REQUEST FOR PROPOSALS

University of Wyoming Office of Water Programs
Water Research Program
FY2027

The Office of Water Programs/Water Research Program (OWP/WRP) welcomes proposals covering topics involved in Wyoming's water resources. Each proposal shall include a brief non-technical summary of relevance that describes in layman's terms:

- how the proposal will address the research and management needs of State and Federal agencies concerning Wyoming's water resources, while ensuring that it does not duplicate previous OWP/WRP research;
- how the proposal will support water-related training and education;
- and specifically, how technology transfer will occur.

Each research topic includes potential agency partners. Principal Investigators are strongly encouraged to consult with the Office of Water Programs and these partners before submitting proposals. Letters of support from local, state and federal agencies are encouraged.

Proposals will be evaluated on the following:

- Benefits
- Likelihood of success
- Scientific merit
    - Ability to expand upon previously funded OWP/WRP projects
    - Ability to develop new techniques that may further future research
- Coordination with potential agency partners and incorporation of their feedback
- Methods
- Timeline
- Overall presentation

Research Topic A: Investigating the Hydrologic and Physical Effects of Water Shortage and Conservation Activities

Extended drought conditions across the West, and particularly the Southwest, have had major effects on water supplies or water management across the state. In addition to in-state impacts, these extended drought conditions can impact Wyoming in river basins that have interstate legal obligations through compacts and decrees. Some of the following research topics can be applied to many areas of the state whereas others may be more applicable to single river basins.

- In Wyoming's Colorado River basin, which includes the Green and Little Snake River basins, valuable research would entail the quantification of reduced depletions (i.e., conserved consumptive use) resulting from voluntary, compensated, and temporary irrigation reduction to a field. This may include practices of partial season fallowing, deficit irrigation and/or crop switching. Research should take into account the beneficial and detrimental effects on fields, both same year and post-season, that may include on-field health related to invasive species and the ecological impacts, quantity, and timing of return flows to the streams, as well as effects on other water rights and water uses.
- Current remote sensing evapotranspiration models have been fairly successful at estimating values in open agricultural fields. However, the models are not as confident in areas of

mixed vegetation (e.g., willows and grass). Research into evapotranspiration of these areas would be beneficial. This research should take into account different climate conditions as well as different hydrologic settings (e.g. bottomlands vs benchlands).

Potential Agency Partners: Wyoming State Engineer's Office, Wyoming Water Development Office

Research Topic B: Enhanced Streamflow Estimation for Ungaged Streams

Long-term streamflow prediction provides essential information for water resources planning and management, interstate discussions, and engineering and design purposes. Stream gages provide valuable information that facilitates responsible management of water resources. Long-term (20+ years) stream gages cannot be installed at every location where streamflow information is needed, however. Estimating streamflow statistics, such as monthly means and exceedance flows, in ungaged basins is a fundamental challenge. The USGS StreamStats Application for Wyoming basins is a tool that can be used for estimating streamflow statistics. However, concurrent discharge methods that incorporate short-term (1-2 years) stream gages are used to improve accuracy of streamflow estimations for basins without long-term gages. Those methods should be updated with new information and analytical approaches, or replaced through application of new technologies. Improved or new tools will aid in watershed planning, water management planning, and hydrologic feasibility studies.

Areas of research include:

- Innovation of new approaches to complement or replace existing methods of streamflow estimation for streams without long-term streamflow gages. Emphasis should be placed on:
    - Improving or developing partial-year concurrent discharge approaches for estimating year-round mean monthly flows and exceedance flow statistics in small basins without long-term gaging stations. New approaches could include spatial analysis tools to incorporate land cover and more precise slope and aspect characterization. Ideally, approaches will include statistical tools, such as confidence intervals, to characterize inherent uncertainty of such streamflow estimates.
    - Developing new or improving weighted averaging approaches for combining regional regression methods and partial-year concurrent discharge measurements for estimating year-round mean monthly flows and exceedance.
    - Use of geospatial models and statistical analyses to better understand the important drivers of streamflow (including drivers that determine whether a stream is intermittent or perennial in a given basin) in small stream basins (<50 square miles).

Potential Agency Partners: Wyoming State Engineer's Office, Wyoming Association of Conservation Districts, Wyoming Game and Fish Department, Wyoming Water Development Office, Wyoming Department of Environmental Quality - Water Quality Division, Wyoming Department of Agriculture, United States Geological Survey

Research Topic C: Protecting Public Health

Wyoming citizens and out-of-state visitors enjoy fishing, boating, swimming, floating and other recreational opportunities provided by Wyoming's lakes, reservoirs, rivers and streams. However, water-based recreational activities may pose a human health risk if individuals are exposed to elevated levels of pollutants in water. In addition, pollutants in surface water and groundwater used for drinking water can pose a risk to human health.

● **Waterborne pathogens** (as typically measured by the fecal coliform bacterium-*E. coli*) are a common surface water quality impairment in Wyoming. Research addressing pathogens is of significant importance to the State of Wyoming. Additional tools are needed to better allow state and local water managers, regulators, conservation groups and others to ascertain and minimize public health risk by 1) better understanding fecal coliform-indicator bacteria such as E. *coli* and their relationship to other pathogens (e.g., cryptosporidium, giardia, Cyclospora) and 2) identifying effective management measures to reduce pathogens and mitigate public health risk. In particular, the following topics are identified as priority research areas:

- Relating pathogen levels to incidence of waterborne pathogen exposure and illness specifically in Wyoming streams and rivers.
- Evaluate the effectiveness of novel conservation practices in preventing, reducing or remediating fecal bacteria indicator (e.g., *E. coli*) loading to surface waters.

● **Nutrients** (nitrogen and phosphorus), in appropriate amounts, are essential to healthy aquatic ecosystems. However, excessive nutrients, or nutrient pollution, can lead to harmful cyanobacteria blooms (HCBs) in lakes, reservoirs, streams and rivers. HCBs are dense concentrations of cyanobacteria (i.e., blue-green algae) that pose a risk to human, pet and livestock health. HCBs can produce cyanotoxins and may be associated with other irritants that can cause adverse health effects such as rashes, itching, numbness, nausea, fatigue, disorientation, abdominal pain, vomiting and diarrhea. In extreme cases, cyanotoxins may lead to pet or livestock death. HCBs can also cause fish kills, interfere with drinking water supplies, and may present risks for human consumption of fish. Recreational use health advisories due to HCBs are issued on numerous publicly accessible Wyoming lakes and reservoirs each year. Mat-forming benthic HCBs have recently been identified in certain streams and reservoirs in Wyoming and also pose a health risk to humans, pets, livestock and wildlife. Research on nutrient pollution and HCBs would help state and local entities better identify, assess and respond to HCBs in order to reduce public health risk from exposure to cyanotoxins and related irritants.

Excess nutrient pollution associated with elevated nitrates can also represent a public health risk for surface water and groundwater used for drinking. Elevated nitrates in drinking water can affect the ability of the blood to carry oxygen and can cause methemoglobinemia. Understanding potential sources (e.g., wastewater, fertilizer, animal waste) and transport of nutrients within a watershed can help local, state, and federal agencies protect water quality for drinking water. The following topics are identified as priority research areas:

- Investigate the types and levels of toxins (or other compounds that cause adverse health effects) in cyanobacteria blooms in Wyoming surface waters.
- Assess the health risk, including maximum threshold concentrations, associated with human and animal exposure (e.g., ingestion, dermal contact) to toxic cyanobacteria in lakes and reservoirs including comparison to benthic forms in streams and rivers.
- Evaluate the health risks (both human and animal) of using irrigation water containing HCBs on forage crops.
- Investigate the health risk of toxic benthic cyanobacteria blooms to drinking water sources.
- Assess the spatial and temporal variation of benthic cyanobacteria blooms in streams and rivers and their potential for cyanotoxin production.
- Evaluate the environmental drivers of cryptophyte (e.g., *Rhodomonas*) blooms, their relationship with cyanobacteria, and their usefulness as indicators of harmful cyanobacteria bloom risk across nutrient and climate gradients.

- Investigate the sources of nutrient pollution in areas of the state where elevated nitrates are being detected in groundwater used for drinking water.
- Investigate the efficiency and efficacy of conventional and novel methods to identify nutrient sources for different waters (e.g., lakes, streams, groundwater) and watersheds.
- Investigate the efficiency and efficacy of conventional and novel methods to monitor benthic cyanobacteria blooms in streams and rivers for identification, enumeration, and ascertaining human and animal health risk.
- Evaluate the effectiveness of conservation practices or advanced treatment systems in reducing nutrient loading to surface waters and groundwater.

Research on these topics would build on the findings from past OWP/WRP funded projects on nutrient pollution and HCBs. Past OWP/WRP funded projects have demonstrated that remote sensing is a useful tool for identifying HCBs in lakes and reservoirs, yet in-situ monitoring will continue to be necessary to confirm HCBs and determine cyanobacteria density. Past OWP/WRP projects also suggest that the increased number of HCB advisories reflects an increased awareness (through monitoring) of a long-term issue rather than the result of increased nutrient pollution over time.

Potential Agency Partners: Wyoming Department of Environmental Quality - Water Quality Division, Wyoming Association of Conservation Districts, United States Geological Survey

Research Topic D: Mine Drainage Analysis and Characterization

Mine drainage and runoff from historic and active mine features may contain unsafe levels of heavy metals and other environmental pollutants. These pollutant sources may create local environmental impacts, and pose risks to both human health and aquatic life through contamination of groundwater and surface waters. Additional research is needed to understand the impact of historic, active and proposed mining features in Wyoming on potential pollution in local watersheds. Areas of research include, but are not limited to:

- How is water contamination affected by the deposit type (i.e., how does the specific geochemistry of the targeted resource and host geology impact water chemistry)? Does the type (in-situ or other) and age of mine impact water quality?
- Identifying cost-effective best management practices (BMPs) for reducing or remediating mine drainage into local watersheds, whether any features in Wyoming should be subject to such measures, and how this may shape policies for future mines and their remediation plans.
- Is there a discernible impact to overall watershed health (other than direct impacts to surface and groundwaters) from mine drainage (e.g., soil acidification, elevated metals in vegetation)?

Potential Agency Partners: Wyoming State Geological Survey, Wyoming Department of Environmental Quality - Water Quality Division

Research Topic E: Dam and Reservoir Operation

- **Sediment Management and Transport**

The accumulation of sediment in stream systems and behind dams presents challenges. Effective dam operations require the ability to meet water user needs while still protecting downstream uses (e.g., fisheries, recreation, aquatic life). Additional research is needed to help understand how to prevent heavy sediment releases and how to effectively respond when they occur. Areas of research

include, but are not limited to:

- Additional studies describing the fate and transport of sediments in Wyoming's erosive watersheds and what best management practices (BMPs) can assist with reducing sediment inputs.
- Further studies on using "flushing flows" to address downstream sediment deposition following releases.
- Studies on economically feasible ways to remove sediment accumulated behind dams.
- Information on ways to most effectively manage sediment at dams and reservoirs to protect and maintain downstream surface water.

● Large Dam and Reservoir Operations

Significant reservoir drawdowns can cause a range of short and long-term impacts. Impacts may include but are not limited to increased tributary sediment inputs from headcutting; resuspension and deposition of fine sediments that adversely affect water use and spawning habitat; damage or clogging of infrastructure; nutrient release from lakebed sediments causing algal blooms and eutrophication; and disruptions to recreational and other uses. Research can also be focused on non-sediment related issues, such as recreational impacts directly or indirectly related to access to the reservoir due to changes in water levels.

- Further research is needed to better understand these processes and to support effective planning and management strategies that mitigate associated impacts.
- Proposals may also address dam infrastructure issues and dam operation.

Potential Agency Partners: United States Geological Survey, Wyoming Water Development Office, Wyoming Department of Environmental Quality - Water Quality Division, Wyoming Association of Conservation Districts, Wyoming Game and Fish Department, Wyoming State Engineer's Office

Research Topic F: Groundwater Analysis/Aquifer Characterization

Research is needed to address the challenges of characterizing, protecting, and managing aquifers in areas of growing population and other vulnerable areas. In addition, conceptualize and quantify the effects of drought on existing surface water and groundwater resources.

Research regarding geochemical, hydrogeologic, and geophysical measurements to understand aquifer reservoir properties and recharge dynamics from surface sources are needed. Priority is given to:

- Detailed aquifer characterization of Cretaceous aquifers in the southeastern portion of the state, to include the Lance and Fox Hills Formations. Aquifer parameter characterization is needed to investigate the underlying units and evaluate interaction with the overlying Tertiary High Plains Aquifer under pumping stress. Proposals may address these questions by additional data collection, analysis, or modeling, or by a combination thereof.
- Applications of geophysical and field measurements to evaluate groundwater presence and flow gradient within the subsurface at comparatively large scales (e.g., well field to watershed scale). Such applications are needed to identify locations of groundwater occurrence for maximum potential development and improve public data collection.
- Groundwater quality characterization of aquifers with potential for geologic sequestration of carbon dioxide (Class VI wells) to aid in determination of aquifer exemption status.
- Research and analysis in the South Platte River Basin, to include surface/groundwater interactions in Crow and Lodgepole Creeks.

Potential Agency Partners: Wyoming State Engineer's Office, Wyoming State Geological Survey, Wyoming Department of Environmental Quality - Water Quality Division, Wyoming Association of Conservation Districts

Research Topic G: Understanding and Responding to Future Change in Hydrologic Variability

Hydrologic variability is predicted to change as climate variability and climate-related events emerge, such as wildland fire. Climate projections indicate Wyoming will become significantly hotter by 2040-2069 (https://wgfd.wyo.gov/habitat/habitat-resources). Precipitation projections are less certain but it is possible there will be increases in springtime flooding, droughts and intensity of precipitation events. Soil moisture projections are also uncertain but with an increase in climate variability, evapotranspiration is likely to increase as well. Better understanding of future changes in hydrologic variability and assessment of on-the-ground management actions will help the State of Wyoming plan for how best to mitigate and adapt to those changes. Areas of research include:

- Evaluating and/or developing models to best predict watershed-specific frequencies, magnitudes, durations and timing of snowfall, rainfall and runoff affecting baseflows, bankfull flows, flooding and droughts in Wyoming.
- Assessing and prioritizing watersheds by their vulnerability to future hydrologic variability.
    - Identify watersheds most susceptible to increased flooding, droughts and evapotranspiration and to reduced availability of water for agricultural, municipal, industrial, domestic and other beneficial uses. This could include assessment of past, current and projected future categorization of streams as ephemeral, intermittent or perennial.
    - Identify watersheds most likely to experience higher rates of erosion and/or sedimentation due to changes in frequency or magnitude of bankfull and flood flows.
    - Determine which watersheds are most likely to show adverse effects to stream, riparian and wetland habitats and species due to changes in water quantity, hydrologic connectivity and water quality (including water temperature).
    - Assess potential for increased threats of invasive aquatic and riparian species due to changes in water quantity, water quality (including water temperature) and habitat availability and/or condition.
    - Develop remote sensing, GIS and/or other tools to identify, monitor and show stream, riparian, wetland and watershed vulnerability to change in hydrologic variability. Such tools will be most useful if they can be updated as additional information and modeling projections become available.
- Identifying and assessing watershed-specific effects (beneficial and detrimental) of on-the-ground restoration and management actions to mitigate long-term change in hydrologic variability and its effects. For example:
    - Upland, wetland and stream restoration to affect water quality and timing and quantity of water availability.
    - Actions that favor native species over invasive aquatic and riparian species.

Proposals may build upon research needs for specific areas of the state.

Potential Agency Partners: Wyoming State Engineer's Office, Wyoming Association of Conservation Districts, Wyoming State Forestry Division, Wyoming Department of Environmental Quality - Water Quality Division, Wyoming Game and Fish Department