**Appendix A: Priority Topic**

<table>
<thead>
<tr>
<th>TOPIC:</th>
<th>Improvement of the Systemwide Eutrophication Model (SWEM) for the Long Island Sound</th>
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<tbody>
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<td><strong>SUGGESTED COST</strong>&lt;br&gt;<strong>ESTIMATE RANGE:</strong></td>
<td>Up to $270,000</td>
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<td><strong>PROJECT PERIOD:</strong></td>
<td>18 months, October 2011 – June 2013</td>
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<td><strong>LISS COMMITMENTS SUPPORTED:</strong></td>
<td>This request is intended to support the commitments made to reducing hypoxia in the LIS 2003 Agreement. As noted in the LISS CCMP, eutrophication models used to support hypoxia management in the Sound (first LIS 3.0, now SWEM), must be periodically evaluated, improved and recalibrated to reflect changing and variable environmental and climatic conditions.</td>
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**BACKGROUND AND REQUEST:**

The Systemwide Eutrophication Model (SWEM) is a three-dimensional model of water quality in New York Harbor and Long Island Sound that was developed by Hydroqual, Inc. (now HDR/Hydroqual) in the mid 1990’s and was approved for use by the Long Island Sound Study in 2001. The SWEM has three main components: a hydrodynamic model, which drives a eutrophication model and a sediment flux model. The code is available at [http://www.hydroqual.com/wr_rca.html](http://www.hydroqual.com/wr_rca.html) (RCA code) and [http://www.hydroqual.com/ehst_ecomsed.html](http://www.hydroqual.com/ehst_ecomsed.html) (ECOMSED). To date, the SWEM has been an important tool in understanding how dissolved oxygen (DO) levels in the Sound react to changes in various landscape inputs and environmental parameters, and it has also informed and continues to inform management decisions about how to reduce nitrogen inputs to reach state water quality criteria for DO.

Over the years that SWEM has been in use, LISS and its partners have generated a list of amendments or additions to the SWEM that would improve its usability and the accuracy and reliability of its outputs. The following prioritized list of SWEM improvements and study is the basis of this RFP. Proposals must address the first two priorities in this list. Proposals that address one or more additional priorities (in order) may be scored higher during review.

1) Integrate current recommendations into the SWEM code. In 2005, LISS funded an enhancement project to evaluate and identify the key model components influencing the intensity of hypoxia and to evaluate the extent to which SWEM reflects the current state of scientific understanding of the Sound. This project was awarded to a team at the University of Connecticut, who made a final report to LISS in 2010, which is available online: [http://longislandsoundstudy.net/wp-content/uploads/2010/02/LI97127101Final-ReportV2.pdf](http://longislandsoundstudy.net/wp-content/uploads/2010/02/LI97127101Final-ReportV2.pdf). Applicants to this RFP should review the UCONN findings and recommendations made by that team and should propose how they would integrate some or all of those recommendations, as appropriate, into the SWEM code.

2) Use or transition to a community modeling framework. Such a framework will advance the cause of accessible, open-source environmental models of the Long Island Sound in support of research & management efforts. Develop extractable data and model products for the SWEM that will facilitate external access, assessment, and enhancement of the model. It is expected that the open framework will enhance opportunities for future collaboration, including but not limited to:
   i) Nesting of more refined models of nearshore areas and embayments within SWEM to better resolve lateral circulation and exchange
   ii) Linking SWEM to watershed and groundwater models to better refine nutrient and water budgets.

3) Evaluate strategies for assimilating existing monitoring data to improve modeled hydrographic fields and circulation.

4) Apply SWEM to support the continuing assessment of eutrophication impairments to Long Island Sound. Following the
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Completion of the modifications described in priorities (1) and (2), conduct nutrient scenario analyses over multiple model years to evaluate the sensitivity of hypoxia in Long Island Sound to variable conditions (wind, rainfall, tributary flow, circulation patterns, temperature, etc.). Explicitly incorporate climate change in testing model sensitivity and in developing future scenarios. Synthesize and communicate model outputs to management. Identify priority observation/monitoring needs to improve modeling and integrate LISS support for research, monitoring, and modeling. Of specific interest is better utilization of high frequency time-series measurements (e.g. moored stations, ferries), additional parameters, consideration of remote sensing data, and appropriate spatial and temporal monitoring scales for model evaluation.

5) Incorporate elements into SWEM that would allow evaluation of bioharvesting technologies that utilize filter feeding shellfish and seaweed to remove nutrients from the water column. Elements that can be considered include but are not limited to the recommendations made by Hydroqual in their LISS-funded report on bioextraction evaluation performed with SWEM. This report is available online: http://www.coonamessetfarm.com/sitebuildercontent/sitebuilderfiles/SWEMbiohvrstrptrv2.pdf. SWEM should be enhanced to implement a more mechanistic approach to modeling shellfish and kelp, similar to the mechanistic approach already taken in SWEM for modeling phytoplankton or in the Chesapeake Bay Environmental Model Package (CBEMP) for modeling oysters. Unlike SWEM’s empirical bivalve water column clearance parameterization, CBEMP’s mechanistic oyster kinetics directly include a full mass balance (i.e., source and sink terms with temperature and oxygen dependencies) around filter feeder biomass: filtration rate, excretion rate, assimilation rate, growth rate, respiration rate, predation rate, and hypoxia mortality rate. Future work might also include a consideration of particle concentration dependence and mass of particles previously filtered dependence on specifying filtration and respiration rates as suggested by mussel filtration rate and shell gape data from Mud Cove, Maine over a tidal cycle (Newell et al., 1998). Mechanistic shellfish modeling could be expanded to include separate kinetics for each of multiple species. Incorporating mechanistic growth kinetics for seaweed/kelp inside a complex three-dimensional, time-variable coupled hydrodynamic and eutrophication model (i.e., SWEM) would be novel. As described in Duarte et al. (2003), hydrodynamic transport phenomena have typically been overly simplified in other ecological models applied to evaluate aquaculture.

**Expected Outcomes:**
- An improved version of the SWEM that will better predict dissolved oxygen concentration in Long Island Sound.
  - This improved version of the SWEM will also be more assessable to LISS partners and should be able to integrate the outputs of other system models to better reflect local or nearshore conditions.
  - Improved ability of LISS managers to prescribe nutrient management activities that will produce the changes in DO predicted by SWEM.
  - Improved understanding of the sensitivity of SWEM predictions to changing environmental conditions, including predicted global climate change.
  - Improved integration of existing monitoring data and improved understanding of further monitoring needs.
  - Improved ability to model bioextraction scenarios with the SWEM.

**Expected Methodology:**
- The project team will meet regularly with the LISS on the direction and conduct of the project. Applicants must formally incorporate peer consultation with an independent Model Evaluation Group, which will be convened by LISS, into all project tasks related to model alteration and application.
  - The award recipient must prepare an approvable Quality Assurance Project Plan consistent with EPA guidance and conform to best practices for ensuring and evaluating the quality of the model.
  - Proposals must include technical workshops to train LISS managers on the modifications and addition to SWEM and to demonstrate all external access points built into the SWEM to enhance its usability by the LISS partners (linkages with other models, etc.)
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### Deliverables/Outputs:
- An approved Quality Assurance Project Plan (QAPP)
- Accomplishment of the first two SWEM enhancements listed above in “Background and Request” is mandatory. Accomplishment of remaining tasks in priority order within the limit of the available budget is optional.
- A final report that includes documentation of the process used, modeling scenarios run, and a user’s manual for the community model framework components of the modified SWEM.
- Project start-up meeting and periodic progress meetings with LISS management.
- Frequent communication via conference calls, email, and other venues not requiring travel.
- Vetting of the final modified SWEM model through an independent Model Evaluation Group
- Quarterly progress reports (format will be provided)
- At least one technical workshop to train LISS managers on the modifications and addition to SWEM and to demonstrate all external access points built into the SWEM to enhance its usability by the LISS partners (linkages with other models, etc.).

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### References:

