

# Project N: Hydropower Monitoring and Research

## 1. Investigators

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## 2. Project Summary and Purpose

The LTEMP (U.S. Department of the Interior, 2016a) states that the objective of the hydropower and energy resource goal is to, “maintain or increase Glen Canyon Dam (GCD) electric energy generation, load following capability, and ramp rate capability, and minimize emissions and costs to the greatest extent practicable, consistent with improvement and long-term sustainability of downstream resources.” Project N will identify, coordinate, and collaborate with external partners on monitoring and research opportunities associated with operational experiments at GCD designed to meet hydropower and energy resource objectives, as stated in the LTEMP EIS and its ROD (U.S. Department of the interior, 2016a, b), and guided by the memorandum (Guidance Memo) from the Secretary's Designee, dated August 14, 2019 (Petty, 2019).

Operational experiments include proposed experiments in the LTEMP EIS (U.S. Department of Interior, 2016b), and other identified operational scenarios at GCD to improve hydropower and energy resources, while consistent with improvement and long-term sustainability of other downstream resources. Project N will prioritize research associated with operational experiments at GCD designed to meet hydropower and energy resource objectives. Project N will also conduct monitoring and research of proposed experiments in the LTEMP EIS and consider impacts on hydropower and energy as part of the experimental design. Coordinated project implementation and development will occur between Reclamation, Western Area Power Administration (WAPA), and other collaborators to utilize and build on existing hydropower and energy models and data, specifically those from Appendix K in the LTEMP EIS (U.S. Department of Interior, 2016b).

## 3. Hypotheses and Science Questions

Specific hypotheses and science questions to be addressed will be determined in coordination with Reclamation, WAPA, and other collaborators during Project N implementation and development.

## 4. Background

Project N will meet critical socioeconomic information needs identified by the GCDAMP (AMWG, 2012). Furthermore, the implementation of proposed experiments in the LTEMP EIS are, “contingent on the responses of one or more socioeconomic metrics” (VanderKooi and others, 2017). The role of the GCMRC, and its cooperators, is to provide information on physical

and biological resources while also providing information related to socioeconomic aspects of resources, including hydropower (VanderKooi and others, 2017). Project N will focus on monitoring and research opportunities, utilizing past and ongoing research at GCMRC, Reclamation, and WAPA, to provide information related to the hydropower and energy objectives identified in the LTEMP ROD (U.S. Department of the Interior, 2016a) and the Guidance Memo.

## 5. Proposed Work

### 5.1. Project Elements

#### **Project Element N.1. Hydropower Monitoring and Research**

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Project N will identify, coordinate, and collaborate on design, monitoring, and research opportunities associated with all operational experiments at GCD to meet hydropower and energy resource objectives, as stated in the LTEMP ROD (U.S. Department of the Interior, 2016a). Operational experiments include experiments proposed in the LTEMP EIS and operations or experiments that improve hydropower and energy resources (e.g., change in ramp rates, change in daily flow range, fluctuating flow factors, and monthly volume patterns), while consistent with improvement and long-term sustainability of other downstream resources (Petty, 2019). Monitoring and research of hydropower and energy resources will be prioritized, in consultation and coordination with Reclamation, WAPA, and other collaborators, based on the sequence of proposed experiments in the LTEMP EIS (U.S. Department of Interior, 2016b), availability of predictive models to assess downstream resource conditions in response to experiments designed to improve hydropower and energy resources, and/or the magnitude of economic impacts of operational changes at GCD.

#### *Development of GCD operational experiments during WY2021 – 2023*

Investigators will work with GCMRC scientists, as they develop proposals for operational experiments, to incorporate the hydropower resource objective as an integral part of the experiment. For each experiment considered, investigators will coordinate with GCMRC scientists and WAPA technical staff throughout the process.

#### *Macroinvertebrate Flows*

Reclamation has conducted ‘Bug Flows’ during the summer months of 2018-2020. The purpose of this experiment is to identify how operations can improve the abundance, diversity, and stability of aquatic insect populations, thereby increasing aquatic foodbase for native fish, nonnative fish, and terrestrial wildlife in the CRE.

If these flows are judged to be beneficial to macroinvertebrates or successful as an experiment, there may be additional years of experimentation. Biologists and ecologists at GCMRC have worked in partnership with technical staff at WAPA in the design of the bug flows.

This collaboration has proved productive. To further the collaborative partnership, investigators in Project N will become part of this scientific exchange in order to identify hydrographs associated with the Bug Flows experiment that improve hydropower resource objectives, while meeting Bug Flows objectives, consistent with improvement and long-term sustainability of other downstream resources.

### *Trout Management Flow*

As part of the LTEMP EIS (U.S. Department of Interior, 2016b), GCMRC scientists and GCDAMP stakeholders are currently discussing the design and implementation of a trout management flow (TMF) experiment to manage rainbow trout recruitment at Lees Ferry. Investigators in Project N will work with biologists and ecologists at GCMRC, and cooperators, who are developing proposed TMF experiments in order to determine how hydropower objectives can be met and improved through TMF experiments. Project N will focus on experiment-specific hydrograph design to maintain or improve objectives of the hydropower resource goal defined in the LTEMP EIS.

### *High-Flow Experiment*

Investigators in Project N will assist the team of GCMRC sediment scientists in an effort to investigate the design parameters of HFEs (both annual and interannual considerations) to maintain or improve hydropower objectives. Project N will focus on experiment-specific hydrograph designs to maintain or improve objectives of the hydropower resource goal defined in the LTEMP EIS. For example, modeling a change in ramp rates to maintain or improve the hydropower resource objectives is a possible application of Project N.

### *Hydropower Improvement Experiment*

Investigators in Project N will identify experimental hydrographs at GCD that improve the value or production of hydropower, outside of flow experiments specific to biological and physical resources, to better achieve the hydropower and energy resource goal. These experimental hydrographs to improve the value or production of hydropower will be consistent with the improvement and long-term sustainability of downstream resources.

### *Hydropower Metrics*

Hydropower objectives to be considered in the investigation of the design of flow experiments will include, but not limited to, the following:

- Economic value of capacity (\$/MW); and
- Economic value of energy (\$/MWh).

The aforementioned objectives are a function of operational parameters at GCD (max ft<sup>3</sup>/s, min ft<sup>3</sup>/s, change in ft<sup>3</sup>/s per hour or over 24 hours, etc.). These operational parameters and other assumptions are included in the development of optimization models (e.g., GTMax) used to maximize the economic value of hydropower (U.S. Department of Interior, 2016b). Examples of metrics to be reported as part of model output include:

- Electric generating capacity (MW);
- Electric generating energy (MWh);
- Min and max MWh within a week;
- Ramp rate (change in ft<sup>3</sup>/s per hour); and
- Daily flow variation (change in ft<sup>3</sup>/s over 24 hours).

As proposed, focusing on specific hydropower resource objectives (e.g., \$/MW or \$/MWh) facilitates a decision framework that supports the assessment of critical uncertainties and the prioritization of monitoring and research funding (Runge and others, 2015).

## 5.2. Outcomes and Products

Products from this project will be determined in coordination with Reclamation, WAPA, and other collaborators during Project N implementation and development. When applicable, presentations will be given at TWG and AMWG meetings, presentations at scientific meetings, and peer-reviewed scientific journal articles.

## 5.3. Personnel and Collaborations

Coordination will occur between scientists and technical staff from GCMRC and WAPA. In addition, support from other organizations, such as Argonne National Laboratory, may be sought depending on the specific scope of work. In support of coordination between scientists and technical staff from GCMRC and WAPA, all energy and power system models and data (e.g., GTMax, PLEXOS) in the analysis of experimental flows will be made available to investigators. GCMRC will be responsible for licensing fees associated with proprietary software whether coordinated with cooperators or acquired independently. These costs are captured in the Operating Expenses column of the Project N budget.

## 6. References

- Glen Canyon Dam Adaptive Management Work Group (AMWG), 2012, Recommended information needs and program elements for a proposed AMP socioeconomics program as approved by AMWG on February 23, 2012: Phoenix, Ariz., AMWG, 20 p., [https://www.usbr.gov/uc/progact/amp/amwg/2012-02-22-amwg-meeting/Attach\\_07b.pdf](https://www.usbr.gov/uc/progact/amp/amwg/2012-02-22-amwg-meeting/Attach_07b.pdf).
- Petty, T.R., Secretary's Designee, Assistant Secretary for Water and Science, 2019, Glen Canyon Dam Adaptive Management Program guidance—August 14, 2019 memorandum: Washington, D.C., U.S. Department of the Interior, Office of the Secretary, 4 p.
- Runge, M.C., LaGory, K.E., Russell, Kendra, Balsom, J.R., Butler, R.A., Coggins, L.G., Jr., Grantz, K.A., Hayse, John, Hlohowskyj, Ihor, Korman, Josh, May, J.E., O'Rourke, D.J., Poch, L.A., Prairie, J.R., VanKuiken, J.C., Van Lonkhuyzen, R.A., Varyu, D.R., Verhaaren, B.T., Vesekla, T.D., Williams, N.T., Wuthrich, K.K., Yackulic, C.B., Billerbeck, R.P., and Knowles, G.W., 2015, Decision analysis to support development of the Glen Canyon Dam Long-Term Experimental and Management Plan: U.S. Geological Survey Scientific Investigations Report 2015-5176, 64 p., <http://dx.doi.org/10.3133/sir20155176>.
- U.S. Department of Interior, 2016a, Record of Decision for the Glen Canyon Dam Long-Term Experimental and Management Plan final Environmental Impact Statement (LTEMP ROD): Salt Lake City, Utah, U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, National Park Service, Intermountain Region, 22 p. plus appendices, [http://ltempeis.anl.gov/documents/docs/LTEMP\\_ROD.pdf](http://ltempeis.anl.gov/documents/docs/LTEMP_ROD.pdf).
- U.S. Department of Interior, 2016b, Glen Canyon Dam Long-term Experimental and Management Plan final Environmental Impact Statement (LTEMP FEIS): U.S. Department of the Interior, Bureau of Reclamation, Upper Colorado Region, National Park Service, Intermountain Region, online, <http://ltempeis.anl.gov/documents/final-eis/>.
- VanderKooi, S.P., Kennedy, T.A., Topping, D.J., Grams, P.E., Ward, D.L., Fairley, H.C., Bair, L.S., Sankey, J.B., Yackulic, C.B., and Schmidt, J.C., 2017, Scientific monitoring plan in support of the selected alternative of the Glen Canyon Dam Long-Term Experimental and Management Plan: U.S. Geological Survey, Grand Canyon Monitoring and Research Center, U.S. Geological Survey Open-File Report 2017-1006, 18 p., <https://doi.org/10.3133/ofr20171006>.

## 7. Budget

Fiscal Year 2021								
Project N Hydropower Monitoring and Research	Salaries	Travel & Training	Operating Expenses	Logistics Expenses	Cooperative Agreements	To other USGS Centers	Burden	Total
							14.00%	
N.1. Hydropower monitoring and research	\$15,863	\$3,500	\$4,500	\$0	\$0	\$0	\$3,341	\$27,204
<b>Total Project N</b>	<b>\$15,863</b>	<b>\$3,500</b>	<b>\$4,500</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$3,341</b>	<b>\$27,204</b>

Fiscal Year 2022								
Project N Hydropower Monitoring and Research	Salaries	Travel & Training	Operating Expenses	Logistics Expenses	Cooperative Agreements	To other USGS Centers	Burden	Total
							22.00%	
N.1. Hydropower monitoring and research	\$16,180	\$1,500	\$2,500	\$0	\$0	\$0	\$4,440	\$24,620
<b>Total Project N</b>	<b>\$16,180</b>	<b>\$1,500</b>	<b>\$2,500</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$4,440</b>	<b>\$24,620</b>

Fiscal Year 2023								
Project N Hydropower Monitoring and Research	Salaries	Travel & Training	Operating Expenses	Logistics Expenses	Cooperative Agreements	To other USGS Centers	Burden	Total
							28.00%	
N.1. Hydropower monitoring and research	\$16,504	\$1,500	\$2,500	\$0	\$0	\$0	\$5,741	\$26,245
<b>Total Project N</b>	<b>\$16,504</b>	<b>\$1,500</b>	<b>\$2,500</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$5,741</b>	<b>\$26,245</b>