MONTANA NSF EPSCoR
NEWSLETTER
SPRING
2019

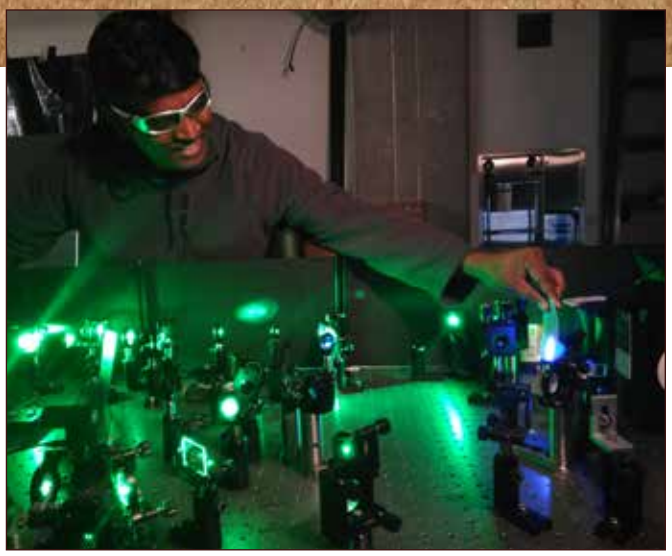
MONTANA AWARDED $20 MILLION FROM NATIONAL SCIENCE FOUNDATION

Clean water is a fundamental resource for people and industries across Montana's working landscapes. The National Science Foundation's EPSCoR program (see page 2) has funded a new $20 million research and education project on water quality in Montana.

"Researchers get resources and opportunities to build new partnerships for research on water quality. Montanans get science and education that supports communities and key industries," says Associate Project Director Todd Kipfer.

The project tackles a deeper understanding of natural water systems and water quality related to three important industries in the Montana economy: mining, agriculture, and energy. Project Director Ragan Callaway emphasizes, "we want to be useful to the communities and industries that we value and that depend on clean water."

"Water is an invaluable resource for Montana that must be managed wisely so that the needs of commercial activities, public recreation, and environmental preservation can be accommodated," says Robert Walker, a chemist working on the project. "Very few elements of Montana's landscape are more critical for the state's long term economic and environmental health than the state's rivers and watersheds."



TOP: Researchers collecting well water data in the Judith River Watershed. Photo by Stephanie Ewing.
ABOVE: Post-doctoral researcher Shelton Jesuraj Varapragasam performing spectroscopy on nitrate photocatalysis derivatives. Photo by Erik Grumstrup.

The Consortium for Research on Environmental Water Systems, or "CREWS," is a five-year project that explores how changing compositions and levels of nutrients and contaminants affect water quality – from soils and rivers to the local communities that rely clean water. Project researchers will focus on three

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WHAT IS EPSCOR?

ABOUT NSF EPSCOR

The National Science Foundation's Established Program to Stimulate Competitive Research (EPSCoR) enhances the research competitiveness of targeted jurisdictions (state, territory, commonwealth) by strengthening Science, Technology, Engineering, and Math (STEM) capacity and capability. RII Track-1 awards improve the research competitiveness of jurisdictions by improving their academic research infrastructure in areas of science and engineering supported by the NSF and critical to the particular jurisdiction's science and technology initiative or plan. Montana's EPSCoR governing committee is the Montana Science & Technology Committee within the Office of the Commissioner of Higher Education. The CREWS project's leadership and topic were selected by this committee through a statewide competitive process and alignment with the Montana Science & Technology Plan.

NSF EPSCoR provides additional funding opportunities through Track-2 FEC awards that build partnerships across jurisdictions and Track-4 awards that provide opportunities for non-tenured research faculty to work with leading research institutions across the country. NSF EPSCoR also provides co-funding to support proposals to other NSF divisions from EPSCoR jurisdictions. NSF EPSCoR has been a quiet but powerful partner in growing Montana's Research and Development enterprise since 1979.

Montana NSF EPSCoR

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Project Director

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MONTANA AWARDED $20M FROM NSF EPSCOR

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landscapes where water systems and economic activity are inextricably linked: the Upper Clark Fork River, the Judith River Watershed, and the Powder River Basin.

The CREWS project will connect science to people across the state. Outreach and partnership programs will increase science and technology fluency for rural K-12 learners and support Native American students in scientific and technological pursuits. The project will create new opportunities for workforce development, innovation, and entrepreneurship through partnerships with private businesses.

"We are eager to find solutions to water quality issues that balance Montana's need for clean water with the natural resource uses that are so crucial to the state's economy," says Callaway.

The core project team is at the University of Montana, Montana State University, Montana Technological University, Salish Kootenai College, and Little Big Horn College. Through competitive investments, the project will provide opportunities to new groups of students and researchers at other universities, private colleges, and Tribal Colleges in Montana.

Stay informed through the Montana NSF EPSCoR website (https://www.mtnsfepscor.org), project newsletters, and Montana NSF EPSCoR annual meetings.

An undergraduate student researcher uses an electrical conductivity probe to measure water quality on the Upper Clark Fork River. Photo by Robert Payn.

Water sampling on the Upper Clark Fork River. Photo by Robert Payn.

MEET THE CREWS PROJECT TEAM

The CREWS RII Track-1 project brings together a unique and diverse team of scientists and educators from five of Montana's universities and colleges. Scientists with backgrounds in systems ecology, earth sciences, chemistry, social science, molecular and materials engineering and sensor development are teaming up so that Montana can respond to water quality challenges associated with balancing economic uses of water with the need for clean water.

These challenges cannot be addressed from the perspective of a single discipline or without working in partnership with the people and industries involved.

"Our team is excited about cross-fertilization among participants and partners, including joint training of students and collaborative projects," says systems ecologist Maury Valett. "The interface among these diverse disciplines and perspectives provides exciting opportunities for discovery."

The project team is administratively led by Project Director and Principal Investigator Ragan Callaway at the University of Montana (UM) and Associate Project Director Todd Kipfer at Montana State University (MSU). Research co-Leads are Robert Walker (MSU) and Maury Valett (UM). The full project team is listed below, with participants from UM, MSU, Montana Technological University (MTech), Little Big Horn College (LBHC), and Salish Kootenai College (SKC).

RESEARCH TEAM

Maury Valett, co-PI, UM, Division of Biological Sciences & Institute on Ecosystems
Robert Walker, co-PI, MSU, Dept of Chemistry and Biochemistry & Graduate Program in Materials Science
Jerry Downey, co-PI, MTech, Dept of Metallurgical & Materials Engineering
Stephanie Ewing, co-PI, MSU, Dept of Land Resources and Environmental Sciences
Antony Berthelote, SKC, Dept of Hydrology
Ben Colman, UM, College of Forestry and Conservation
Wyatt Cross, MSU, Department of Ecology & Montana Water Center
Michael DeGrandpre, UM, Dept of Chemistry and Biochemistry
John Doyle, LBHC, Crow Water Quality Project
Margaret Eggers, MSU, Center for Biofilm Engineering
Erik Grumstrup, MSU, Dept of Chemistry and Biochemistry
Julia Haggerty, MSU, Dept of Earth Sciences & Institute on Ecosystems
Bob Hall, UM, Division of Biological Sciences & Flathead Lake Biological Station
Janene Lichtenberg, SKC, Dept of Wildlife and Fisheries
Liddi Meredith, MTech, Montana Bureau of Mines and Geology
Elizabeth Metcalf, UM, College of Forestry and Conservation
Robert Payn, MSU, Dept of Land Resources and Environmental Sciences & Institute on Ecosystems
Joe Shaw, MSU, Dept of Electrical and Computer Engineering & Optical Technology Center
Jack Skinner, MTech, Dept of Mechanical Engineering
Katherine Zodrow, MTech, Dept of Environmental Engineering

EXTERNAL ENGAGEMENT & PARTNERSHIPS

Jakki Mohr, UM, College of Business
Suzi Taylor, MSU, Academic Technology and Outreach
Aaron Thomas, UM, Dept of Chemistry and Biochemistry & Indigenous Research and STEM Education
Holly Truitt, UM, Broader Impacts Group

MONTANA NSF EPSCOR OFFICE

Ragan Callaway, Project Director/Principal Investigator, UM
Todd Kipfer, Associate Project Director, MSU
Chelle Terwilliger, Project Administrator, UM
Rhonda Stoddard, Fiscal Administrator, UM
Susie Couch, Fiscal Administrator, MSU
Andrew Hauer, Technical Coordinator, UM

INITIAL PROJECT PARTNERS

Clark Fork Coalition
Missoula Department of Public Works
Montana Bureau of Mines and Geology
Montana Department of Environmental Quality
Montana Fish, Wildlife, & Parks
Montana Natural Resource Damage Program
Resonon, Inc.
Sunburst Sensors, Inc.
Water & Environmental Technologies, Inc.

THE UPPER CLARK FORK RIVER AND A LEGACY OF MINING

Called the "The Richest Hill on Earth," Butte's mining activities provided copper to the country for a century. These mines created jobs and made Montana a national economic force. However, extensive mining and smelting operations in the headwaters of the Upper Clark Fork River left a legacy of poor water quality. In 1908, a massive flood contaminated the waterway with millions of tons of mine tailings laden with toxic heavy metals and arsenic originating from historic mining activities in the river's headwaters.

Today the Upper Clark Fork River is part of the largest EPA Superfund site in the U.S. and one of the focus landscapes of the CREWS project. A once ecologically vibrant stream providing fishing, wildlife habitat, and water for agriculture and growing communities is in need of cleanup and repair. The water contains heavy metals, and the problems these cause are compounded by nutrient enrichment from municipal and agricultural development interacting with naturally high phosphorus availability. The result? Striking geographic gradients in pollutants, changed ecological conditions, and complex social responses. Following decades of litigation, restoration efforts are now underway, including removal of contaminants and restoration of the river's floodplain.

Researchers Cory Beatty and Laura Jungst deploy a SAMI sensor in the Clark Fork River near Missoula. Photo by Mike DeGrandpre.

Building on previous research projects developed at the University of Montana, the CREWS research team will quantify and monitor river sediment metals (copper, arsenic, zinc, cadmium, and lead) and nutrients along 200 km of the river. CREWS will also study river productivity, algal blooms, ecological integrity, and develop science needed for technical solutions that address the character of contaminants and the social and ecological systems that depend on the Upper Clark Fork River. Social science researchers will study how water quality issues and solutions are influenced by the people who live and work along the Upper Clark Fork River.

THE JUDITH RIVER WATERSHED AND AGRICULTURE

A tributary of the Missouri River, the Judith River runs through central Montana with its headwaters in the Little Belt, Highwood, and Big Snowy Mountains. The river's watershed is a productive agricultural region dominated by livestock, small grains, and forage production.

Due to exceptionally shallow unconfined aquifers and gravelly soils, agricultural activities in the Judith River Watershed over the last century have gradually resulted in high levels of nitrate and low levels of herbicides in ground water, challenging farming communities to find workable solutions that address both water quality and soil health concerns while also sustaining local livelihoods.

Aerial view of a farm near Stanford. Photo by Kestrel Aerial Services.

Researchers within the Montana State University Department of Land Resources and Environmental Sciences, Montana Agricultural Experiment Station, and Extension Service have worked extensively with local producers and stakeholders to complete initial research on water chemistry and quality in the Judith River Watershed. The CREWS project will build upon these efforts with new scientific partnerships to determine key controls on movement of nitrate and residual herbicide through soils, groundwater and streams. We will work with community partners to evaluate and communicate the results of our studies.

CREWS researchers will investigate these systems at scales ranging from molecular science to studies of landscapes in order to understand drivers of nitrate and herbicide levels in groundwater. These efforts will lead to new technologies for removing nitrate and other contaminants from water systems.

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POWDER RIVER BASIN AND COAL MINING

The Powder River Basin is a geological region in southeast Montana and northeast Wyoming that includes the Powder River, Tongue River, and Rosebud Creek and is one of the world's largest deposits of low-sulfur coal. The area provides more than 40% of the nation's coal and is a major economic engine in Montana. The Powder River Basin is broadly representative of landscapes influenced by energy extraction associated with open-air coal mining. Open pit mining development in the Powder River Basin overlays extensive rangeland that needs high quality water to be productive.

Aquifer disruption and spoil heap processing from coal mining can create groundwater conditions that are of concern to both the mining and agricultural communities. An important area for interdisciplinary research that can benefit the state is the interaction between mining and reclamation activities and sulfate concentrations in both surface- and groundwater.

The Powder River Basin research will ramp up over the five-year project period. The CREWS research team will focus on understanding the impacts of coal mining on ground and surface water exchange and surface water quality. The goal of this project is to understand the formation, transport, and transformation of sulfate compounds mobilized in coal-spoils aquifers.

Students in an Energy Resource Geography course participate in a guided tour of the coal extraction process at the West Rosebud Mine. Photo by Julia Haggerty.

SOCIAL FACTORS AND WATER QUALITY

Water quality issues present an environmental problem with complex social factors. The capstone element for the CREWS project will be to study the communities that have been impacted by adverse water quality at each of the study sites.

"Our team is focused on community resilience – how communities bounce forward after acute or chronic stressors like water quality issues," says Elizabeth Metcalf, social science researcher. "We will get to work with rural communities and learn about the things they want to be resilient, the things that they need to be resilient, and how they evolve as a result of water quality challenges. My hope is that the work we do will make big differences for communities across the state."

A Montana landowner hosts faculty and graduate students at a restoration project. Photo by Julia Haggerty.

CREWS social scientists will study how factors such as social trust and governance processes affect community resilience. Across all the project research sites, CREWS researchers will gather information through focus groups and interviews with key community members representing diverse stakeholder groups: industry, state government, federal government, tribal representatives, citizens, and representatives of non-profit organizations. Findings will provide insight into the complex relationships between communities and their environment and inform decision makers from the community level to state agencies.

SCIENCE AND TECHNOLOGY FOR ALL MONTANANS

Native Americans are the largest minority group in Montana at ~6.5% of the population, spanning ten federally recognized tribes and seven reservations across the state. Despite their important role in Montana's economy, culture and social fabric, Native Americans are underrepresented in science, technology, engineering and math (STEM) fields. The CREWS project presents an opportunity for collaboration between researchers at state institutions and researchers at Tribal Colleges to explore water quality issues affecting all Montanans. Salish Kootenai College and Little Big Horn College are two Tribal Colleges involved in the project's primary research activities and core research team. This provides Native American students with research experiences, supports tribal colleges and their surrounding communities, and builds relationships between Tribal Colleges and state institutions.

Little Big Horn College (LBHC) is a two-year college on the Crow Indian Reservation that will play an integral role in the research activities in the Powder River Basin. Led by John Doyle, LBHC researchers and students will conduct surface water and well water sampling to better understand and identify the source and prevalence of arsenic-sulfate compounds on the Crow Reservation. As part of these activities, LBHC researchers will build awareness in the Tribal community around water quality and contamination and its impact on domestic and community quality of life.

Students and CREWS researcher Stephanie Ewing at a spring in Chief Plenty Coups State Park. Photo by John Doyle.

Salish Kootenai College (SKC) is a four-year college with a main campus on the Flathead Indian Reservation. Researchers Janene Lichtenberg and Antony Berthelote will examine the effectiveness of water-related education and outreach activities that are implemented on the Flathead Indian Reservation. Their findings will contribute to the Natural Resource Social Science work for the CREWS project and inform future outreach and education work on the Flathead undertaken by the Confederated Salish Kootenai Tribes and SKC.

The CREWS project will involve Native American researchers and students through other avenues, such as seed funding opportunities for researchers and students at other Montana Tribal Colleges. CREWS will support Native American graduate students pursuing STEM degrees, as well as programs providing STEM opportunities to Native American undergraduate and high school students. Partners for these programs include UM's Indigenous Research and STEM Education (IRSE) and MSU's American Indian Research Opportunities (AIRO).

Site of the annual River Honoring, a 2-day outdoor environmental education event coordinated by the Confederated Salish and Kootenai Tribes for over 30 years. The event is geared towards the approximately 1,000 4th and 5th graders attending schools on the Flathead Reservation. Photo by Dennis Lichtenberg.

A developed natural spring on a central Montana ranch. Photo by Julia Haggerty.

BUILDING MONTANA'S WORKFORCE AROUND WATER

CREWS will build Montana's workforce in water-related sciences and other STEM topics. The project will provide education and training opportunities for university students, education professionals, faculty researchers, and working professionals—building Montana's current and future workforce in environmental water quality and related sciences.

The CREWS project will train dozens of graduate and undergraduate students in water-related sciences and engineering. Students and postdocs will be an integral part of the CREWS interdisciplinary research team, taking part in environmental, molecular, and social science research and development focused on water quality. CREWS students will be prepared to enter the workforce through project-related trainings in commercialization, data management, science communication, and collaboration.

CREWS will invest in the professional development of Montana's existing workforce in science, technology, engineering and math (STEM). The CREWS professional development program will transform project research findings into career-focused training opportunities for workers in water quality and related industries, such as engineering, water management, restoration ecology, and forest conservation. CREWS will also respond to K-12 education by developing training for teachers in the ecological, molecular, engineering and social sciences.

CONNECTING YOUNG LEARNERS WITH SCIENCE

A key part of the NSF EPSCoR mission is connecting youth with experiences in science, technology, engineering and math, or "STEM." The CREWS project will focus on STEM outreach and education through the Small Town STEM initiative, putting science in the hands of rural students across the state. Montana has the highest percentage of small rural districts in the U.S., with 75% of the state's schools serving rural communities. Research shows that rural students are less likely to further their education beyond high school, so this investment in young learners is important to Montana NSF EPSCoR and the CREWS project team.

Small Town STEM will reach students in all corners of Montana by creating a network for sharing resources, providing training for rural teachers, and delivering hands-on activities and STEM role models to small town schools. Researchers and educators will work together to translate CREWS research concepts into activities and media that are relevant to and interactive for youth. Students will build sensors, explore water systems, and meet CREWS researchers and students.

CREWS aims to engage as many students as possible by also delivering training and content to educators to reach youth throughout Montana and by building the Montana STEM Exchange. This network will bring together stakeholders from academia, government, industry, and education to share resources and build the STEM pipeline in Montana, especially for rural and Native American populations.

Partners for CREWS outreach and education activities include UM Broader Impacts Group (BIG) and MSU Academic Technology and Outreach (ATO).

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NSF EPSCoR MONTANA

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THE UPPER CLARK FORK RIVER AND A LEGACY OF MINING

Called the "The Richest Hill on Earth," Butte's mining activities provided copper to the country for a century. These mines created jobs and made Montana a national economic force. However, extensive mining and smelting operations in the headwaters of the Upper Clark Fork River left a legacy of poor water quality. In 1908, a massive flood contaminated the waterway with millions of tons of mine tailings laden with toxic heavy metals and arsenic originating from historic mining activities in the river's headwaters.

Today the Upper Clark Fork River is part of the largest EPA Superfund site in the U.S. and one of the focus landscapes of the CREWS project. A once ecologically vibrant stream providing fishing, wildlife habitat, and water for agriculture and growing communities is in need of cleanup and repair. The water contains heavy metals, and the problems these cause are compounded by nutrient enrichment from municipal and agricultural development interacting with naturally high phosphorus availability. The result? Striking geographic gradients in pollutants, changed ecological conditions, and complex social responses. Following decades of litigation, restoration efforts are now underway, including removal of contaminants and restoration of the river's floodplain.

Researchers Cory Beatty and Laura Jungst deploy a SAMI sensor in the Clark Fork River near Missoula. Photo by Mike DeGrandpre.

Building on previous research projects developed at the University of Montana, the CREWS research team will quantify and monitor river sediment metals (copper, arsenic, zinc, cadmium, and lead) and nutrients along 200 km of the river. CREWS will also study river productivity, algal blooms, ecological integrity, and develop science needed for technical solutions that address the character of contaminants and the social and ecological systems that depend on the Upper Clark Fork River. Social science researchers will study how water quality issues and solutions are influenced by the people who live and work along the Upper Clark Fork River.

THE JUDITH RIVER WATERSHED AND AGRICULTURE

A tributary of the Missouri River, the Judith River runs through central Montana with its headwaters in the Little Belt, Highwood, and Big Snowy Mountains. The river's watershed is a productive agricultural region dominated by livestock, small grains, and forage production.

Due to exceptionally shallow unconfined aquifers and gravelly soils, agricultural activities in the Judith River Watershed over the last century have gradually resulted in high levels of nitrate and low levels of herbicides in ground water, challenging farming communities to find workable solutions that address both water quality and soil health concerns while also sustaining local livelihoods.

Aerial view of a farm near Stanford. Photo by Kestrel Aerial Services.

Researchers within the Montana State University Department of Land Resources and Environmental Sciences, Montana Agricultural Experiment Station, and Extension Service have worked extensively with local producers and stakeholders to complete initial research on water chemistry and quality in the Judith River Watershed. The CREWS project will build upon these efforts with new scientific partnerships to determine key controls on movement of nitrate and residual herbicide through soils, groundwater and streams. We will work with community partners to evaluate and communicate the results of our studies.

CREWS researchers will investigate these systems at scales ranging from molecular science to studies of landscapes in order to understand drivers of nitrate and herbicide levels in groundwater. These efforts will lead to new technologies for removing nitrate and other contaminants from water systems.

POWDER RIVER BASIN AND COAL MINING

The Powder River Basin is a geological region in southeast Montana and northeast Wyoming that includes the Powder River, Tongue River, and Rosebud Creek and is one of the world's largest deposits of low-sulfur coal. The area provides more than 40% of the nation's coal and is a major economic engine in Montana. The Powder River Basin is broadly representative of landscapes influenced by energy extraction associated with open-air coal mining. Open pit mining development in the Powder River Basin overlays extensive rangeland that needs high quality water to be productive.

Aquifer disruption and spoil heap processing from coal mining can create groundwater conditions that are of concern to both the mining and agricultural communities. An important area for interdisciplinary research that can benefit the state is the interaction between mining and reclamation activities and sulfate concentrations in both surface- and groundwater.

The Powder River Basin research will ramp up over the five-year project period. The CREWS research team will focus on understanding the impacts of coal mining on ground and surface water exchange and surface water quality. The goal of this project is to understand the formation, transport, and transformation of sulfate compounds mobilized in coal-spoils aquifers.

Students in an Energy Resource Geography course participate in a guided tour of the coal extraction process at the West Rosebud Mine. Photo by Julia Haggerty.

SOCIAL FACTORS AND WATER QUALITY

Water quality issues present an environmental problem with complex social factors. The capstone element for the CREWS project will be to study the communities that have been impacted by adverse water quality at each of the study sites.

"Our team is focused on community resilience – how communities bounce forward after acute or chronic stressors like water quality issues," says Elizabeth Metcalf, social science researcher. "We will get to work with rural communities and learn about the things they want to be resilient, the things that they need to be resilient, and how they evolve as a result of water quality challenges. My hope is that the work we do will make big differences for communities across the state."

A Montana landowner hosts faculty and graduate students at a restoration project. Photo by Julia Haggerty.

CREWS social scientists will study how factors such as social trust and governance processes affect community resilience. Across all the project research sites, CREWS researchers will gather information through focus groups and interviews with key community members representing diverse stakeholder groups: industry, state government, federal government, tribal representatives, citizens, and representatives of non-profit organizations. Findings will provide insight into the complex relationships between communities and their environment and inform decision makers from the community level to state agencies.

SCIENCE AND TECHNOLOGY FOR ALL MONTANANS

Native Americans are the largest minority group in Montana at ~6.5% of the population, spanning ten federally recognized tribes and seven reservations across the state. Despite their important role in Montana's economy, culture and social fabric, Native Americans are underrepresented in science, technology, engineering and math (STEM) fields. The CREWS project presents an opportunity for collaboration between researchers at state institutions and researchers at Tribal Colleges to explore water quality issues affecting all Montanans. Salish Kootenai College and Little Big Horn College are two Tribal Colleges involved in the project's primary research activities and core research team. This provides Native American students with research experiences, supports tribal colleges and their surrounding communities, and builds relationships between Tribal Colleges and state institutions.

Little Big Horn College (LBHC) is a two-year college on the Crow Indian Reservation that will play an integral role in the research activities in the Powder River Basin. Led by John Doyle, LBHC researchers and students will conduct surface water and well water sampling to better understand and identify the source and prevalence of arsenic-sulfate compounds on the Crow Reservation. As part of these activities, LBHC researchers will build awareness in the Tribal community around water quality and contamination and its impact on domestic and community quality of life.

Students and CREWS researcher Stephanie Ewing at a spring in Chief Plenty Coups State Park. Photo by John Doyle.

Salish Kootenai College (SKC) is a four-year college with a main campus on the Flathead Indian Reservation. Researchers Janene Lichtenberg and Antony Berthelote will examine the effectiveness of water-related education and outreach activities that are implemented on the Flathead Indian Reservation. Their findings will contribute to the Natural Resource Social Science work for the CREWS project and inform future outreach and education work on the Flathead undertaken by the Confederated Salish Kootenai Tribes and SKC.

The CREWS project will involve Native American researchers and students through other avenues, such as seed funding opportunities for researchers and students at other Montana Tribal Colleges. CREWS will support Native American graduate students pursuing STEM degrees, as well as programs providing STEM opportunities to Native American undergraduate and high school students. Partners for these programs include UM's Indigenous Research and STEM Education (IRSE) and MSU's American Indian Research Opportunities (AIRO).

Site of the annual River Honoring, a 2-day outdoor environmental education event coordinated by the Confederated Salish and Kootenai Tribes for over 30 years. The event is geared towards the approximately 1,000 4th and 5th graders attending schools on the Flathead Reservation. Photo by Dennis Lichtenberg.

A developed natural spring on a central Montana ranch. Photo by Julia Haggerty.

BUILDING MONTANA'S WORKFORCE AROUND WATER

CREWS will build Montana's workforce in water-related sciences and other STEM topics. The project will provide education and training opportunities for university students, education professionals, faculty researchers, and working professionals—building Montana's current and future workforce in environmental water quality and related sciences.

The CREWS project will train dozens of graduate and undergraduate students in water-related sciences and engineering. Students and postdocs will be an integral part of the CREWS interdisciplinary research team, taking part in environmental, molecular, and social science research and development focused on water quality. CREWS students will be prepared to enter the workforce through project-related trainings in commercialization, data management, science communication, and collaboration.

CREWS will invest in the professional development of Montana's existing workforce in science, technology, engineering and math (STEM). The CREWS professional development program will transform project research findings into career-focused training opportunities for workers in water quality and related industries, such as engineering, water management, restoration ecology, and forest conservation. CREWS will also respond to K-12 education by developing training for teachers in the ecological, molecular, engineering and social sciences.

CONNECTING YOUNG LEARNERS WITH SCIENCE

A key part of the NSF EPSCoR mission is connecting youth with experiences in science, technology, engineering and math, or "STEM." The CREWS project will focus on STEM outreach and education through the Small Town STEM initiative, putting science in the hands of rural students across the state. Montana has the highest percentage of small rural districts in the U.S., with 75% of the state's schools serving rural communities. Research shows that rural students are less likely to further their education beyond high school, so this investment in young learners is important to Montana NSF EPSCoR and the CREWS project team.

Small Town STEM will reach students in all corners of Montana by creating a network for sharing resources, providing training for rural teachers, and delivering hands-on activities and STEM role models to small town schools. Researchers and educators will work together to translate CREWS research concepts into activities and media that are relevant to and interactive for youth. Students will build sensors, explore water systems, and meet CREWS researchers and students.

CREWS aims to engage as many students as possible by also delivering training and content to educators to reach youth throughout Montana and by building the Montana STEM Exchange. This network will bring together stakeholders from academia, government, industry, and education to share resources and build the STEM pipeline in Montana, especially for rural and Native American populations.

Partners for CREWS outreach and education activities include UM Broader Impacts Group (BIG) and MSU Academic Technology and Outreach (ATO).

A child plays with the Erosion Table exhibit at the spectrUM Discovery Area. Photo by Olga Helmy.

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