Cornell Cooperative Extension
Ulster County

Cornell Cooperative Extension of Ulster County
REQUEST FOR PROPOSALS

Analysis, Calibration, and Validation of the Cornell Culverts Model for Use in the Ashokan Reservoir Watershed

Cornell Cooperative Extension of Ulster County (CCEUC) is seeking proposals for a multi-phase investigation into the Cornell Culverts Model (CCM, v2.1) for estimating hydrology and culvert hydraulics in the Ashokan Reservoir watershed. Phase I will involve a quantitative comparison of the CCM with other industry standard hydrology and hydraulics methods (e.g., gage analysis, HEC-RAS, etc.) to determine if the current model provides reliable outputs at small road-stream crossing sites. If deemed necessary in Phase I, a second phase will involve performing model recalibration for local conditions and subsequent validation. A third phase will involve development of an interface or protocol to easily compare design alternatives to improve the CCM's utility in the Ashokan basin. The CCM is an ArcGIS-based hydrology and culvert hydraulics model that uses landscape and precipitation data to estimate recurrence interval discharges at road-stream crossing (RSX) sites, total hydraulic capacity of the crossing infrastructure, and the maximum recurrence interval flow accommodated at the site, both under current and future precipitation scenarios.

CCEUC participates in the Ashokan Watershed Stream Management Program (AWSMP), a collaboration between Cornell Cooperative Extension of Ulster County, Ulster County Soil and Water Conservation District (UCSWCD) and the New York City Department of Environmental Protection (NYCDEP). The NYCDEP provides funding to CCEUC to deliver education and research programs in support of stream and floodplain management within the Ashokan watershed.

For more information on the AWSMP, visit: www.ashokanstreams.org

Please submit an electronic proposal and quotation to Leslie Zucker at laz5@cornell.edu by Friday, May 14, 2021, by 5:00pm.

This RFP is posted on our website at: http://ashokanstreams.org/projects-funding/

Contract Requirements:
Before responding to this solicitation, carefully review information on Insurance Requirements, Intellectual Property, and Subcontractor Approval policies, online at:
http://ashokanstreams.org/projects-funding/smip-project-insurance-requirements-2/
http://ashokanstreams.org/projects-funding/copyrights-and-access-to-information/
http://ashokanstreams.org/projects-funding/subcontractor-approval-policy/
For more information on the AWSMP, visit: http://ashokanstreams.org
For more information on the stream management program in the NYC Watershed, visit: https://catskillstreams.org
For more information on Cornell Cooperative Extension of Ulster County, visit: http://ulster.cce.cornell.edu

Project Timeline and Selection Schedule:
The anticipated selection schedule is as follows:

- Submit full proposals by Friday, May 14, 2021
- Applicants will be notified on or around May 28, 2021
- Anticipated start date around June 15, 2021
- Anticipated project completion and final report by December 31, 2021

Background Information:
The Cornell Culverts Model (CCM) was originally created by Becky Marjerison, David Gold, and Todd Walter at Cornell University. Subsequent versions have been developed and maintained by several post-doctoral researchers at the Cornell Water Resources Institute and made publicly available from the Cornell Soil & Water Lab GitHub page. The current model is version 2.1 and can be accessed via the following link:
https://github.com/SoilWaterLab/CulvertModel_2.1

The CCM works with the North Atlantic Aquatic Connectivity Collaborative (NAACC) data structure where the NAACC data outputs serve as the infrastructure input for the model. These data are used to generate hydraulic capacity estimates for RSX structures. Precipitation data from the National Oceanic and Atmospheric Administration and spatial data derived primarily from high-resolution digital elevation models are used to estimate recurrence interval discharges at individual RSX sites. The model then compares the hydraulic capacity to the discharge estimates at individual sites to determine the highest recurrence interval flow the structure can accommodate before being exceeded under both current and future climate change scenarios. Implementing the CCM adds another level of RSX prioritization by integrating a flood hazard metric into the NAACC framework that prioritizes crossings based on how severe a barrier the structure is to upstream aquatic organism migration.

The AWSMP sees significant utility in the CCM, not only as a prioritization tool but as a structure sizing and design tool, particularly at road crossings over small streams where detailed engineering and design is often absent during replacement projects. AWSMP's 2018 assessment of over 600 road-stream crossings in the Ashokan Reservoir watershed determined that approximately 50% of all stream crossings involved first order streams, with a mean drainage area of 0.26 mi^2. Second order streams with a mean drainage area of 1.1 mi^2 comprised another 28% of the public crossing dataset. Thus, over 75% of public RSXs can be considered "small" with drainage areas less than 1.5 mi^2. This dominance of small crossings makes sense when considering that at least 80% of the nation's stream network consists of small, headwater streams (Meyer *et al.* 2007). Due to their ubiquity, the cumulative impact of improper engineering and design of small crossings may be substantial.

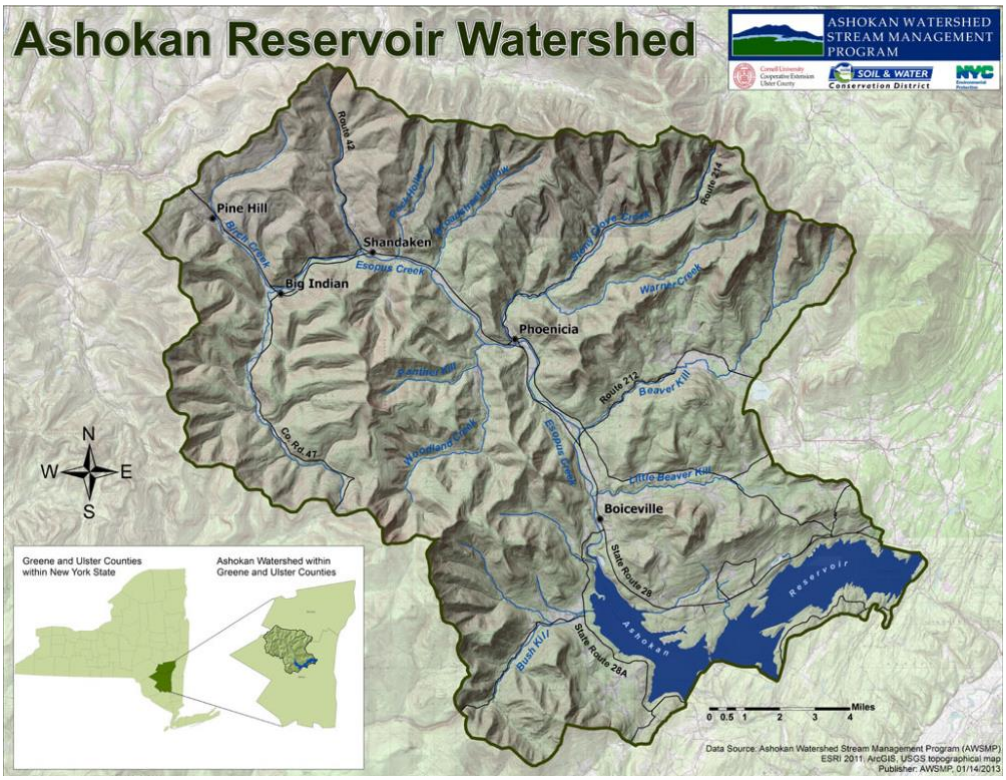
The AWSMP sees the CCM as a relatively easy-to-use tool that can help to prioritize crossing sites, generate site hydrology, and assist in structure design by modeling proposed structure alternatives with differing dimensions and materials. Trust in the hydrology and capacity estimates generated by the CCM would enable watershed highway departments to better manage and replace small RSXs, improve water quality, and enhance aquatic connectivity through more informed design and engineering without the substantial cost increase associated with professional engineering and design services.

However, previous use of the model in the Ashokan Reservoir watershed in 2018 found significant discrepancies between CCM-derived hydrology and hydraulics estimates and those generated by professional engineers using industry standard methods. When CCM outputs were compared to hydrology and hydraulics generated by other methods, including but not limited to local gage analysis, StreamStats, and HEC-RAS, the CCM consistently over-estimated discharges by a significant amount, while under-estimating structure capacity. The doubly conservative results of the model, and the significant degree of these conservative tendencies, has limited the usefulness of the model in the Ashokan watershed.

The AWSMP and CCEUC seek to perform a detailed study to quantify this comparison of the CCM with other well-established methods for developing hydrology and hydraulics at RSXs. A sensitivity analysis of the landscape variables involved in estimating hydrology may determine which variables are most important for developing Ashokan specific hydrology estimates. In addition, the AWMSP and CCEUC seek to investigate whether the CCM can be modified (calibrated and validated) to better estimate the hydrology of the Catskill Mountains. If a version of the CCM is determined to be suitable for use in the Ashokan basin, either version 2.1 or a locally calibrated one, a model extension that can generate side by side comparisons of design alternatives would further enhance the model capabilities for improving small culvert management in the region.

References:
Meyer, JL, LA Kaplan, D Newbold, DL Strayer, CJ Woltemade, JB Zedler, R Beilfuss, Q Carpenter, R Semlitsch, MC Watzin, PH Zedler. 2007. *Where Rivers are Born: The Scientific Imperative for Defending Small Streams and Wetlands.* https://www.americanrivers.org/wp-content/uploads/2016/05/WhereRiversAreBorn_report.pdf

Study Area:
The Ashokan Reservoir watershed is located about 90-miles north of New York City primarily in the Ulster County towns of Shandaken, Olive, Woodstock, and Hurley. The reservoir is supplied primarily by the upper Esopus Creek and Bush Kill watersheds, and a diversion from the Schoharie Creek basin that outlets to the Esopus Creek near Shandaken, NY. The region is mountainous and forested, with tributary streams running through steep narrow valleys often bordered by roads and other development.



Project Goals and Scope of Work:
The AWSMP and CCEUC desire a definitive measure of how suitable the CCM is for use at small RSX sites in the Ashokan Reservoir watershed. If deemed necessary and determined to be possible, a recalibrated and validated version of the model specific to the Ashokan watershed is desired, as is a user interface that allows for design alternatives comparison.

The following work should proceed in three phases. The results of each phase will determine if the subsequent phase proceeds. For that reason, applicants should prepare separate cost-proposals and identify timelines for each phase:

Phase I – Analyze and Validate the CCM

- Acquire needed software and data layers from state clearinghouse databases and/or from CCEUC, Ulster County Soil & Water Conservation District, or New York City Department of Environmental Protection under data-sharing agreements as required.

- Perform an as-is run of the CCM using the same data used by AWSMP in 2018, to assess whether the CCM produces results similar to those developed previously. This step identifies whether an issue exists with the process or within the model. RSX structure data will be provided by the AWSMP.
- Compare CCM results to the hydrology and hydraulics developed by engineers for RSX replacement projects designed and constructed in the Ashokan watershed over recent years. Past projects include hydrology developed using a number of methods deemed acceptable, including but not limited to stream gage analysis, HY-8, HEC-RAS, and HydroCAD. Hydrology and hydraulic estimates from past projects will be provided by the AWSMP.
- Generate new models using multiple currently acceptable methods such as gage analysis, HEC-RAS, and other methods agreed upon at up to 10 (ten) RSX sites selected in consultation with the AWSMP. At these sites, develop both hydrology and hydraulics for current and for multiple proposed scenarios that can be modeled as alternatives in the CCM. It is expected that multiple methods will be used at each of the sites to develop a convergence of data to identify the best available hydrology. The number of sites modeled should be sufficient to cover different watershed sizes, stream types, and valley characteristics in the study area.
- Analyze the as-is CCM in comparison with both the historic and newly developed hydrology and hydraulics models to develop a thorough understanding of how the CCM performs in the study area when compared to other industry standard methods. Determine whether the as-is model is appropriate for use at small RSX sites within the study area.

Phase II – Calibrate and Validate CCM

- If determined to be needed, calibrate the CCM to improve the predictive capability to generate hydrology and hydraulics estimates that more closely align with industry standard methods at small RSX sites in the Ashokan watershed.
- Validate the modified CCM by running the new model and comparing to models developed by other methods such as gage analysis, HEC-RAS, or other industry standard methods at up to 5 (five) sites not used during calibration.

Phase III – Develop Alternatives Analysis Model Extension

- If the CCM is determined suitable for use in the study area, whether version 2.1 or a newly calibrated version, develop an automated model extension where proposed alternatives can be compared at specific sites. For instance, at a site with a 0.75 mi^2 drainage area, where it has been determined that an existing 16” corrugated metal pipe with wingwalls is a high priority site for replacement due to being undersized and in poor condition, generate an interface or process where the user can quickly and easily compare the results of the current structure with a number of available alternatives, such as a 24” corrugated metal pipe, a 24” HDPE pipe, an 36” open bottom arch culvert, and a 48”x24” concrete box culvert with headwall and wingwalls. This will allow the CCM to serve not only as a prioritization and modeling too, but also a design guidance tool for replacement projects.

Deliverables:

- Regular progress reports and consultations via webinar meetings with AWSMP staff at key decision-making points in the analysis.
- Model outputs from CCM and all other methods used included with progress reports.
- A tabular or graphical comparison between CCM and other methods at all sites.
- A report at completion of Phase I and expanded to include Phase II results outlining the methods used and discussion and conclusions related to the suitability of v2.1 of the CCM for conducting hydrology and culvert hydraulics modeling.

- If Phase II is required, a functioning recalibrated and validated version of the CCM including updated ArcGIS tools and Python scripts, as well as a report detailing and justifying any modifications made to the methods.
- A final report at completion of Phase III detailing all project methods, results, model assumptions and limitations, and conclusions and recommendations for model use and future development.
- All field data, electronic files, and databases developed for the project delivered to CCEUC on an external harddrive and/or downloadable from an online file-sharing site.
- If a version of the model is deemed suitable for use in the study area, a working model extension for conducting alternatives analysis.

Evaluation Criteria:
Proposals will be evaluated and scored for reasonableness of costs, appropriateness of methods, project timeline, reasonableness of budget, applicant qualifications, and partnerships and coordination with stakeholders. AWSMP requires proof of expertise in industry standard hydrologic and hydraulic modeling methods for engineering and design at RSXs. Experience with version 2.1 or past versions of the CCM is beneficial, but not required.

Proposal Format and Instructions:
The proposal should include a cover page with contact and project summary information, pages with detailed information about the proposed project, and a budget and budget narrative. Provide a schedule for project implementation. Provide a separate cost-estimate and schedule for Phase I, Phase II, and Phase III of the project. Additional pages should outline the qualifications of the individuals and organizations involved.

The budget should include a detailed cost statement showing proposed project staff, billing rates, and estimated hours to complete the scope of work and deliverables. Also include an itemized listing of other expenses or fees that are anticipated, such as travel and clerical time, printing and materials costs, and project supplies. Provide a budget narrative with detail on how cost estimates were determined. Also include a presentation or work sample of a similar project for review.

Proposal Submission:
Submit proposals in electronic format by 5:00 pm on Friday, May 14, 2021 to:

Ashokan Stream Management Program
Attn: Leslie Zucker
P.O. Box 667
Shokan, NY 12481
laz5@cornell.edu