Procurement (PT)	2	3
Task 3. Plan and Convene Focus Group 1 (F)	3	4
Task 4. Website Development Contractor Procurement (PT)	4	5
Task 5. Focus Group Facilitator & Web Design Contractor Coordination (F/WDC)	6	6
Task 6. Plan and Convene Focus Group 2 – WDC Present Mock-up (F/WDC)	9	9
Deliverables: 2 Procured contracts, 2-year project schedule chart; 2 Focus Groups & memos		12
<i>WHIP Development Phase</i>		
Task 1. Prepare hydrologic data locations (TL)	6	8
Task 2. WHIP Functionality Decision Point Meeting (PT)	7	7
Task 3. Data Processing (WDC/TL)	8	9
Task 4. Build WHIP Wireframes and Web Applications (WDC)	6	9
Task 5. Finalize WHIP Based on Focus Group 2 and USPP Input: (WDC)	10	12
Task 6. Load, Test, Final WHIP Refinements (WDC)	13	14
Task 7. Hydrologic State of the Upper San Pedro Basin Report Template (WDC)	15	16
Task 8. Launch WHIP (WDC)	17	18
Deliverables: WHIP Flow chart, Database of Hydrologic Data-Served, Wireframe, Server contract, Report Template, Launched WHIP		19
<i>WHIP Dissemination Phase</i>		
Task 1. Compile a Quick Start Guide for typical and basic WHIP uses (WDC/PT)	20	22
Task 2. Roll out WHIP (PT)	22	24
Task 3. Develop WHIP Maintenance Plan (WDC)	23	24

Task 4. WHIP Webinar Presentation to BOR (PT)	24	24
Deliverables: Quick-start guide, 2 Press releases, Maintenance Plan, BOR Webinar (WHIP application to management questions)		24

E.1.4. Evaluation Criteria D- Dissemination of Results

As the applicant the City of Sierra Vista will be one of the primary beneficiaries, but not necessarily the main beneficiary of the WHIP development project. The primary beneficiaries of the project will be the 21-member organizations of the Upper San Pedro Partnership, the Cochise Conservation and Recharge Network, universities and other research institutions working in the Arizona portions of the Upper San Pedro Basin, and the interested general public. The steps taken in the WHIP Planning Phase for meaningful engagement will result in the WHIP directly benefitting these partners and resource managers. The **WHIP Dissemination Phase** will include the final five months of the project and include the following deliverables: Quick-start guide, 2 Press releases, Maintenance Plan, BOR Webinar (WHIP application to management questions).

Task 1. Compile a Quick Start Guide for typical and basic WHIP uses: (Month 20-22) WHIP Team and WDC draft a WHIP Quick-Start Guide and distribute to stakeholders, water managers, researchers, and the general public, perhaps on thumb-drives. Quick Start Guide enables users to get up and running on quickly performing basic WHIP functions, including basic step-by-step instructions for several data retrieval activities. Also included will be a how-to-guide to access WHIP landing page; website map; retrieve raw data; chose data/information retrieval activity; select data retrieval method (e.g. geospatially, chronological, by indicator category); retrieve geospatial, temporal, or content-based data; conduct simple data comparisons and statistical manipulations; and save and/or print the results. The Quick Start Guide will also be available from the WHIP platform and the USPP website.

Task 2. Roll out WHIP: (Month 22-24) WHIP project team, with support possibly from Focus Group Facilitator and WDC, will issue a press release to stakeholders (USPP members - Federal, State, County, and municipal agencies); conservation organizations; interested businesses (e.g. all municipal water companies); Cochise County and Tucson news outlets; Researchers (for example, UA and ASU departments with past/current Upper San Pedro research interests - Hydrology & Atmospheric Sciences, School of Natural Resources and the Environment, Geosciences, School of Life Sciences). Also issue email notice to stakeholders and provide presentations and training sessions for partners and stakeholder groups as well as general public (as requested). Roll out will include a feedback component on how to further improve the WHIP tool, including a specific feedback component/session during the USPP science summit and during monthly USPP Technical Committee meetings.

Task 3. Develop WHIP Maintenance Plan: (Month 23-24) WHIP project team and WDC will draft a WHIP maintenance/annual update plan to ensure USPP resources are dedicated to the

longevity of its upkeep under the purview of the USPP Technical Committee: how/when to make improvements to interface to meet evolving needs, checking and updating links and loading new data. The WHIP Team will also track user feedback via the USPP, including gathering input at the annual science summit, and recommend improvements to the interface and how to support the usefulness of the data analysis tools. WDC will provide a Google Analytics type-tool for the WHIP.

Task 4: WHIP Webinar Presentation to BOR: (Month 24) As required by the BOR Applied Science Grant, the project team will present the WHIP at a BOR meeting, outlining how the WHIP applied to the management questions.

The WHIP and the results delivered through Hydrologic State of the Upper San Pedro Basin Report will be showcased at the subsequent Upper San Pedro Basin Science Summit. This will further embed the WHIP in meeting the purpose and goals of the USPP to “ensure an adequate long-term groundwater supply is available to meet the reasonable needs of both the area’s residents and property owners and the SPRNCA”. It will also highlight the use of the WHIP as a research tool and its usefulness to researchers, water managers, decision makers, and the general public for obtaining the data and information necessary for making informed decisions when resolving issues related increasing groundwater supply reliability in the USB.

Feedback will be continuously sought on WHIP resources (data and information), functionality, and general usefulness to users will be solicited annually with the intent that updates and revisions will always be part of the annual maintenance of the WHIP platform. This will ensure that the WHIP is, and remains, as useful as possible to the user-base. By keeping the WHIP relevant, especially by weaving it into the USPP annual science summit, we ensure that our user-base continues to spread the word and disseminate the tool to others long into the future.

E.1.5. Evaluation Criteria E- Department of Interior Priorities

Creating a conservation stewardship legacy second only to Teddy Roosevelt: Sound, credible, scientific research and data collection have been the foundation of cooperation in the USPB and the USPP for more than 20 years. But, up until now, those data have resided in the hands of the individual agencies and organizations conducting the research and data collection, making the data either entirely unavailable or available via non-intuitive web-based procedures that are difficult to navigate. WHIP will provide a unique opportunity for all stakeholders and decision makers to access all USPB data from a single location on the internet and in a simple and intuitive manner. Science-based decision making has become the hallmark of adapting to climate disruption and WHIP will allow all concerned to be working from a common, dynamic, functional, user-friendly foundation.

Foster relationships with conservation organizations: The SPRNCA has been the focal point for several conservation organizations, namely The Nature Conservancy (TNC), Friends of the San Pedro River, and Audubon Arizona, in terms of monitoring conditions, management decisions and compliance with SPRNCA’s enabling act. These organizations have actively participated as

members of the USPP, engaging with agencies and decision makers. TNC has contributed financial, land, staff, and research resources to support the efforts of the USPP and its other members to ensure a strong funding base for the watershed research and projects designed to protect endangered species and their habitat by maintaining flows and riparian health in the SPRNCA. The WHIP will foster and enhance a common foundation of understanding about the state of the USBP.

Restoring trust with local communities: WHIP will provide a credible, consistent, and current source of information for the scientific community as well as the general public. Having this increased transparency for hydrologic data via the WHIP platform will help to build trust and understanding of the complex hydrology of the region. It will serve as the “go to” source to inform diverse users—spanning from curious residents to agencies with regulatory and legal concerns. All discussions about USBP water management and use will begin from the same point and subsequent discussion can then focus on solutions to the problem or issue at hand rather than on data access, quality, and validity. By providing access to USBP data and research, the WHIP will foster more substantive dialogue between the USPP, agencies, decision makers and members of the USBP communities, and provide a common foundation from which productive dialogue can be built.

Expand line of communication: The purpose of the WHIP is to do exactly this—expand line of communication about USBP science with those users who stand most to benefit from it: decision makers, water managers, researchers, and the interested general public including conservation organizations. Currently, the vast wealth of USBP science is difficult to access, harder to grasp, and almost impossible to co-locate for analysis. The WHIP will be the tool that solves all of these problems—improve access to USBP data, assist with user understanding through graphical interfaces and presentation tools, and juxtaposition of numerous streams of scientific data from disparate sources.

F. PROJECT BUDGET

F.1. Funding Plan

The non-federal local share of the project cost will be contributed by the City of Sierra Vista through in-kind personnel match and cash, as well as by three other funding partners associated with the Upper San Pedro Partnership (USPP). Under the USPP and its Memorandum of Understanding, these entities enjoy a shared purpose of “coordinating and cooperating in the identification, development and utilization of science and technical information to assist in meeting water needs in the Sierra Vista Subwatershed of the Upper San Pedro River Basin” and an established goal of “ensuring an adequate long-term groundwater supply is available to meet the reasonable needs of both the area’s residents and property owners (current and future) and the San Pedro Riparian National Conservation Area (SPRNCA)”. The Arizona Department of Water Resources (ADWR) is a participant whose interests align with those of the USPP and has provided technical support and financial assistance at ADWR discretion since the late 1990’s .

Letters of Funding Commitment are included from the following funding partners: Cochise County, City of Sierra Vista, The Nature Conservancy (TNC), and ADWR (Appendix C). Their total cash match (\$99,000) will or has already been deposited into the USPP budget, of which the City of Sierra Vista is the fiscal agent. As the applicant, the City of Sierra Vista will also contribute \$10,850 in-kind personnel match from the City Manager Administrator, Finance and Procurement staff. Cash funds have been received or committed by the following non-Federal funding partners.

- TNC granted \$20,000 on May 31, 2019 to the USPP, via the City of Sierra Vista, to provide funds to expand the availability of hydrologic monitoring data online, specifically for the web portal project. The funding is available anytime once the grant application is awarded by the Bureau of Reclamation.
- Local funds originating from the City of Sierra Vista (\$23,000) and Cochise County (\$23,000) were approved by the USPP Administration Committee on August 14, 2019 from the USPP Program Administration balance to be used for this grant application. The funding is available anytime once the grant application is awarded by the Bureau of Reclamation.
- ADWR committed to fund 50% of all other local non-federal funding commitments not to exceed \$33,000.

F.2. Budget Proposal

Table 1. Total WHIP Cost

SOURCE	AMOUNT
Costs to be reimbursed with the requested Federal funding	\$99,000
In-kind cost by the applicant/City of Sierra Vista	\$10,850
Value of third-party cash contributions	\$99,000
TOTAL PROJECT COST	\$208,850

Table 2. WHIP Budget Proposal

BUDGET ITEM DESCRIPTION	COMPUTATION		Quantity Type	TOTAL COST
	\$/Unit	Quantity		
Salaries and Wages				
City of Sierra Vista Staff	41.175	200	hours	\$8,235
Fringe Benefits				
City of Sierra Vista Staff	13.075	200	hours	\$2,615
Contractual				
Stakeholder Engagement & WHIP Dissemination			Fee per task	\$33,000
U.S. Geological Survey Technical Lead			Fee per task	\$65,000
Website/Portal Designer Contract			Fee per task	\$100,000
TOTAL DIRECT COSTS				\$208,850
Indirect Costs				
Type of rate	-	-	-	\$0
TOTAL ESTIMATED PROJECT COSTS				\$208,850

F.3. Budget Narrative

Salaries and Wages includes costs for Sierra Vista Procurement staff and (Interim or) Chief Procurement Officer to manage the grant administration. However, these funds would be considered in-kind cost share above-and-beyond the cash needed for contractual work. Based on an estimated 200 hours of work on the WHIP, \$8,235 of in-kind match is offered.

Fringe Benefits are based on an estimated 200 hours of work by Sierra Vista staff to administer the WHIP grant, calculated at \$2,615 of in-kind match.

Contractual budgeted items will be where the majority of the tasks will be charged as follows:

- a. Stakeholder Engagement and WHIP Dissemination: Estimated cost \$33,000 to contract with a firm to facilitate the Planning Phase stakeholder and public engagement processes and lead the WHIP Dissemination Phase. The estimate is based on consultation with professional meeting facilitation and stakeholder involvement firms working throughout the Western U.S. who indicated the relevant Planning and Dissemination Phase tasks could be successfully completed with a budget of \$33,000. Specific tasks are listed in Section E.1.3. and E.1.4. Procurement method to be used to select the contractor will follow City of Sierra Vista and Federal requirements. A contractor skilled in facilitation will be hired for the Planning Phase (0-7 months), to facilitate two focus groups. The first will be held at the project onset with the water managers and general public (in two different, but possibly concurrent sessions) to

identify the desired functions for the WHIP. The outcome will inform the Website/Portal Designer contract scope of work. A second focus group will be held later in the Planning Phase to provide feedback on a WHIP mock-up created by the subsequently hired Website/Portal Designer, but prior to construction of the web portal. Based on their in-depth experience with the stakeholders and public from the Planning Phase, the firm will develop and launch the Dissemination plan, which may include a quick-start guide to help users perform the most typical web portal activities, web portal roll-out including notifications/outreach tasks, presentations, trainings, and feedback on the web portal, and development of a plan for a short annual analysis of the Hydrologic State of the Upper San Pedro Basin in Arizona.

- b. Technical lead: Estimated cost \$65,000 based on consultation the U.S. Geological Survey (USGS). Specific tasks are listed in Section E.1.3. Sole Source procurement method to be used to contract directly with the USGS will follow City of Sierra Vista and Federal requirements. U.S. Geological Survey Hydrologist, Bruce Gungle was the lead author of USGS Scientific Investigation Report 2016-5114 (“sustainability report”), which serves as the foundation for the web portal, and thus he possesses a unique knowledge of the data sets that will be accessible through the WHIP web portal. A sole-source contract will be sought to engage Mr. Gungle in guiding the project development team to the relevant Upper San Pedro Basin data sets and ensure they are easily accessible, and accurately represented.
- c. Website/Portal Designer Contract: Estimated at \$100,000, based on consultation with professional web design firms working throughout the Western U.S., and who designed some of the other web portals described in section B.1. Specific tasks are listed in Section E.1.3. Procurement method to be used to select the contractor will follow City of Sierra Vista and Federal requirements. A firm will be contracted to design and construct web portal wireframe based on the scope of work informed by the Planning Phase and in close coordination with the Technical Lead. The firm will also develop a plan for a short annual analysis of the Hydrologic State of the Upper San Pedro Basin, and work with the Web portal Dissemination team to disseminate the analysis.

G. ENVIROMENTAL AND CULTURAL COMPLIANCE

The WHIP is a technical tool based on the internet, therefore it will not impact any land or water-based environments (including no wetland or surface waters). There will be no earth-disturbing work associated with the WHIP development, nor will the project or its development affect any air, water, or animal habitat. Likewise, there are no species listed or proposed to be listed as a Federal threatened or endangered species or designated critical habitat that will be affected by any activities associated with the WHIP development. No water delivery systems will be constructed, nor will the WHIP result in any modification of or effects to, individual features of an irrigation system. There are no irrigation districts associated with this project, thus none are listed or eligible for listing on the National Register of Historic Places. There no

APPENDICES

APPENDIX A: Works Cited

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APPENDIX B: Data Availability

Listed below are the proposed data categories, period of record, and sources to be included in the WHIP under the current WaterSMART Applied Science Grant proposal. This list will be analyzed and refined in discussions between the WHIP Team and the WDC during the Development Phase of the WHIP project. The data categories and sources may be expanded in the future, following successful completion of this initial WHIP development project.

Data categories (**bold**) and data locations (*italics*) for inclusion in the WHIP:

USGS NWIS data

- **Groundwater levels, regional aquifer** (28 wells; 2001 to present; collected quarterly and continuously; *USGS NWIS*)
- **Groundwater levels, alluvial aquifer** (42 wells; 1995 to present; collected quarterly and continuously; *USGS NWIS*)
- **Groundwater levels, alluvial aquifer vertical gradients** (8 well pairs; 2001 to present; collected continuously; *USGS NWIS*; requires data manipulation)
- **Groundwater levels, fluctuation** (7 wells; 2001 to present; collected quarterly and continuously; *USGS NWIS*; requires data manipulation)
- **Total discharge, all gaging stations** (9 current/1 removed gaging stations; from 1935 to present; collected continuously; *USGS NWIS*)
- **Total discharge, springs** (5 springs; 2003 to present; collected quarterly; *USGS NWIS*)
- **Base-flow discharge, main stem** (3 gages on San Pedro, 1 gage on major tributary Babocomari River; 1935 to present; collected continuously; *USGS NWIS*; requires data manipulation)
- **Base-flow discharge, mountain front** (4 gages; 2001 to present; collected continuously; *USGS NWIS*; requires data manipulation),
- **Surface water stable isotopes** (6 sampling sites; 2000 to present; collected about 8 months per year; *USGS NWIS*)
- **Water quality, main stem** (1 site; 1987 to 2014, collected at least annually; *USGS NWIS*)
- **Water quality, springs** (3 sites; 2006, 2008 – 2010; collected periodically; *USGS NWIS*)

ARS data

- **Precipitation** (30 gages; 2008 to present; collected continuously; U.S. Agricultural Research Service [ARS])
- **Vegetative flux/evapotranspiration** (1 site; [2001 to present; collected continuously])

USGS data, non-standard formats

- **Micro-gravity aquifer storage change** (58 stations; 2008 – 2010; 2014 – 2015; collected periodically; *USGS (Science Base)*, (Gungle and others 2016)

- **Recharge, detention basin** (11 basins; 2002 to present; collected continuously, reported annually; *USGS [Science Base], Gungle and others (2016)*)
- **Stream-flow permanence** (6 stand-alone sites plus 4 main-stem gages; 2001 to present; collected continuously; *USGS [Science Base], Gungle and others (2016)*)
- **Geophysical soundings (boreholes, electromagnetics (EM), temperature, etc.)**(various; collected periodically; ADWR, *USGS [Science Base], (Pool and Coes, 1999; Coes and Pool, 2005; Gungle, 2006; Callegary and others)*)
- **Groundwater pumping (USGS Water Use Team &/or Science Base)** (*Gungle and others, (2016)*)

Other data, non-standard formats

- **Recharge, treated effluent** (2 managed sites, 2 ephemeral stream sites; 2003 to present; calculated and reported annually; *City of Sierra Vista, Department of Public Works; Fort Huachuca; City of Tombstone; City of Bisbee, Department of Public Works)*)
- **Recharge, stormwater runoff** (1 site, others planned; 2016 to present; calculated and reported annually; *Cochise County*)
- **Dry season wet-dry survey** (entire reach; 1999 to present; collected annually; *The Nature Conservancy*)
- **Groundwater levels, regional well sweep** (about 600 wells; 19XX to 2006; collected every 5 to 10 years; published static image and/or as data from ADWR's GWSI; *Arizona Department of Water Resources (ADWR)*)
- **[various ADWR data, such as GWSI Index wells, well sweep, Drilling data, Geophysics data**

The WDC will obtain or create plug-ins that will provide for periodic, automatic harvesting of data from USGS NWIS and potentially other permanent, stable, web-accessible data bases such as ADWR's Ground Water Site Inventory (GWSI).

The WDC will establish stubs within the WHIP for creation of links in the future to additional data locations not included in this initial development project. These might include:

- Arizona Department of Water Resources groundwater, geophysical, and well log data;
- Arizona Department of Water Quality water quality data; Bureau of Land Management monitoring data including discharge, vegetation, and watershed characteristics;
- Arizona State University and University of Arizona data including vegetation, water level, isotope;
- aerial EM survey data;
- Agricultural Research Service data including Charleston Mesquite research site data related to evapotranspiration, flow data from Walnut Gulch Experimental Range, Walnut Gulch precipitation and runoff data;

- other research data from various program over the last 25 years including the SALSA project and EPA's imaging work led by Dr. William Kepner

Indicator 1: Regional-aquifer water levels

- **Data type:** Groundwater elevations; numeric
- **Data location, name:** USGS NWIS (GWSI)
- **Data display, group:** map of trends
- **Data display, individual:** plot (include linear regression line)
- **Data location, link:** available upon request
- **Data sites:** available upon request

Indicator 2: Horizontal gradients (regional-aquifer wells)

- **Data type:** Groundwater elevations; numeric in decimal feet converted to dimensionless (ft/ft) via subtraction and division
- **Data location, name:** USGS NWIS (GWSI);
- South Transect includes Antelope #3, BLM Well B, BLM Well C. This has not been calculated in the past except between B & C (not published) and is available for review at: Bruce Gungle\Shared\BG Papers\Sustainability\DATA\I-2 Horiz Gradients\ Reach 5 Ant-3, BLM-B, -C
- **Data display, group:** map of trends
- **Data display, individual:** plot (include linear regression line)
- **Data location, link:** available upon request
- **Data sites:** currently 3 transects, plus 1 South Transect: available upon request

Indicator 3: Aquifer-storage change measured with microgravity

- **Data type:** numeric, in microgals
- **Data location, name:** in the AZWSC gravity data archive (stand-alone server/machine)
- **Data display, group:** map of trends; contour plot
- **Data display, individual:** plot (with GW data if available/nearby)
- **Data location, link:** check with Jeff Kennedy
- **Data sites:** available upon request

Indicator 4: Annual groundwater-budget balance

- **Data type:** various
- **Data location, name:** various. 2002-2012 data are available from USGS shared drive; future data will need to be harvested from various sources as in the past
- **Data display, group:** see fig. 19 of sustainability report for bar plot of human effects derived from water budget data; numerical value in acre-feet (per year)

- **Data display, individual:** 14 individual water budget elements grouped into 4 categories, and separated out, especially pumping and active-management measures. For the sustainability report, natural aspects of system were kept static to reduce noise.
- **Data location, link:** available upon request
- **Data sites:** Pumping data from USGS water use group (residential/ commercial/ irrigation), rural exempt pumping and industrial pumping are calculated as a function of increase in relevant population groups (sand and gravel mining), golf course irrigation, and stock tank pumping; municipal recharge data from jurisdictions of Sierra Vista, Ft. Huachuca, Tombstone, and Bisbee; detention basin recharge from Ft. Huachuca and Sierra Vista (latter value can be derived from precipitation using ARS regression equation); mesquite and tamarisk treatment, if any, from BLM; incidental recharge is derived as a function of pumping deliveries and irrigation volumes; urban enhanced recharge has been derived as a function of impervious surface in the subwatershed. This value has always been somewhat speculative and should be derived in part as a function of watershed precipitation. The degree to which UER is enhanced by detention basin recharge is particularly uncertain.

Indicator 5: Near-stream alluvial-aquifer water levels

- **Data type:** Groundwater elevations; numeric
- **Data location, name:** USGS NWIS (GWSI)
- **Data display, group:** map of trends
- **Data display, individual:** plot (include linear regression line)
- **Data location, link:** available upon request
- **Data sites:** available upon request

Indicator 6: Near-stream vertical gradients

- **Data type:** Groundwater elevations; numeric in decimal feet converted to dimensionless (ft/ft) via subtraction and division
- **Data location, name:** USGS NWIS (GWSI)
- **Data display, group:** map of trends
- **Data display, individual:** plot (include linear regression line)
- **Data location, links:** Discrete data and Continuous data available upon request
- **Data sites:** available upon request

Indicator 7: Annual fluctuation of near-stream alluvial-aquifer water levels

- **Data type:** Alluvial well data—annual highest & lowest values; will require a script to search for annual high, annual low, and differencing for fluctuation value. Will need to decide whether flood spikes count, or if we only want longer term highs and lows.
- **Data location, name:** USGS NWIS (GWSI)

- **Data display, group:** Report used plot and map, although neither was really satisfactory. Map with color ramp keyed to fluctuation values, scroll through years.
- **Data display, individual:** [Reaches are displayed in group map, above]
- **Data location, link:** available upon request
- **Data sites:** available upon request

Indicator 8: Streamflow permanence

- **Data type:** Gage data RE: flow present (wet) or absent (dry or ponded) for Palominas, Lewis Springs stage recorder, Charleston, Tombstone, AND Photos of streamflow every 12 hrs. converted to wet (flowing or ponded) and dry data. (Note that data types are inconsistent with regard to ponded, not flowing data—“not flowing” is problematic to define via photography; it could be possible but difficult to determine “ponded but not flowing” from stage data. Charleston is the primary site with a deep pool by the gage, but has only been not-flowing for a short period in 2005)
- **Data location, name:** ARS has photo data. Through 2012 these data are analyzed in Excel file found here: \\gs\tucsonaz-w\WSC\Bruce Gungle\BG Papers\Sustainability\DATA\I-11 Streamflow Permanence\321 Stream Flow Permanence-Camera Data 2007-2012-BG.xlsx
- Discharge & stage data can be found on NWIS web for Palominas, Lewis Springs, Charleston, and Tombstone sites.
- **Data display, group:** Fig. 28 (line plot of each site vs. precipitation) shows these data are a function of precipitation and thus not terribly unique.
- Perhaps best to stay away from a river length-style plot as locations are not always representative of the area in which they are found, or there is much variability up and downstream from camera or gage location. Average all sites and run against precipitation
- **Data display, individual:** Horizontal bar chart from Sustainability Report (fig. 27).
- **Data location, link:** available upon request **Data sites:** available upon request

Indicator 9: Base-flow on San Pedro and Babocomari Rivers

- **Data type:** 15 min or daily discharge data
- **Data location, name:** NWIS web discharge data which has been processed using Jeff Kennedy’s delta filter winter hydrograph-separation technique to determine base flow. Flows over 20 cfs can be removed under the assumption that such flows almost certainly include surface runoff from large and/or consecutive precipitation events.
- **Data display, group:** static plots
- **Data display, individual:** slider controlled vertical bars either for a year or by year through complete record—do selected multiples side-by-side for comparison as desired
- **Data location, link:** available upon request
- **Data sites:** available upon request

Indicator 10: June wet-dry status

- **Data type:** GPS data displayed in an ArcGIS environment of wetted lengths of stream on the 3rd week of June each year
- **Data location, name:** TNC (with BLM) collects, stores, analyzes, and publishes these data. To obtain raw data, contact Holly Richter or Dale Turner, Tucson TNC.
- Maps (pdf):
- http://azconservation.org/downloads/san_pedro_wet_dry_mapping
- Animation:
- <http://tnc.maps.arcgis.com/apps/OnePane/azuretime/index.html?appid=2ec647b821654da79a52ffd795fbbd70>
- **Data display, group:** map of trends, year by year. In a story map format these could either be annual tabs on a wet-dry page, or a single animation embedded in a page.
- **Data display, individual:** No real “individual” data for this one. Data can also be analyzed by reaches, numerically/statistically, etc., however.
- **Data location, link:** Contact Dale Turner, The Nature Conservancy, Tucson
- **Data sites:** Entire San Pedro River in subwatershed, Babocomari River, Curry Draw (EOP to river), Coyote Wash (Escapule Rd. to River).

Indicator 11: San Pedro River water quality

- **Data type:** Wide variety of numerical data related to amounts of various constituents as well as physical parameters of sample site
- **Data location, name:** QW Data
- **Data display, group:** see sustainability report for different methods of display for different parameters and constituents
- **Data display, individual:** see sustainability report for different methods of display for different parameters and constituents
- **Data location, link:** available upon request
- **Data sites:** Charleston

Indicator 12: San Pedro and Babocomari Rivers isotope analysis

- **Data type:** $\delta^{18}\text{O}/\text{O}^{16}$ and $\delta^2\text{H}/\text{H}^1$ numeric mass ratios
- **Data location, name:** QWData on NWIS Web
- **Data display, group:** p value of $\delta^{18}\text{O}/\text{O}^{16}$ ratio through time
- **Data display, individual:** Fig. 43 a & b of sustainability report shows $\delta^{18}\text{O}/\text{O}^{16}$ ratio data for the two sites with increasing trends (more evaporation indicating reduced contribution of groundwater to baseflow)
- **Data location, link:** available upon request
- **Data sites:** available upon request

Indicator 13: Springs discharge

- **Data type:** Discharge data; numeric in ft³/s
- **Data location, name:** NWIS (ADAPS); National Climate Center; City of Sierra Vista Annual Report
- **Data display, group:** east-side plots plus EOP recharge; west-side plots plus precipitation
- **Data display, individual:** plot (regression line)
- **Data location, link:** available upon request
- **Data sites:** available upon request

Indicator 14: Springs water quality

- **Data type:** Wide variety of numerical data related to amounts of various constituents as well as physical parameters of sampling sites
- **Data location, name:** QW Data
- **Data display, group:** see sustainability report for different methods of display for different parameters and constituents
- **Data display, individual:** see sustainability report for different methods of display for different parameters and constituents
- **Data location, link:** available upon request
- **Data sites:** available upon request

Other Data: Precipitation

4 station average precipitation (used in sustainability report) was based on National Climate Data Center precipitation data. However, those data have problems and require filling in gaps based on relationships to other stations for some months. For precipitation data 1989 to 2012, see spread sheet: available upon request

- **Data type:** monthly precipitation totals; numerous missing data points
- **Data location, name:** National Climate Data Center or ACIS for 4 station average noted in sustainability report; ARS maintains a 100+ rain gage network in Walnut Gulch subwatershed of the Sierra Vista Subwatershed as well as additional precipitation gages across the Sierra Vista Subwatershed.
- **Data display, group:** If include ARS data, would be nice to have annual contour plots (and animation?) of precipitation across the subwatershed. Otherwise, 4 station individual plots with 4 station average all on same plot is how subwatershed precipitation has been displayed in 321 Reports and sustainability report.
- **Data display, individual:** 4 station individual plots with 4 station average all on same plot is how subwatershed precipitation has been displayed in 321 Reports and sustainability report.
- **Data location, link:** available upon request

ARS Precipitation Gages: Precipitation data for Walnut Gulch (88 raingauges), Upper San Pedro (27 raingauges) and Santa Rita(7 raingauges) are available at:

http://www.ars.usda.gov/main/site_main.htm?modecode=53-42-45-00

- **Data sites:** Y Lightning Ranch, Coronado National Memorial, Tombstone, Sierra Vista