REQUEST FOR PROPOSALS

University of Wyoming Office of Water Programs
Water Research Program
FY2024

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 State and Federal agencies 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 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

Investigating the Hydrologic and Physical Effects of Water Shortage and Conservation Activities

Extended drought conditions in the Southwest have had major effects on water supplies, especially reservoir levels. In Wyoming's Upper Colorado River basin, which includes the Green and Little Snake River basins, this may result in eventual curtailment of water rights per existing interstate compacts. Due to these conditions, there is a need for information to implement water conservation programs such as the System Conservation Pilot Program and a potential Demand Management Program. Furthermore, related information is necessary for the State Engineer's Office and water users to be prepared for a compact curtailment.

A major component of these actions could include reduced flow to fields and possible transfer of water downstream. Information gathered to date has identified the need for further research and data gathering (communication and coordination with the State Engineer's Office is highly encouraged for any proposals). Research results should have applicability to other basins in

Wyoming. Areas of research include:

- The quantification of reduced depletions (i.e., conserved consumptive use) resulting from reducing irrigation to a field. This may include practices of partial and/or full season fallowing, foregoing the use of free river and surplus water rights (2^{nd} cfs per 70 acres), deficit irrigation and/or crop switching. Research should consider sprinkler and/or basic flood irrigation methods and incorporate the effects of annual precipitation and subirrigation.
- The effects of fallowing on harvest yields. Research should take into account same-year yields of fields that are partial-season fallowed and/or the post-season effects on yields of fields fallowed in the prior season(s).
- The effects, both beneficial and detrimental, on field health related to invasive species due to fallowing. Research should consider partial season and/or full season fallowing time frames as well as flood and/or sprinkler irrigation methods.
- The short- and long-term effects, both beneficial and detrimental, of fallowing fields on stream health, including quality and quantity of flow. Research should consider partial season and/or full season fallowing time frames as well as flood and/or sprinkler irrigation methods.
- Assessment of stream transit losses utilizing existing stream gage data. Research should quantify transit losses as well as identify locations where additional stream gaging infrastructure is recommended for data gaps. Researchers should coordinate with the State Engineer's Office in order to utilize new gage location data.

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 pathogen (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:

- Evaluating the effectiveness of conservation practices or advanced treatment septic systems in reducing nutrient loading to surface waters and groundwater.
- Investigate the types and levels of toxins (or other compounds that cause adverse health effects) in cyanobacteria blooms in Wyoming surface waters.
- Evaluate the risks of exposure to cyanotoxins from human consumption of fish harvested in lakes and reservoirs with toxic cyanobacteria blooms.
- Assess the health risk, including maximum threshold concentrations, associated with human and animal exposure (e.g., ingestion, dermal contact) to toxic cyanobacteria found suspended in lakes and reservoirs compared to benthic forms in streams and rivers.
- Assess the spatial and temporal variation of benthic cyanobacteria blooms in streams and rivers and their potential for cyanotoxin production.
- Evaluate the health risks (both human and animal) of using irrigation water containing HCBs on forage crops.
- 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 (e.g., nutrient isotope analysis) 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.
- Investigate the health risk of toxic benthic cyanobacteria blooms to drinking water sources.

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.

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 measures 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.
- Best management practices (BMPs) for reducing sediment transport from contributing watersheds.

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, drought and its effects on Wyoming via interstate regulations, such as the Colorado River Compact, have required users that rely on surface water to look to groundwater as a backup source in the event of a curtailment of their water rights.

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.

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., Upper Colorado River Basin).

Enhanced Streamflow Estimation and Water Supply Forecasting

The Wyoming Water Strategy identified the need to better understand watershed, atmospheric, and climatic variables and their effects on streamflows and water supply, as well as the need to update, improve and/or develop water supply forecasts in river basins of Wyoming.

Areas of research include:

- Innovation of new approaches to complement or replace existing methods of streamflow estimation and flow forecasting tools that analyze the response of various combinations of climate, water demand and land use on streamflow as well as general watershed hydrology. New and improved tools will aid in watershed planning, water management planning, and feasibility studies. Particular emphasis should be placed on:
    - 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 flow statistics in small basins without long-term gaging stations. Ideally approaches will include statistical tools, such as confidence intervals, to characterize inherent uncertainty of such streamflow estimates.
    - 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).
    - Calibration of forecasting tools in hybrid plains/mountain streams with highly variable climates during low flow years. This could include an evaluation of temperature predictions in relation to water demand factors as well as research aimed at enhancing understanding of transitional zones (i.e., foothills that typically receive intermittent to seasonal snowpack) and lower-elevation (i.e., high plains) contributions to streamflow. Two examples of basins of interest in Wyoming that have large datasets that can contribute to the initiation of research are the Tongue River and Upper North Platte River Basins.