EPA EE Model Grant: *SCAPE (Sustainable Communities and Place-based Education)*

2016 update by Dan Collins

(a) Project Summary

(i) Organization and Partnerships

1) Lead Organization: Arizona State University, in the Phoenix Metropolitan Area (Tempe), the largest public research university in the U.S., has very high research activity (RU/VH; Carnegie Classification of Institutions of Higher Education) and annual research expenditures of $310 million. Since 2002, ASU has made applied sustainability research and teaching top priorities.

2) Management and Implementation: Dr. Dan Collins will lead development of *SCAPE (Sustainable Communities and Place-based Education)*, an environmental education (EE) curriculum combining classroom learning, online tools, and field research. Dr. Helen Rowe will co-manage the project and interface with scientists and educators. Monica Elser will develop and run teacher development workshops, develop and review online curricula, and provide teacher support. Drs. Hilairy Hartnett and Paul Haberstroh will contribute online content, participate in professional development workshops, and verify data for the *SCAPE* website. High school teachers and partner organizations along the Colorado River (CR), will implement curricula. This initial *SCAPE* project focuses on the CR and its tributaries. Sites cover the entire CR Basin in five Western states (WY, UT, CO, AZ, NV) and two of the EPA’s regional divisions (8 and 9). ASU’s University Office of Evaluation and Educational Effectiveness will evaluate outcomes.

3) Partners. Diné College, Tsaile, AZ (facilitating sub-awardee on Navajo Nation); Telluride Institute, CO (Watershed Education Program & logistics).

(ii) Summary

The lead and partner organizations listed above are not currently receiving, nor have they previously received, funding for this project from the EPA’s EE Grant Program.

*SCAPE* is a pilot high school and community-based science education project combining online learning and field observations linked to “living classrooms” across the CR Basin. The program builds on EPA recognized EE curriculum design guidelines (e.g., Simmons et al, 2004) and workshops (*Vital Signs*, 2012), and provides opportunities for science teachers to learn both the science of water quality and best practices for EE. *SCAPE* trained teachers will introduce students to the hydrology of the CR System, methods for measuring in-stream flow, and techniques for testing water quality. The program will provide specific training in EE pedagogy as related to real-world problems—water quality and supply—and will give our partner high school teachers the tools and methods to move from knowledge to action.

In addition to improving EE teaching skills, *SCAPE* will enhance students’ STEM learning outcomes. *SCAPE* is designed to improve students’ decision-making skills and achieve behavioral changes that foster a sense of stewardship and benefit the environment through five objectives:

1. Build *SCAPE*, an EE experience combining classroom, field, and online learning;
2. Train teachers to create and interact with *SCAPE* in 10+ regional high schools and institutions;
3. Teach students and citizens sustainability, water quality/supply, and environmental protection.
4. Foster “stewardship” of the CR system—our shared “commons” (*sensus* Hardin, 1968)—among students, teachers, and communities, especially in under-represented groups.
5. Implement an equitable funding mechanism for sub-awardee grants of $5000 or less.

The program will advance science by generating a dataset valuable to researchers studying water quality and water rights. With the technology platform in place and demonstrated success, we will broaden the program to address water quality and supply issues and other environmental issues of concern to youth, citizens, and scientists in the CR and other watersheds.

*SCAPE* builds from significant work in K12 EE including the Telluride Institute’s *Watershed Education Program* (Kudo, 2016), ASU’s School of Life Science (SoLS) programs *Ask-A-Biologist* (Kazilek, 2016) and *Ecology Explorers* (Banks, Elser & Salz, 2005), and the Julie Ann Wrigley Global Institute of Sustainability (GIOS). We aim to develop a robust EE platform that serves watershed education across the western states.
SCAPE activities address the EPA’s educational priorities of (2) Educational Advancement and (5) EE Teaching Skills; and environmental priorities of (4) Protecting Water and (5) Launching New Partnerships.

(iii) Implementation / Delivery Method
Master teachers, curriculum designers, and media experts will meet in Year 1 to craft a prototype EE curriculum focused on water quality in the CR Basin. Classroom teachers will be introduced to SCAPE through summer workshops and on line courses in Year 2. In Fall 2017, students will start using custom SCAPE interfaces (maps, database, keyed resources) to identify and share water quality issues on their stretch of the River, and conduct fieldwork to measure water quality and supply. Using the SCAPE interface, students from multiple living classrooms in the CR Basin will compare data and collaborate on summative conclusions about the quality, supply, and utilization of CR water. The SCAPE model will be shared with regional educators online and presented at conferences focused on EE to report lessons learned and recruit new participants.

(iv) Audience
Ten “living classroom” sites across the CR Basin, many with high percentages of under-represented groups, will participate. This includes 30 - 80 junior and senior level students from each high school (HS) (~600 total): Green River, WY (Pinedale HS, 10% Latino); Colorado River, CO (Yampah HS, 40% Latino); San Miguel River, CO (Telluride HS, 7.5% Latino); Dolores River, CO (Nucla HS, 55% Combined/Free lunch, 6% Latino); Colorado River (Grand Junction HS, Grand Junction, CO, 1% Nat. Am, 11% Latino); Colorado River (Grand County HS, Moab, UT, 5% Nat. Am, 5% Latino); Colorado River / Lake Mead (Boulder City HS, NV, 8% Latino); San Juan River (Diné College, 99% Nat. Am.); Lake Havasu, AZ (Lake Havasu HS, 8% Latino); Colorado River (Yuma HS, 75% Latino).

(v) Costs
EPA funding will be used to cover personnel, travel, supplies, and indirect costs. See form 424A for budget.

(b) Project description

(i) WHAT

(1) Educational priorities (2) and (5): Educational Advancement and EE Teaching Skills

   Educational Advancement: SCAPE is a place-based science education pilot for HS students. Through a STEM-focused curriculum, students become stewards of the environment by linking their experience of place (personal habits and patterns of living) with conditions and evidence from specific locations (local, regional, global), as well as with a network of living classrooms across the CR Basin through the SCAPE website. Each classroom will adopt a section of the CR system that will be their living classroom for conducting fieldwork and stewardship activities. The SCAPE curriculum uses online tools, documentary video, field research, and discussions and readings of environmental history, policy, and ethics to raise students’ awareness of the importance of healthy river ecosystems and water security. The course will culminate in student projects that catalyze action within local communities and foster behavioral changes. This fulfills the priority of educational advancement by connecting STEM skill development to real environmental conditions and outcomes.

   EE Teaching Skills: Master teachers, curriculum designers, and media experts will meet in Year 1 to craft a prototype EE curriculum focused on water quality in the CR Basin. In Year 2, classroom teachers will be introduced to SCAPE through on line courses, regional meetings, streamed mini-conferences, and summer workshops. Two courses are being developed to support teachers’ understanding of water quality protocols and EE teaching strategies: a) Chemistry of the Colorado River, and b) Teaching Water Quality.

(2) Environmental Priorities (4) and (5): Protecting Water and Launching a New Era of Partnerships

   Protecting Water: Students will study water sources from across the CR Basin (high mountain streams, regional reservoirs, groundwater, springs, imported via pipes and aqueducts, and recycled from treatment plants) to learn about the quality and source of their water supply. They will learn how to assess downstream consequences, and identify changes in river flow and the potential pollution sources in their adopted stretch of river (their living classroom). Using place-based learning, they will: 1) measure stream flows; 2) collect and
analyze biological, chemical, and physical samples from above and below potential pollution sources to assess water quality; 3) observe the correlations between stream flow, water quality, and ecosystem health; 4) investigate and quantify the role that aquatic microorganisms and macro-invertebrates play as indicators of water quality; 5) upload data and observations to the SCAPE website; 6) interpret the data in terms of threats to clean water and ecosystem resilience along the CR; and 7) and adopt actions to become stewards of the watershed.

**Launching a New Era of State, Tribal, and Local Partnerships:** Our aim is to make STEM learning outcomes and environmental stewardship relevant to students by connecting them with the values of local communities. Following research that shows the importance of connecting local messengers in the community (Bonta & Jordan, 2007), we will recruit local talent (gifted teachers and community leaders) who understand their communities and can connect with students. Three schools (of 10) from our study—Yuma HS, Chinle HS, and Telluride HS—illustrate the wide cultural and economic range among our student populations. The following vignettes from these locations illustrate how we hope to bridge the gap between environmental science and the wisdom of local environmental values:

- **Yuma HS** in SW Arizona is over 75% Latino and is located at the heart of an agricultural town dependent on manual labor and CR water for irrigation. Diminished CR flows and high salinity levels have impacted the local agricultural economy by limiting the extent and diversity of crops that can be grown. The HS neighborhood has a per capita income of $18,467 (US Census Bureau, 2010). Unemployment in Yuma during the spring of 2013 was 30%, the highest in the nation. Filomeno Muñoz, a bilingual 1st generation Latino with dual citizenship in Mexico and the U.S., teaches AP Biology at Yuma High School. Many of his students are children of migrant workers with limited English proficiencies. His language skills and ability to move freely across cultural and economic divides allow him to connect with and motivate students who have not been encouraged to pursue higher education in science and technology.

- **Chinle HS** in the middle of the Navajo Nation, is Chinle, AZ. Chinle HS is small, with a population of 99+% Native American students. Over 40% of the town’s population lives below the poverty line (US Census Bureau, 2010). Water is scarce and many families must haul water from community wells on the outskirts of town. Water security is a major issue; many wells are unregulated and contaminated with heavy metals and radioactive materials. Extended drought has impacted the health of grazing herds and led to a reduction in cultivated acreage. In this region, changes in behavior will only be accepted when Western scientific methods are seen as being in harmony with traditional Navajo principles and values. Corvina Etsitty, born and raised on the Reservation and fluent in both Navajo and English, teaches science at Chinle HS. As part of a team of indigenous researchers and teachers, she is working with her students to research unregulated water supplies across the Navajo Nation. The goal is a comprehensive database, constructed with students who can guide families to safe drinking water while honoring principles and values of the Diné (The People).

- **Another 200 miles to the northeast,** at the headwaters of the San Miguel River in SW Colorado, is Telluride HS. The campus population is primarily Caucasian (93%) and median household income is $64,244 (US Census Bureau, 2010). Diminished snowpack has led to tradeoffs between habitat preservation and the local recreational economy. Ski areas use increasing amounts of water for snowmaking. Spring run-off starts and stops earlier, which impacts local rafting companies and limits fishing. High altitude farms are subject to dropping water tables. The cost of living is high and full time employment is hard to find—especially outside of the tourism industry. Still, awareness of climate and water issues is leading to more opportunities in STEM and environmental science fields. AP Environmental Science teacher, Rex Lybrand, is an avid outdoorsman who combines his love of rafting, mountain biking, and rock climbing with teaching science. He has been successful in directing students to careers in environmental science and raising community awareness about the importance of water quality and healthy ecosystems. With Lybrand’s guidance, local students are recognizing the importance of personal choices and environmental stewardship.

With the support of SCAPE, Mr. Muñoz, Ms. Etsitty, and Mr. Lybrand will be able to introduce students to protocols for water quality testing in the CR Basin. Related benefits include an introduction to a wide range of environmental and science disciplines, an increase in STEM skills, heightened environmental awareness, a broadened perspective on the CR Basin as a system, and a connection to career paths in related professions. In each case there is a careful balance between meeting EE standards and the recognition and importance of local environmental values and partnerships.
(3) Goals

The SCAPE model is a new approach to EE that connects students with local water issues (e.g., pollution, water security, seasonal variability of flows, etc.) and the same or differing issues experienced in other CR Basin schools to create system-wide knowledge. SCAPE will create behavioral change via non-regulatory means, deepen students’ understanding of digital tools, provide opportunities to conduct field research, increase environmental literacy, and foster a sense of stewardship. Our larger aim is to expand SCAPE to other systems and schools diversify our audience and broaden our impact.

Goal I: Connect local data to system-wide knowledge. Students will:
   a. Engage in field research to measure water quality parameters, make observations, document findings, and then upload data, descriptions, media, photographs, and drawings of samples and organisms from each local reach (section of the CR) to the SCAPE website
   b. Conduct comparative analyses of data and observations from all ten living classrooms
   c. Use the SCAPE interface to work on solutions collectively and share findings, stewardship activities, and reflections (Kessler et al, 2004) with other classrooms and the public.

Goal II: Experience behavioral changes through non-regulatory means. Students will:
   a. study and discuss news and journal articles on the behavior of individuals and family groups globally in areas suffering drought, water pollution, or inadequate water supply
   b. demonstrate connections between personal habits and environmental impact by creating a log of individual and/or family water use; create a model of how private use contributes to community and state use; use the model to show how small individual changes affect regional water supply
   c. link local health, recreational opportunities, and other quality of life issues to beneficial environmental policies and practices.

Goal III: Learn to use digital tools and conduct field research. Students will:
   a. use the SCAPE online GIS map to identify potential pollution point sources
   b. use the SCAPE interface to map points of interest and polygons of their study area and load photographs from their site and organize them by name, geographic location, date
   c. practice using indicator species (e.g., macro-invertebrates) to assess water quality
   d. collect water quality and flow data and quantify differences in chemical, physical and biological parameters among the living classrooms, upload data to the SCAPE website, and share reflections on investigations and stewardship actions via the website.

Goal IV: Increase environmental literacy and a sense of stewardship. Students will:
   a. collaborate with project scientists to verify and compare living classroom data on the SCAPE website
   b. participate in place-based EE through observation, sampling, and comparative analysis
   c. synthesize knowledge of place from first hand field research, primary sources such as peer-reviewed journal articles, and secondary sources such as the Internet
   d. engage in constructive dialogue and produce written reports for publication on the SCAPE website about environmental stewardship, policy, and ethics
   e. conduct a water-related stewardship project with a local farmer, agriculture specialist, natural resource professional or member of the community (National Research Council, 2012)

(4) Increase environmental stewardship

The curriculum will address the whole of the EE continuum (Fig. 1). Students will learn about the CR, historical flows, and common sources of point and non-point source pollution (awareness and knowledge); investigate how flows have changed over time and locate potential pollution sources in their living classroom; and identify which pollution sources are most threatening to human health (critical thinking). Students will also log their household water use to quantify the amount they use and what potential pollutants they discharge, and then model usage regionally to understand how small changes have larger impacts (critical thinking). Students will engage in field research through sample...
collection and basic water chemistry analysis at sites above and below the pollution source (awareness and knowledge), and compare data with other living classrooms to understand the effects of water use and pollution across the watershed (critical thinking). Students will design solutions to minimize contamination of the river and maximize environmental flows (problem solving). Each living classroom will decide on actions and post them to the SCAPE website (decision making), and will have a blog on the site to share strategies, track progress, and document the impacts of their community-based projects (action). In this way, each living classroom will engage in the full spectrum of EE and experience environmental stewardship across the watershed.

Our overarching approach to curriculum design follows the Framework for K-12 Science Education (National Research Council, 2012), which states that students need to become well versed in three dimensions of science: scientific and engineering practices, crosscutting concepts, and core content. Our program will provide explicit experience in scientific best-practices, including: asking questions (for science) and defining problems (for engineering); developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations (for science) and designing solutions (for engineering); engaging in argument from evidence; obtaining, evaluating, and communicating information.

(ii) WHY

Why this particular project?

In the past decade, the SW US has seen temperatures 1°C warmer than the 20th century average, leading to reduced late-season snowpack and annual flow of the CR. The largest regional water reservoirs declined by half in the early 2000s with no subsequent recovery (Overpeck & Udall 2010). Therefore, teaching water conservation and water quality in schools and promoting community outreach and stewardship is highly relevant to the region and will engage students in a multi-tiered place-based curriculum that connects them to the River and addresses deficiencies in STEM education.

Why are the priorities and issues important to our target schools?

Populations in the largely rural areas served by the schools participating in this project typically have less access to higher education. SCAPE builds a bridge between regional schools and the university system, and has the potential to inspire students to consider higher education. Our model, from awareness to action, also provides teachers with an exceptional curriculum that embodies the new Framework for K-12 Science Education: Practices, Crosscutting Concepts and Core Ideas, released by the National Research Council in July 2011 and the Next Generation Science Standards (NGSS, 2013). The SCAPE curriculum will focus on the interdependence of science and technology to solve environmental problems, as well as many of the crosscutting concepts (e.g., systems and system models) outlined in the Framework.

Why have we chosen these goals?

Linking the “WHAT” in Question (i) to the “WHY” in question (ii).

Goal I: Connect local data to system-wide knowledge. The SCAPE system will allow data, narrative accounts, and documentary videos of student experiences to be shared and compared across the living classroom system, and with an audience in watersheds worldwide. Local data capture and interpretation provides depth; putting that data in the context of the entire Colorado River system provides breadth.

Goal II: Experience behavioral changes through non-regulatory means. Behavioral change is central to achieving sustainability. Community-based social marketing can motivate environmental protection behaviors as diverse as water and energy efficiency, alternative transportation, and watershed protection (McKenzie-Mohr 2011). Other approaches reveal that the most powerful learning happens when students self-monitor, or reflect (e.g. Zemelman et al. 2005). As students distinguish what they know from what they need to reevaluate or relearn, they translate discoveries about their own learning into plans for improvement. SCAPE combines external motivation with opportunities for self-reflection, starting in the students’ own backyards. Engaging students through place-based education fosters awareness of their own environment and a sense of connectedness and responsibility. To connect the local with the global, students will study how people behave in areas plagued by drought, water pollution, or inadequate water supply around the world to emphasize that...
water quality, security, and conservation are global challenges. Reflective journals in the form of blogs geared to millennials, will allow students to compare their actions with those they are studying and give teachers insight into how students value their own learning and progress. Personal accounts can easily be linked back to SCAPE as social media, laying the foundation for dialogue and action across the CR system.

**Goal III: Learn to use digital media and conduct field research.** The majority of newly created jobs result from advancements in science and technology; thus, these and related disciplines assume disproportionate importance (Boskin & Lau, 1992). Individuals who lead scientific research will be conversant in digital tools, such as instruments for data capture and modeling, and software for visualization graphing, mapping, imaging, and building networks to share data. Field research is a powerful way to bridge the gap between awareness, knowledge and action. By combining field experience, classroom exercises, and building skills in digital media, students will develop flexibility and can move freely across different modes of inquiry and convey their ideas and findings in a digital space.

**Goal IV: Increase environmental literacy and a sense of stewardship.** Environmental literacy requires that students understand that world systems are interconnected, and that individuals have the ability and responsibility to improve the environment (Maine Environmental Literacy Plan, 2010). Using the EE Continuum, educators can help foster environmental literacy. Our living classrooms, enhanced by 21st century research methods and digital tools, will help students move from awareness to action. Students will not only develop knowledge of place, but also take ownership of their own environmental problems. Our place-based approach further reinforces a sense of stewardship.

**Why these schools?**

SCAPE is targeted to high schools along the CR system because the river provides a natural conduit that highlights both local conditions and system-wide challenges. The project will provide a unique educational experience for diverse populations—from economically privileged communities in the tributaries and headwaters of the Colorado, to under-served tribal, high minority, low-income communities in Wyoming, Colorado, Utah, Nevada, and Arizona (see **Appendices: Table 6 and Figure 2. Map of partner institutions**). Data and narrative accounts of student experiences from one living classroom can be shared and compared using the SCAPE online hub, giving students personalized perspectives about water issues faced by students with diverse economic and cultural backgrounds.

**(iii) HOW**

**How we will reach our goals and objectives (See Logic Model, Appendices. Table 3.)**

**Curriculum design:**

**Unit 1: Pre-Field Work.** In class, students will engage readings in environmental history, policy, and ethics, with special emphasis on the CR. They will use pre-defined SCAPE maps to investigate a stretch of river near their school and use the SCAPE custom interface (text mark-ups, points, and polygons) for their living classroom. Students will develop hypotheses regarding water quality above and below their chosen site, and use local sources (photographs, oral histories, data from local water boards or USGS databases) to understand historical flows and uses of the river. Household water use logs will help students quantify personal use and identify the pollutants they discharge. Students will create a model of how individual water use contributes to community and regional water use, and utilize the model to demonstrate how individual actions may affect the regional water supply.

**Unit 2: Field Work.** On their river site, students will make observations, measure water flow, measure chemical and physical water quality, and survey biological indicators (microorganisms and macro-invertebrates) of water quality at sites above and below their hypothesized source of pollution, as developed with online maps. With the help of trained teachers, students will conduct standard water quality measurements using both traditional and digital instruments to evaluate basic water quality parameters (e.g., temperature, salinity, water clarity, and pH, as well as chemical species such as dissolved oxygen and nitrate).

**Unit 3: Post-Field Work.** All water quality data, photos of identified insects and water samples, hand-drawn illustrations, and field notes will be uploaded to the SCAPE website via custom forms. This data will be automatically translated into Google Spreadsheets and posted to a secure website. Measurements and observations will be verified by water quality and bio-indicator specialists from ASU. Once the data is verified,
students will use Google fusion tables to assemble a spreadsheet indicating accurate geo-coordinates, water quality, flow, and observed organisms. From these tables, they will create their own hyperlinked Google map to visualize the data. They will then compare and evaluate the data and identify pollution sources from their sites and those from other living classrooms.

Unit 4: System-wide Impacts. By looking at all of the living classrooms across the CR Basin, students will develop an understanding of system-wide river water quality, security, and supply issues—our shared commons. Each school will decide on an action to take, such as planning a water-related stewardship project with a local farmer, agriculture specialist, natural resource professional or member of the community, and will post their solutions and report their progress on the SCAPE website.

SCAPE design and presentation – A new model for the field of environmental education:

Education manager, Monica Elser will lead development of the EE curriculum to meet both national science standards and best practices. The project team, led by Collins, will guide the design and presentation of the online SCAPE curriculum. We will create step-by-step instruction and graphics for an EE curriculum on water quality for a regional audience focused on the CR system. Materials will include ways to adapt the curriculum for different ecosystems, cultural, and regional differences. The curricular materials will be shared on websites including ASU’s Ask-A-Biologist and Ecology Explorers, the San Miguel County Public School District, the Telluride Institute, the websites of all partner high schools, the National Science Digital Library (http://nsdl.org/), and national conferences (e.g, North American Association for Environmental Education, regional National Science Teacher Association meetings, and the Ecological Society of America).

Curriculum and Teacher Professional Development (see Time Line, Appendices, Table 1)

This two year project is organized in two phases: Phase 1 focuses on curriculum design and testing; Phase 2 includes teacher training and the roll-out of our EE curriculum in 10 pilot schools.

Phase 1 will begin in Telluride, in summer 2016. A 3-day workshop will convene research scientists, environmental educators, two regional high school teachers, educational media designers, and a computer networking expert to brainstorm and produce a prototype curriculum. This prototype will be beta-tested in the 2016-2017 academic year by two master high school science teachers with their AP science classes in Telluride, CO and Yuma, AZ (one site on the upper CR; one site on the lower CR). Regular Skype interviews with the teachers and quarterly formative reviews of their experience will be conducted by the curriculum design and evaluation teams.

During the summer of Year 2, a smaller core project team will meet in Telluride for a follow-up workshop to refine the curriculum. Towards the end of the summer, ASU faculty and teachers from each pilot school will be invited to participate in a water quality camp (WaterCamp) that will provide hands on training in water sampling and allow teachers to test the SCAPE software.

Phase 2: Rollout of the SCAPE curriculum to partner schools is targeted for Fall 2017. HS teachers will be encouraged to integrate SCAPE into their regular science curriculum. The ASU team and HS teachers will meet quarterly using online collaborative tools to evaluate SCAPE effectiveness and impact.

HS teachers will have opportunities to interact with the project curriculum team and research scientists at each step. In addition, for teachers seeking professional development beyond the structure of the SCAPE curriculum, two University-level courses are under development by the project team. The first, “The Chemistry of the Colorado River,” focuses on Riverine BioGeoChemistry; the second, “Teaching Water Quality,” focuses on pedagogical issues related to EE. The courses will be facilitated by The Telluride Institute and offered as 3 credit hybrid field work/distance learning courses at the 400/500 level at Mesa College, Grand Junction, CO.

(iv) WHO

Participating schools/Target Audience

The ten pilot schools were selected (see Appendices, Table 6), based on a list of criteria including proximity to the target watershed, appropriate biology and/or EE curriculum, uniqueness of geographic location, motivated and gifted faculty, supportive administration, and willingness to share data with schools system-wide. These schools range from economically privileged to under-served tribal, high minority, and low-income.
Teacher Stipends
$1000 of the $5000 sub-award will be used for teacher stipends (paid in $250 increments upon completion of: 1) curriculum review; 2) 2017 Telluride workshop; 3) curriculum implementation and virtual workshops; 4) evaluation survey), and travel expenses to support each teacher’s involvement in the teacher training workshop and curriculum implementation. In-service and continuing education credits are also available.

Sub-award distribution and utilization
The remainder of the $5000 sub-award ($50K total) will be used for water testing kits and field trips. These expenses advance the water quality environmental priority and educational priorities of the EPA.

Recruitment plan
SCAPE infrastructure will enable our master teachers to spread the curriculum across the CR watershed by recruiting new participants in subsequent years. National audiences will have access to water quality curricular materials on education resource websites at ASU, and in nationally respected websites and journals focused on environmental and science education. Web-based curricula will allow for classroom or independent participation.

Evaluation and External Review (see also Appendices, Evaluation for Metrics and Evaluation, pp. 12 - 13)
Project Evaluation for EPA SCAPE will be led by Dr. Shelly Potts and Dr. Alison Cook-Davis of the University Office of Evaluation and Educational Effectiveness (UOEEE) at ASU. They will interface with Ms. Monica Elser of ASU’s Julie Ann Wrigley Global Institute of Sustainability (GIOS). UOEEE will provide performance monitoring and independent evaluation of SCAPE activities and outcomes. UOEEE provides expert resources and services in program evaluation, social science research, and learning assessment. UOEEE has extensive experience having worked with clients including the NSF, DoE, NIH, and USAID. As leaders in UOEEE, Drs. Potts and Cook-Davis lead numerous evaluation projects for official reporting and university improvement.

The project team, led by Ms. Elser, will manage the daily implementation of the evaluation plan, (data collection, analyses, and reporting) under consultation with the external evaluators who will periodically check the integrity of evaluation activities, data, and deliverables; and project development, expenditures, and outcomes. UOEEE will conduct evaluation activities and findings, review formal and informal project communications, and observe project activities through ongoing communication with project leadership. UOEEE will also provide feedback to the project leadership team to support the development and implementation of the educational activities throughout the duration of the grant.

Evaluation Plan
The evaluation plan follows a mixed-methods approach, including both formative and summative components (Garrison, 2007) in order to: 1) review data collection processes; 2) estimate whether the project met stated objectives; and 3) provide feedback to improve project quality. Evaluators will refine the evaluation plan, data collection processes, and instrumentation and protocols—including participant perspectives and evidence of project implementation and impact. The formative external evaluation will provide initial and ongoing feedback (biannually) for project development and effectiveness. Initially, the evaluation team will observe selected activities (e.g. project team meetings, emails, the Curriculum Design Workshop) to understand project context and implementation, and review products created during implementation and development (e.g., pre/post-tests, surveys). The summative evaluation will assess quality, impact, and any unintended outcomes. Outcomes will be assessed at both the project and site level (e.g., scores will be compared between sites).

Evaluation Reports
Reports will be prepared in a summative manner; however, ongoing formative feedback will be provided. Evaluation data will be used iteratively to inform project and evaluation activities and communicate project milestones and outcomes. Evaluators will assess project implementation, impacts, and outcomes and provide a first year report. The evaluation team will also produce a final evaluation report on the extent to which the project goals and objectives were met. Evaluators will highlight the most successful project components, areas for improvement, and unexpected outcomes. In addition, evaluators will provide ongoing informal feedback to the project team through email, phone calls, and meetings.
### 5(a). Timeline (Milestones are in bold and underlined)

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Activity</th>
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<tbody>
<tr>
<td>Summer 2016</td>
<td><strong>Organize and launch communication framework for all project partners.</strong></td>
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<td></td>
<td>Prep pilot high schools within the Colorado River system for involvement in the project. Skype calls between HS and Curriculum Design (team combines scientific, educational, computational, and evaluative expertise from ASU and off-campus partners). Build wiki for communication among partners. Post archive on wiki of prior related research for use by development team.</td>
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<td>Accounting and Procurement Management: The project management team will coordinate expenditures for supplies, travel, and other expenses.</td>
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<td>Late June 2016</td>
<td><strong>Summer Curriculum Design Workshop I.</strong> Using the EPA EE guidelines, Next Generation Science Standards (NGSS Lead States, 2013), and Common Core standards (NGACBS, 2010), a rubric will be developed to assess all curricular materials, including online content.</td>
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<td>SCAPE development will focus on the content management system, interface design, integration of curriculum design with digital tools, development of evaluation instruments and materials, development of online resources in specific content areas, and user-experience benchmarking.</td>
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<td>July – Aug 2016</td>
<td>Q3 2016 product development and evaluation reporting to EPA with focus on the results of the Summer Curriculum Design Workshop I. Goal is to have working prototype completed by August.</td>
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<td>Accounting and Procurement Management: 2 of 10 water quality test kits purchased for testing by master teachers. Their feedback will be used to refine equipment purchase in year 2.</td>
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<td>2016 – 2017</td>
<td>Casey Jones, Orme School Environmental Science teacher, and Rex Lybrand, Telluride High School Environmental Science teacher, will <strong>beta-test the SCAPE Curriculum</strong> with their classes. The SCAPE team fine-tunes curriculum and software based on their feedback.</td>
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<td>Academic Year</td>
<td><strong>Evaluation:</strong> High school students’ and teachers’ knowledge and understanding of water quality issues will be evaluated using pre- and post-tests based on common measures about environmental science in general and water quality and supply in particular. These tests will be used to detect change in perception and interest in stewardship (i.e., increased motivation towards water quality issues). Using established resources (e.g., American Association for the Advancement of Science Project 2061, NAEP, TIMSS, PISA), we will target areas of water quality, water supply and environmental science that are misunderstood by most high school students. These resources target focal areas and have developed appropriate questions to assess knowledge and understanding of content and critical thinking in environmental science.</td>
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</table>
| 2016 – 2017 Academic Year (con’d.) | **Formative Feedback to Development Team from Master Teachers**  
Four Skype conference calls, spaced every two months (Oct. Dec. Feb. April) between master teachers and development team. Adjustments to online materials can be made remotely. Development team will seek feedback from both teachers and students via SCAPE interface and related emails, tweets, and blog postings.  
**Evaluation:** Selective evidence of student and teacher engagement and collaboration via SCAPE. Evidence of increased knowledge, including from vocabulary and details of posts, and skills in content areas, including local and systemic environmental policies and practices, water quality, and environmental science. Coding of online feedback provides grounded method (Strauss, 1987; Charmez et al, 2001) for capturing key constructs, common themes, technical issues, and novel outputs. |
|---|---|
| June/ July 2017 | **Summer Curriculum Design Workshop II.** With the benefit of lessons learned from the beta-test of SCAPE in 2016-2017, a smaller core project team will meet again in Colorado to refine the curriculum.  
SCAPE development will focus on the content management system, interface design, integration of curriculum design with digital tools, development of evaluation instruments and materials, development of online resources in specific content areas, user-experience benchmarking. Goal is to have final SCAPE curriculum completed by end of July.  
**Accounting and Procurement Management:** Remaining 8 water quality test kits ordered and distributed to pilot high schools. |
| August 2017 | Towards the end of the summer, ASU faculty and teachers from each pilot school will be invited to participate in a water quality camp that will provide hands-on training in water sampling and allow teachers to test the SCAPE software. |
| Fall 2017 | Roll out of SCAPE curriculum to all ten pilot schools.  
**Evaluation:** Administration of pre- and post-tests, surveys, and other relevant evaluation instruments are overseen by the evaluation team. |
| 2017 - 2018 | **Data Gathering and Formative Feedback to Development Team from Master Teachers**  
Four Skype conference calls, spaced every two months (Oct. Dec. Feb. April) between high school teachers and development team. Adjustments to online materials can be made remotely. Development team seeking feedback from both teachers and students via SCAPE interface and related emails, tweets, and blog postings.  
**Evaluation:** Formative reports focused on outcome and outputs from partner schools to be delivered at the end of each semester or trimester. Development team and evaluation team work together on template for feedback and assessment to be used by high school teachers.  
Seeking broad evidence of student and teacher engagement and collaboration via SCAPE. Evidence of increased knowledge, including from vocabulary and details of posts, and skills in content areas including local and systemic environmental policies and practices, water quality, and environmental science (Sung et al, 2003). Coding of online feedback provides grounded method (Strauss, 1987; Charmez et al, 2001) for capturing key constructs, common themes, technical issues, and novel outputs. |
| April 2018 | Product development and evaluation reporting including results from WaterCamp and teacher training. Compile feedback from pilot high school teachers, master teachers, and evaluator’s analysis into summative document for publication and distribution. ASU faculty, master teachers, and teachers from each pilot school submit final reports on their experience of the SCAPE curriculum using evaluation template provided by UOEEE. Final summative evaluation from Evaluation Team. |
| Summer 2018 | **Summative Report to EPA submitted.** |

Our approach, procedures, and controls will ensure that the awarded grant funds will be expended in a timely and efficient manner. Please see *The project's management plan and collaborative strategies*, in section 5(c)2, where we discuss accounting, the resource calendar, and guarantee of final deliverables.
5(a)1. Supplemental Information on SCAPE Evaluation Methods and Evaluation Timeline

The external evaluation will utilize both qualitative and quantitative data to examine the implementation, impacts, and outcomes of the project throughout the grant cycle (Table 2 below).

Table 2. Evaluation Objectives, Sources, Data Collection, and Outcome Indicators

<table>
<thead>
<tr>
<th>Project Objectives</th>
<th>Data Sources</th>
<th>Data Collection</th>
<th>Outcome Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build SCAPE, an environmental education experience that combines classroom, field, and online learning</td>
<td>Curricular materials, website, workshop materials, teachers</td>
<td>EE-, NGSS-, and CC-aligned rubric-driven review(s) of curricular materials, review of website, pre/post surveys</td>
<td>SCAPE uses EE, NGSS, and CC best practices and piloted in targeted classes; based on feedback and assessment, the tool is revised and implemented. Once developed, the tool is disseminated through faculty workshops.</td>
</tr>
<tr>
<td>Engage teachers in creating and interacting with SCAPE</td>
<td>Teachers, workshop materials, online tools</td>
<td>EE-, NGSS-, and CC-aligned rubric-driven review(s) of materials (see Table 3), pre-tests, post-tests, surveys, focus groups</td>
<td>Project outputs (# of teachers involved); Teacher and student ratings of workshop quality, curriculum quality (i.e., NGSS and CC alignment), and implementation. Teacher knowledge and understanding of EE principles, water quality, and environmental science content. Project outputs (e.g. # of students involved, # of projects). Evidence of student engagement and collaboration via SCAPE. Evidence of increased knowledge and skills in content areas including local and systemic environmental policies and practices, water quality, and environmental science.</td>
</tr>
<tr>
<td>Teach students about environmental health, water quality and water supply, and protecting our natural waters</td>
<td>Students, website, course materials, student logs, student assignments and projects, tracking database</td>
<td>Pre/post-tests, pre/post-surveys, rubric-driven review of student products and overall curriculum.</td>
<td></td>
</tr>
<tr>
<td>Foster next generation stewardship of the Colorado River system</td>
<td>Students, student blogs, website, student projects, tracking database</td>
<td></td>
<td>Project outputs (e.g. # of outreach projects, # of people affected). Evidence of student awareness, critical thinking, problem solving, and decision-making related to stewardship; student report of increased knowledge, skills, and personal actions.</td>
</tr>
</tbody>
</table>
The evaluation plan metrics include the following:

- **Content knowledge and perception of water quality issues**: High school students’ and teachers’ knowledge and understanding of water quality issues will be evaluated using pre- and post-tests based on common measures about environmental science in general, and water quality and supply in particular. These tests will also be used to detect change in perception and interest in stewardship (i.e., increased motivation towards water quality issues). Using established resources (e.g., NAEP, National Assessment of Educational Progress), we will target areas of water quality and supply, and environmental science that are misunderstood by most high school students. These resources target focal areas and contain appropriate questions to assess knowledge and understanding of content and critical thinking in environmental science.

- **Understanding of EE pedagogy**: Pre- and post-tests on the EE principles (based on the NAAEE’s Guidelines for Excellence in EE) will be developed to assess teacher participants’ awareness of and ability to describe and apply EE principles. In addition, teacher observations will be measured using a checklist focused on STEM content and practices (e.g., hands-on use of scientific instruments) and 21st Century skills (e.g., critical thinking and problem solving) in the classroom.

- **Quality of curricular material**: Using the EE guidelines, Next Generation Science Standards (NGSS), and Common Core standards (CC), a rubric will be developed to assess all curricular materials, including online content. In addition, teacher and student perceptions of the curricular material, its quality, and its classroom implementation will be assessed in surveys and focus groups. In particular, the surveys and focus groups will inquire as to whether the curriculum was engaging and motivating for students and whether student awareness of, knowledge of, and interest in environmental science increased as a result of the curriculum.

- **Environmental stewardship**: The impact of projects and field research (e.g., numbers of outreach projects and people affected) will be documented at each school using a tracking spreadsheet. Students’ perceptions of and commitment to environmental stewardship, measured via student engagement in, motivation towards, and persistence in projects and field research over time, will be assessed via pre/post surveys and reviews of student blog posts.
(b) **Logic model:** The following table provides a rubric of learning outcomes using a Logic Model.

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop and implement recruitment plan for teachers and students with emphasis on rural and low income/high minority school districts</td>
<td>Identify 10 schools and teachers and ~600 students. Increase access and engagement by under-represented communities to EE resources</td>
</tr>
<tr>
<td></td>
<td>Participants demonstrate increased awareness and comprehension of environmental issues and how policies and practices affect their community’s environment</td>
</tr>
<tr>
<td></td>
<td>Establish sustainable EE programs on water conservation and quality in targeted regions featuring well-defined, professionally formatted curricula</td>
</tr>
<tr>
<td>Create professional development workshops and training for high school teachers and community educators.</td>
<td>High school teachers and community educators participate in summer workshops, university-level distance learning courses, and community-based volunteer work to increase awareness.</td>
</tr>
<tr>
<td></td>
<td>Teachers integrate increased knowledge of EE best practices into the classroom. Teachers and students lead environmentally-focused projects to improve their communities.</td>
</tr>
<tr>
<td></td>
<td>Materials are shared online and with educators at local and national EE or science teacher conferences. Improved environmental literacy in targeted communities.</td>
</tr>
<tr>
<td>Develop high quality online-accessible curricular materials on sustainable water use and quality; assist teachers in developing materials for wider use</td>
<td>Increase capacity and motivation for teachers to develop quality EE materials. Reinforce local identity. Assess and evaluate materials</td>
</tr>
<tr>
<td></td>
<td>Take specific actions on water conservation and quality at campus and community levels to reinforce local identity.</td>
</tr>
<tr>
<td></td>
<td>Students and teachers demonstrate behaviors and commitments to environmental protection and educate others outside of program about environmental issues—especially in under-served communities. Persistence in and knowledge of STEM skills. Wide adoption and dissemination of SCAPE curriculum</td>
</tr>
<tr>
<td>Support teachers in implementing STEM-driven environmental education (EE) program focused on sustainable water use and quality</td>
<td>Increased capacity for teachers to implement EE programs tied to STEM learning objectives. Increased teacher and student understanding and awareness of water quality in the Colorado River System.</td>
</tr>
<tr>
<td></td>
<td>Formative assessment of student and teacher actions to improve local environmental outcomes and STEM learning. Persistent application of proven STEM and EE learning methods.</td>
</tr>
</tbody>
</table>
Table 4. Programmatic capability and past performance

<table>
<thead>
<tr>
<th>Name of PI</th>
<th>Period of Award/ Agency</th>
<th>Amount of Award</th>
<th>Title</th>
<th>How was the Project Completed &amp; Managed?</th>
<th>How did you meet the Reporting Requirements?</th>
<th>Did you adequately and timely report on progress?</th>
<th>If not, why not?</th>
<th>Submitted Final &amp; Acceptable Reports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul Westerhoff</td>
<td>01-Dec-2011 - 30-Nov-2014 EPA</td>
<td>$500,000</td>
<td>Sustainable Sorbent- Monitoring Techs - Ground H2O</td>
<td>Ongoing and Managed Satisfactorily</td>
<td>All met on time, satisfactory</td>
<td>Yes</td>
<td></td>
<td>Project has not yet ended, annual reports have been submitted</td>
</tr>
<tr>
<td>Paul Westerhoff</td>
<td>01-Dec-2011 - 30-Nov-2014 EPA</td>
<td>$204,645</td>
<td>SC U of Alaska - Anchorage: Sustainable Sorbent- Monitoring Techs - Ground H2O</td>
<td>Ongoing and Managed Satisfactorily</td>
<td>All met on time, satisfactory</td>
<td>Yes</td>
<td></td>
<td>Project has not yet ended, annual reports have been submitted</td>
</tr>
<tr>
<td>Jim Elser</td>
<td>NSF 9-2012 to 9-2016</td>
<td>$750,000</td>
<td>Phosphorus Sustainability Research Coordination Network</td>
<td>Project Ongoing and Managed Satisfactorily</td>
<td>All met on time, satisfactory</td>
<td>Yes</td>
<td></td>
<td>Project has a NCE, annual reports have been submitted</td>
</tr>
<tr>
<td>Helen Rowe</td>
<td>USDA NIFA – 4/30/2009-2014</td>
<td>$500,000</td>
<td>Enhancing Ecosystem Services From Agricultural Lands: Management, Quantification, and Developing Decision Support Tools</td>
<td>Project Ongoing and Managed Satisfactorily</td>
<td>All met on time, satisfactory</td>
<td>Yes</td>
<td></td>
<td>Project has not yet ended, annual reports have been submitted</td>
</tr>
</tbody>
</table>

5(c)2 Project Management

I. Leadership and Coordination Team

Project Management Team

Dan Collins is the project’s Principal Investigator. Dr. Collins will take responsibility for overall project coordination and implementation. Collins is founding Co-Director of the PRISM lab (a 3D visualization and prototyping facility at ASU). He developed and directs the teacher training curriculum for the foundation program in the School of Art (artCore). Dr. Collins has developed innovative, online curricula for teaching art and design as well as computer-aided visualization. He has served as a PI on a number of successful grants.
focused on digital media for 3D visualization and prototyping. He is President of the Board of the Telluride Institute in Colorado (http://tellurideinstitute.org) and has helped develop and administer a watershed education program (WEP) that delivers place-based learning to schools in the San Miguel River system. His recent work focuses on interactive media, participatory research methods, documentary video, and community mapping. Collins will dedicate his time to administration, logistics, writing, video editing, and media development.

Helen Rowe, Co-PI, will assist with project implementation and coordination. Dr. Rowe is an assistant research professor in the School of Life Sciences and was recently appointed as the Director of the McDowell-Sonoran Field Institute, McDowell-Sonoran Conservancy. Dr. Rowe is the PI of a USDA-NIFA funded Ecosystem Services project that looks at carbon sequestration and insect biocontrol in agroecological landscapes. Dr. Rowe is also the Partnerships Program Lead for Center for Biodiversity Outcomes where she brings together scientists and partners (NGOs, land managers, policy makers, etc.) to pursue use-inspired research. Dr. Rowe will provide project management, logistical support, writing, evaluation, and budget oversight to the project.

2. Members of the larger project team
Curriculum Management Team

Monica Elser, Co-PI, the Education Manager and Senior Sustainability Scientist at ASU’s Julie Ann Wrigley Global Institute of Sustainability, has been directing an environmental education program for over ten years. Elser directs the K-12 education and outreach programs for ASU’s Global Institute of Sustainability including the successful Ecology Explorers program, the K-12 education outreach initiative for the NSF-funded Central Arizona—Phoenix LTER project. As part of the NSF-funded Decision Center for a Desert City project, Elser has led yearly Advanced Water Educator Workshops and is currently leading the development of teaching material for DCDC’s on-line WaterSim modeling program. She was also Co-PI on the NSF ITEST grant “Learning through Engineering Design and Practice: Using our Human Capital for an Equitable Future” and the outreach component of the NSF Grant: Collaborative Research: Urban Vulnerability to Climate Change. Elser is co-PI on the NSF-funded GK-12 program, Sustainability Science for Sustainable Schools, which links graduate students with local schools. Elser has also been active in working with the Arizona Association for Environmental Education to develop local EE guidelines and developing a certification program for non-formal educators. Elser will also assist in developing the formative and summative assessments for this project.

Karl Topper will act as a consultant on the water quality sampling protocols and STEM curriculum design. Dr. Topper has over 20 years teaching experience at the elementary to college levels. He is also a soil scientist working on a wide range of environmental science projects. Prior to his more recent work as a STEM educator and Telluride Institute program director, he taught environmental science and science education at Colorado Mesa University. During this time, he developed a new environmental science and science education program that required extensive curriculum and materials development. He was the principal investigator on a variety of NSF projects, with focus on tribal college education.

Laura Kudo, along with Vicki Phelps (see below), will head up the high school teacher training efforts in the Upper Colorado River Basin (north of Page, AZ). Co-Director of the Watershed Education Program at the Telluride Institute (WEP, 2016), she is a non-profit program director with over 10 years of experience designing, building, and leading environmental educational programs. She holds an MA in Environmental Education from Prescott College in Arizona and Teaching Certification for K–12 Education and Art from Fort Lewis College in Durango, Colorado. Along with Phelps, Kudo’s contribution to the project will include assistance with curriculum design, field research, and interfacing with high school teachers along the upper tributaries of the Colorado River.

Vicki Phelps, along with Laura Kudo (see above), will head up the high school teacher training efforts in the Upper Colorado River Basin (north of Page, AZ). Co-Director of the Telluride Institute’s Watershed Education Program (WEP, 2016), Phelps has taught for some 27 years, including middle and high school science and math, all subjects in fourth grade and KG-8th grade visual arts. She has facilitated many outdoor environmental education and watershed studies in her district. As a botanist and landscape supervisor at the Arizona-Sonora
Desert Museum, Phelps taught classes in ethnobotany, desert ecology, and xeriscape gardening. She has trained at CU-Boulder’s ICEE (Inspiring Climate Education Excellence), funded by NASA, run a middle school River Watch water quality monitoring program, and was an Adopt-a-Watershed program teacher. She has a BA in Biology with a minor in art from The Evergreen State College, a secondary science teaching certification from the University of Arizona, and elementary certification and a master’s degree in Education from Adams State College.

**Media Development Team**

*Shaun Ylatupa-McWhorter* will serve as project system administrator and GIS mapping specialist. Ylatupa-McWhorter brings a valuable depth and breadth of experience from the environmental and wildlife arenas with respect to GIS analysis and programming. He has created or helped to create interactive maps for the Arizona Department of Game and Fish and Arizona State University. He will aid in the design and development of the data structures and delivery medium. He worked on the Green Revolution, a traveling Smithsonian exhibition that was displayed recently at the Tempe Center for the Arts.

*Kaard Bombe* is an independent director of photography and producer of documentary videos. Bombe is taking the lead in producing on-site videography, assisting with interviews, and creating a comprehensive chronicle of the EE process, particular stories of place, and the people we meet in the course of the project.

**Evaluation Team**

*Dr. Shelly Potts* has worked in the fields of social science research, assessment, and evaluation for nearly 25 years and has provided consultation to 175+ colleges. Dr. Potts has evaluated projects for the NSF, the United States Department of Education, the Ford Foundation, and the Alfred P. Sloan Foundation. She earned her Ph.D. in Educational Policy with emphasis in educational research and evaluation from ASU. She holds degrees in psychology and counseling from Purdue and Ball State Universities. Dr. Potts is Past President of the AZ Evaluation Network, an affiliate of the American Evaluation Association.

*Dr. Alison Cook-Davis* has over nine years of experience in applied research and program evaluation. Since joining the University Office of Evaluation and Educational Effectiveness, Dr. Cook-Davis has led monitoring and evaluation activities for over 40 separate grants funded by the National Institutes of Health, National Science Foundation, ASU Foundation, W. K. Kellogg Foundation, and a private donor. These projects have included the evaluation of student success, outreach impacts, innovative learning techniques, and STEM. Dr. Cook-Davis earned her M.A. and Ph.D. in Social Psychology from University of Missouri, Columbia.

**Research Science Team**

Co-PI *Dr. Hilairy Hartnett* and consultant *Dr. Karl Topper* will provide guidance in the concepts and delivery of science content to teachers and support students in the verification process for water quality testing.

*Hilairy Hartnett* is a Senior Sustainability Scientist in the Julie Ann Wrigley Global Institute of Sustainability at ASU, where she holds a joint appointment as an Associate Professor in the School of Earth and Space Exploration and in the Department of Chemistry and Biochemistry. Dr. Hartnett was awarded an NSF CAREER award to study carbon cycling in the Colorado River System in 2009. Her research in biogeochemistry focuses on how geochemical, microbial, and anthropogenic processes affect elemental cycles in environments that range from arid terrestrial systems, to rivers and lakes, to marine sediments. She uses both experimental fieldwork and cutting-edge analytical techniques to investigate the transfer of elements and energy between different geological pools. She teaches courses in geochemistry, field geochemistry, advanced biogeochemistry, oceanography and introductory geology.

**The project’s management plan and collaborative strategies**

*Project Management Team: PI Dan Collins and Co-PI, Helen Rowe have overall authority and responsibility for management and execution. Researchers from ASU and partner organizations comprise a management team,*
a curriculum design team, a media development team, a research science team, and an evaluation team—each with a coordinator. External partners report to the Project Management team. Good communication and collaboration between team members and partner organizations is essential.

**Project Scope, Logic, and Navigation:** The scope of the project is set forth in the time line (see Table 1), which includes a summary list of milestones tied to specific dates. Scope is managed and verified via standard metrics—quality checklists, scope baseline documents, and work performance measurements, etc. The timing, sequence, and staging, of project components are ultimately the responsibility of the project management team; however, the evaluation team will help the project stay on track by refining the data collection processes and instrumentation protocols developed by the core project team. They will provide essential feedback in the form of evaluation data and bi-annual reports. The evaluation team will assess the quality and impact of the project in reaching its key goals and deliverables and document any unintended outcomes. This key partnership between the project management team and the evaluation team will facilitate effective communication of project milestones and outcomes to stakeholders.

**Communications Management:** A project team directory, available on the website, provides contact information for all stakeholders as well as other project contacts. The project manager will take the lead role in ensuring effective communications on this project. Besides regular email and video-phone communication, face-to-face meetings will be held, at minimum, quarterly. The management structure is horizontal; all project partners are encouraged to communicate directly with fellow team members. All agenda and minutes will be available to the project team on the project website ensuring transparency and providing a running record of internal discussion and progress.

**Accounting and Procurement Management:** The project management team will be responsible for managing and reporting on the budget on a quarterly basis, including budgetary planning, tracking, reporting, and management of costs. All expenditures are approved by the project management team.

**Risk Management:** The project management team members and coordinators are responsible for ensuring the health and safety of all participants. Every effort will be made to proactively identify risks from the project’s onset. Oversight is provided by ASU’s Institutional Review Board (IRB), which reviews all research involving human subjects and ensures that subjects are treated ethically and that their rights and welfare are adequately protected.

**Resource Calendar:** The project manager, in consultation with team coordinators, will develop a resource calendar that identifies and schedules key resources and facilities for the project (e.g., water quality testing kits, transportation, lodging/camping facilities, video/photo shoots, meeting facilities, etc.)

**Quality Oversight, Evaluation, and Final Deliverables:** It is the responsibility of the project management team, in consultation with team coordinators, to ensure accuracy and quality of all products, including vetting of final deliverables and approvals for dissemination of products released to the public.

**Three one-page resumes follow:**
BIographiesketch -Dan Collins

Professor, School of Art / Co-Director, PRISM (Partnership for Research in Spatial Modeling)
Arizona State University, PO Box 871505, Tempe, AZ 85287-1505
Phone (c): (480) 206-2037; Fax: (480) 965-8338; email: dan.collins@asu.edu

Professional preparation
PhD, Arizona State University, Interdisciplinary Humanities / Curriculum and Instruction, 2009
MFA, University of California, Los Angeles, Sculpture and New Genres, 1984
MA, Stanford University, Art Education, 1975
BA, University of California, Studio Art and Art History, 1974

Academic appointments
2005 – present, Full Professor, Intermedia and Foundations School of Art, Arizona State Univ.
1987-88, Visiting Professor, Sculpture and 3-D Design, Pusat Seni (Art Center), Universiti Sains Malaysia, Penang, Malaysia

Professional activities
• Organized/developed in-service workshops/internships with national arts organization (FATE)
• Created and implemented first year curriculum for University level art and design courses
• Organized/developed teaching pedagogy seminars for graduates student in the School of Art
• Administered curriculum for watershed education in K-12 schools in SW Colorado.
• Presented poster, papers, installations, workshops at over 100 professional meetings and exhibitions including: SIGGRAPH, College Art Association; National Association of Interpreters; Bioneers; Telluride Institute Ideas Festival, CyberArts (Boston); Peking University, China
• Founded an interdisciplinary Art/Science lab for visualization and prototyping (PRISM)
• Created “San Francisco Bay Model,” a permanent exhibit at the Exploratorium in San Francisco with G. Cooper (Four Chambers) and O. Fringer (Stanford) for interacting with San Francisco Bay data.
• Created "Tangible User Interface for the Grand Canyon," with Gene Cooper, AZ Science Center.

Selected publications


Selected Awards
2014 Citizen Science and Citizen Engagement, ASU East Polytechnic Campus.
2014 Senior Sustainability Scholar award, GIOS, Arizona State University
2000, 2007, 2013 ASU Herberger Institute Award for Research and Creative Activity
1987-88, Fulbright Research and Teaching Fellow, Malaysia
BIographiesKETCH - MONICA M. EL Ser
Education Manager, Global Institute of Sustainability
Arizona State University, PO Box 875402, Tempe, AZ 85287-5402
Phone: (480) 965-6046; Fax: (480) 965-8087; mmelser@asu.edu

Professional Preparation
University of Notre Dame, Notre Dame, IN, Biology, B.S., 1980
University of Tennessee, Knoxville, Ecology, M.S., 1983
Arizona State University, Tempe, Curriculum and Instruction, M.Ed., 1998

Appointments
1998-present, Education Manager, Global Institute of Sustainability, Arizona State University (ASU), Tempe;
1994-1996, General Biology Lab Coordinator, ASU;
1987-1990, Student Affairs Officer (Academic Advising), Div. of Biological Sciences, University of California, Davis;
1984-1986, Research Technician, Biology Department, University of Notre Dame, Notre Dame, IN.

Related Publications


Synergistic Activities
1. Organized/developed teacher workshops/internships associated with a variety of NSF-sponsored research projects
2. Assisted in development of evaluation tools and analysis of the GIOS K-12 education outreach programs
3. Organized/developed teaching pedagogy seminars for graduate students in the School of Sustainability
4. Developed after-school and summer programs engaging minority and inner-city youth in learning about their local environment
5. Developed an on-line graduate-level course on sustainability science for teachers

Selected Awards
2014 Senior Sustainability Scientist Award, Global Institute for Sustainability, ASU
2013 ASU President’s Award for Sustainability
2013 Environmental Excellence Award from AZ Forward Association
Biographical Sketch – Hilairy Ellen Hartnett
School of Earth & Space Exploration, Department of Chemistry & Biochemistry Arizona State Univ.
Tempe, AZ 85287-1404 Ph: 480.965.5593; Fax: 480.965.8102; Email: h.hartnett@asu.edu

Professional Preparation
Vassar College Chemistry A.B. 1990
Univ. Washington Oceanography M.S. 1995
Rutgers University Oceanography Post-Doctoral fellow 1998-2000

Appointments
2010-present Associate Professor. School of Earth and Space Exploration and Department of Chemistry & Biochemistry, Arizona State University.
2003-2010 Assistant Professor. SEPE and Department of Chemistry & Biochemistry, AZ State Univ.
2007-present Senior Sustainability Scientist. School of Sustainability, Arizona State University.
2006-present Honors Disciplinary Faculty. Barrett Honors College, Arizona State University.
2000-2003 Visiting Assistant Prof. Inst. of Marine & Coastal Sciences, Rutgers Univ.

Research Interests
Chemical Oceanography; Hot spring ecosystem biogeochemistry; Carbon and Nitrogen cycling; Urban biogeochemistry; mass spectrometry techniques for organic carbon characterization

Products


Synergistic Activities (Recent and Current)
*Scientist:* IODP Leg 331. Deep Hot Biosphere
*K-12 E/O:* SW Consortium for Educ. & the Natural Environment (SCENE); Washington Initiative for Science Education-Science Teacher Enhancement Program. (WISE-STEP)
Fed. Funded grants, etc. similar in size, scope and relevance.

Table 5. Current and Pending Support

<table>
<thead>
<tr>
<th>Researcher(s)</th>
<th>Agency</th>
<th>Amount</th>
<th>Dates</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dan Collins</td>
<td>ASU/HIDA</td>
<td>$5000</td>
<td>2010 - 2011</td>
<td>Gaming the Museum (3D Archive for ASU Art Museum)</td>
</tr>
<tr>
<td>Dan Collins</td>
<td>ASU/CSCE</td>
<td>$10,000</td>
<td>2014-2015</td>
<td>The Colorado River Re-Storied (documentary video w/ high schools)</td>
</tr>
<tr>
<td>Arleyn Simon/Dan Collins</td>
<td>National Park Service</td>
<td>$12,000</td>
<td>2012</td>
<td>3D Imaging of Prehistoric Rock Art and Historic Inscriptions</td>
</tr>
<tr>
<td>Dan Collins</td>
<td>School of Art/ASU</td>
<td>$400</td>
<td>2012 - 2013</td>
<td>Atlas of the Rio Salado (participatory online map)</td>
</tr>
<tr>
<td>Dan Collins</td>
<td>IHR / ASU</td>
<td>$12,000</td>
<td>2012 - 2013</td>
<td>Restoring and Re-storying the Hidden Cultural Landscape of the Colorado River Basin</td>
</tr>
<tr>
<td>Dan Collins</td>
<td>ASU/HIDA</td>
<td>$5000</td>
<td>2012 - 2013</td>
<td>Multi-spectral 3D Body Scanner</td>
</tr>
<tr>
<td>Monica Elser (Co-I)</td>
<td>NSF</td>
<td>___</td>
<td>2013 - present</td>
<td>Sustainability Science for Sustainable Schools.</td>
</tr>
<tr>
<td>Hilairy Hartnett</td>
<td>NSF</td>
<td>___</td>
<td>2009 - 2014</td>
<td>NSF CAREER award to study carbon cycling in the Colorado River System</td>
</tr>
<tr>
<td>Helen Rowe et al.</td>
<td>USDA NIFA</td>
<td>$500,000</td>
<td>2013</td>
<td>Enhancing Ecosystem Services from Agricultural Lands: Management Quantification, and Developing Decision Support Tools</td>
</tr>
<tr>
<td>Helen Rowe et al.</td>
<td>NSF</td>
<td>$750,000</td>
<td>2013</td>
<td>RCN-SEES: Coordinating Phosphorous Research to Create a Sustainable Food System</td>
</tr>
</tbody>
</table>

Results of Prior Federally funded Research

**Monica Elser:**
Co-I Elser is currently Co-I on the NSF funded GK-12 program (0841374), *Sustainability Science for Sustainable Schools*. This project’s focus is working with graduate students to implement sustainability projects at area high schools. Elser was co-PI on an NSF ITEST grant (0737616) from 2007-2011 entitled *Learning through Engineering Design and Practice*, an afterschool program targeting women and minority middle school students. Elser is a senior scientist with CAP LTER (0423704, 971433). She manages outreach program (Ecology Explorers). Projects above have been reported in peer-reviewed journals. She is senior scientist on NSF grant 0816168, *Understanding Vulnerability to Climate Change*. Elser led development of a UHI module and assisted in developing a magazine targeted at middle and high schools students.

**Hilairy Hartnett:**
EAR-0846188 *CAREER: Transformation and transport of organic carbon in the Colorado river-reservoir system;* 09/09-10/14; $573,548. PI: H. Hartnett. This project investigates terrestrial and aquatic organic carbon cycling and focuses on processes that degrade organic carbon and examines effects of biogeochemical processes and metabolic processes. Intellectual Merit: Results: a *Field Geochemistry* course at ASU; development of a carbon budget for the CR.; exploration of the role of landscape-scale effects on dissolved organic carbon composition and reactivity; and biomarker analyses to assess contributions from terrestrial and aquatic sources of organic matter. Broader Impacts: Field research for 8 undergraduates, 3 students presented at the 2013 ASLO Aquatic. 3 grads trained, 12 abstracts presented, 3 papers submitted, 4 manuscripts in prep.

OISE-0968421 *PIRE: Toward a holistic and global understanding of hot spring ecosystems: A US-China based international collaboration;* 08/10-07/15; $397,785. PI: Hedlund (UNLV), Co-I’s: Hartnett, et al. Scientists from the US and China develop a new model for the geochemistry and geobiology of terrestrial hydrothermal
ecosystems. The project has a fully integrated educational component. Intellectual Merit: trips to Yunnan Province, P.R.C. obtained co-located, contemporaneous geochemistry and geobiology samples from 27 hot springs. Rate measurements and enrichments reveal similarities and differences relative to US hot springs. Chemical analyses and DNA sequences interpreted. 4-week field experiment to determine rates of carbon and nitrogen processing and characterize organic matter reactivity in hot springs. Broader Impacts: 2 REU programs supporting more than eight undergraduates to work in Chinese research labs are complete. Hartnett results: 1 PhD student and 2 undergraduates trained, 1 AGU session convened on terrestrial geothermal systems, 6 presentations, 3 papers published, 3 papers in prep.
(d) Partners, consultants, and sub-awardees

5(d)1. Map showing extent of Colorado River Basin and participating institutions

**Fig. 2. Map of the Colorado River Basin showing participating institutions**
### 5(d) List of sub-awardee “living classrooms,” locations, schools, teachers, and demographics

#### Table 6. Living classrooms: location, schools, teachers, demographics

<table>
<thead>
<tr>
<th>Institution</th>
<th>Living classroom</th>
<th>Administrators &amp; Teachers</th>
<th>Demographics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinedale High School</td>
<td><strong>Green River, WY</strong> Headwaters of the Green &amp; Colorado River</td>
<td>Ben Smith, Principal Deb Noble, Science Teacher</td>
<td>~60 students, mid. Class (80% Cauc., 10% Latino)</td>
</tr>
<tr>
<td>Glenwood Springs, CO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yampah High School</td>
<td><strong>Colorado River, CO</strong> Colorado River @ Glenwood Springs</td>
<td>Leigh McGowan, Principal Susy Ellison, Science Teacher</td>
<td>~20 students 40% Latino</td>
</tr>
<tr>
<td>Telluride, CO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dolores High School</td>
<td><strong>Delores River, Bedrock CO</strong> (tributary of the Colorado River)</td>
<td>Mike Epright, Principal Christine Harty, Science Teacher</td>
<td>~60 students, Working class, (55% Free/Reduced lunch)</td>
</tr>
<tr>
<td>Dolores, CO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Junction HS</td>
<td><strong>Colorado River, CO</strong> Colorado River at Grand Junction, CO</td>
<td>William Larsen, Principal Kristen McClellen, Science Teacher</td>
<td>~60 students, Working class, (89% Cauc., 11% Latino &amp; Nat. Am.)</td>
</tr>
<tr>
<td>Grand Junction, CO</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Grand County HS</td>
<td><strong>Colorado River, UT</strong> Colorado River at Moab, UT</td>
<td>Stephen Hren, Principal Laura Reed, Science Teacher Mary Walker-Irvin, Science Teacher</td>
<td>~30 Students Working class (5% Latino; 5% Nat. Am.)</td>
</tr>
<tr>
<td>Moab, UT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Page Middle School</td>
<td><strong>Colorado River, AZ</strong> Colorado River at the Glen Canyon Dam</td>
<td>Jodi Garduno, Science teacher <a href="mailto:jgarduno@pageud.k12.az.us">jgarduno@pageud.k12.az.us</a></td>
<td></td>
</tr>
<tr>
<td>Page, AZ</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Diné College</td>
<td><strong>San Juan River</strong> (tributary of Colo. R. near Chinle, AZ)</td>
<td>Henry Fowler, Professor Corvina Etsitty, Science Teacher</td>
<td>Nat. Am. community group (99% + Nat.)</td>
</tr>
<tr>
<td>Tsaile, AZ</td>
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<tr>
<td>Boulder City High School</td>
<td><strong>Lake Mead</strong> (Colorado River above Boulder City, NV)</td>
<td>Daphne Brownson, Asst. Prin., Boulder City HS, NV Chris Bires, Science Teacher</td>
<td>~60 stud., Mid. class (81% Cauc.,11% Lat., 7.5% other)</td>
</tr>
<tr>
<td>Boulder City, NV</td>
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<tr>
<td>Lake Havasu City High School</td>
<td><strong>Lake Havasu</strong>, Arizona (main stem Colo.River)</td>
<td>Scott Becker, Principal Paul Haberstroh, Mohave CC <a href="mailto:phaberstroh@mohave.edu">phaberstroh@mohave.edu</a> Alisha Porosky, LHHS <a href="mailto:Aporosky@havasu.k12.az.us">Aporosky@havasu.k12.az.us</a></td>
<td>~60 stud., Mid. class (81% Cauc.,11% Lat. 7.5%)</td>
</tr>
<tr>
<td>Mohave Community College</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lake Havasu City, AZ</td>
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</table>
Kofa High School  
Yuma, AZ

<table>
<thead>
<tr>
<th><strong>Colorado River</strong> at Yuma, Arizona</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Sharp, Principal</td>
</tr>
<tr>
<td>Thomas Thomas, Env. Science</td>
</tr>
<tr>
<td>Jason Flora, Env. Science</td>
</tr>
<tr>
<td>Francisco Flores, Videographer</td>
</tr>
<tr>
<td>480-261-6577</td>
</tr>
</tbody>
</table>

| ~20, Title I, Working class (81% Latino) |

5(d)3. *Letters of commitment*

*Attached.*
References


Students participating in the ASU Ecology Explorers program coordinated by M. Elser

Students use digital probes to measure pH and temperature in the field.