REQUEST FOR PROPOSALS

University of Wyoming Office of Water Programs
Water Research Program
FY2025

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 study results could be used by governmental agencies in the management of Wyoming's water resources;
- how this proposal will meet the research needs of stakeholders regarding Wyoming's water resources, including how this new proposal does not duplicate previous OWP/WRP research;
- how this proposal will support water-related training and education;
- specifically, how technology transfer will occur.

Principal Investigators are encouraged to consult with the Office of Water Programs and state agencies concerning the following topics prior to submitting proposals. Letters of support from local, state and federal agencies are also encouraged to be submitted with proposals.

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
- Methods
- Timeline
- Overall presentation

<u>Investigating the Hydrologic and Physical Effects of Water Shortage and Conservation Activities</u>

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. 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 ecological impacts, quantity, and timing of return flows to the streams, as well as effects on other water rights and water uses.
- Water banking could potentially be a tool for managing drought or mitigating the impacts of drought. The research would include the consideration of historical studies as well as potential

future options and should include both paper banks and physical water banking options. Research would include options that would pertain to a situation that includes intrastate as well as interstate administration and purposes. Focus on Wyoming's Colorado River basin is preferable.

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, recreational activities, particularly those that result in full-body immersion, can pose a risk to public health if individuals are exposed to pollutants in the water that cause adverse health effects. In addition, pollutants in surface water and groundwater used for drinking water can pose a risk to human health.

- **Water borne pathogens** (as typically measured by the fecal bacteria indicator *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-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:
    - Evaluate the ability of fecal bacteria indicators other than *E. coli* (e.g., enterococci, streptococci, coliphage), and their relationships to waterborne pathogens, to accurately assess public health risk from waterborne pathogens.
    - 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 or reducing 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.
- 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 septic 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.

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 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.
- Can mine drainage serve as a resource?

- 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)?

Dam Operation and 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, 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 waters.

Proposals may also address dam infrastructure issues and dam operation.

Groundwater Analysis/Aquifer Characterization

Research is needed to address the challenges of measuring, characterizing, protecting, and managing aquifers in areas of growing population and those identified as vulnerable. In addition, the effects of drought on existing surface water resources and looking to groundwater as a reliable resource.

Research regarding the integration of recognized or novel methods with geochemical, hydrogeologic and geophysical measurements to understand aquifer reservoir properties and recharge dynamics is needed. Priority is given to:

- Detailed aquifer characterization of the deeper aquifers in the southeastern portion of the state, including the Cretaceous Lance Formation and the Cretaceous Fox Hills Sandstone. Aquifer characterization is needed to investigate and define aquifer properties such as grain size distribution, transmissivity, yield, lateral continuity and extent, 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.
- Novel applications of geophysical or other remotely sensed measurements to evaluate groundwater presence and movement within the subsurface at comparatively large scales (e.g., larger than a single well; well field to watershed scale). Such applications are needed to identify locations of groundwater occurrence for potential development, refine methods for groundwater exploration, and improve data collection methods relative to the scale of aquifer heterogeneity.
- 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, including Crow and/or Lodgepole Creeks. The study should include groundwater modeling that works in concert with the existing groundwater model or is an update of the existing groundwater model, with the intention of better understanding the interaction of surface water and groundwater flow of Crow and/or Lodgepole Creeks. It is highly encouraged to work with the Wyoming State

Engineer's Office and local conservation districts.

Understanding and Responding to Future Change in Hydrologic Variability

Hydrologic variability is predicted to change as climate variability changes. 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 (i.e., the Bear, Snake, Tongue and Colorado River Basins).