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To: Theresa Portante-Lyle, NEIWPCC (tportante-lyle@neiwpcc.org)

From: Mick DeGraeve, GLEC

Date: July 25, 2013

Subject: **Supplementary information related to GLEC's proposal to NEIWPCC "Impact Evaluation of Projected DO deficits in the NY/NJ Harbor Estuary"**

GLEC is excited about this opportunity to work on some of the scientific issues related to ambient dissolved oxygen levels in the Harbor and the effects of those measured (and projected) levels on aquatic life. We very much appreciate being selected for this program, and are grateful for the funding provided to GLEC from NY/NJ HEP (through NEIWPCC) and the New Jersey Harbor Dischargers Group (NJHDG). We look forward to working with the Technical Advisory Committee to generate the type of biological effects of low DO information that is currently lacking for the Harbor. Below are GLEC's responses to your July 17, 2013 letter to me notifying us that GLEC had been selected for this project.

- The Review Team's assumption is correct: we intend to perform the described evaluations for all of the management zones that were under investigation through the HEP Nutrient (DO) Work Group.
- Under Task 2.1 we will without question solicit fisheries data and related information from both the States of New Jersey and New York. In addition, we will request fisheries data from the Hackensack Meadowlands Commission and any academic institutions involved in fisheries sampling in the Harbor.
- Regarding the two action scenarios to be tested under Task 2.3, the "Revised Planned Improvements Simulation" is the most recent SWEM simulation representing already completed and already agreed to actions and is the best SWEM representation available for current conditions in the Harbor. The conditions of "Plan Run February 2013" were developed by EPA and the States after two years of deliberations and represent the most recent TMDL condition simulated. Below is a discussion of the SWEM simulations:

  For purposes of final model simulations, EPA and the States proceeded with a sub-regional approach, working on specific sub-regions one at a time in order from the edges of the Estuary inward. This approach and the model simulations completed are documented in two reports: the May 2009 HydroQual report, *Nitrogen and Carbon Sub-Regional TMDLs Planning Document* and *Progress as of June 25, 2010 on Completing a Dissolved Oxygen Management Plan/TMDL for the NY/NJ Harbor Attachments Updated July 28, 2010.*

  After completion of *Progress as of June 25, 2010 on Completing a Dissolved Oxygen Management Plan/TMDL for the NY/NJ Harbor Attachments Updated July 28, 2010,* EPA and the States carefully considered and further evaluated the numerous model outputs before completing a final TMDL simulation in early 2013. TMDL activities between July 2010 and early

2013 are documented in the report, *Summary of Progress on Completing a Dissolved Oxygen Management Plan/TMDL for the NY/NJ Harbor July 2010 to October 2012.*

Ultimately, a final TMDL plan simulation was performed which was an iteration of the "Revised Sub-Regional Plan" simulation presented in the July 2010 document. The modifications (i.e., increases) to loadings considered in the July 2010 "Revised Sub-regional Plan" simulation for the final TMDL plan simulation included: NJDEP requested Dundee Dam and Fieldville Dam loadings; design/permit flows for selected Harbor STPs; a relaxed definition of LOT for stormwater; and relaxing of Hudson River and Upper Bay STPs low level reductions nitrogen and carbon effluent concentrations.

If necessary, additional documentation and discussion of the SWEM simulation scenarios can be provided to NEIWPCC.

- We have revised the project schedule to accommodate the time requirement for the Quality Assurance Project Plan (QAPP) development and review process. A timeline for the revised schedule is provided below:

Project Start	**Activity**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Project End**
August 2013	Task: QAPP development and review process													July 2014
	Task 2.1: Summarize health and ID Gaps													
	Task 2.2: Determine species and life stages present													
	Task 2.3: ID critical locations and periods of DO													
	Task 2.4: Identify aquatic life most impacted													
	Task 2.5: Develop method to assess boil. impact													
	Task 2.6: Compile biological data requirements													
	Task 2.7: ID site specific or UAA DO Standards													
	Task 3.1: Compare critical areas vs. similar areas													
	Task 3.2: Method to eval. spatial extent of low DO													
	Task 3.3: Apply method to ID locs/times of concern													
	Task 3.4: Provide eval of projected conditions in 2050													
	Task 4.0: Provide Proj Summary and Conclusions													

- We concur with the Review Team's request for kickoff and project progress meetings with a Technical Advisory Committee. Aside from the kickoff meeting, which could be scheduled immediately, we believe that appropriate milestones for these meetings would be at the completion of Tasks 2 and 3. According to the revised schedule presented above, these meetings would take place in January 2014 and July 2014. If this is acceptable to NEIWPCC, we will add these project progress meetings to the task deliverables and schedule.

Again, let me express our appreciation for being selected for this project. We are excited about this opportunity and look forward to working with the Technical Advisory Committee. If you have any questions regarding our proposal or the information presented in this memo, please do not hesitate to contact me.

Cc: Robin Landeck Miller
John R. Waldman

Title: Impact Evaluation of Projected DO Deficits in the NY-NJ Harbor Estuary

Project Leader: G.M. (Mick) DeGraeve – Great Lakes Environmental Center, Inc. (GLEC) – Senior Aquatic Biologist/Toxicologist; GLEC Project Leader; GLEC Project Technical/Financial Contact; and primary point of contact between the GLEC Team and EPA/NEIWPCC.

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Total Funds Requested from HEP: $50,000 **Total matching funds**: $20,000

Previous Funding: None

Project Abstract

The proposed work of the GLEC Team will consider existing organism abundance and diversity in the open waters of NY/NJ Harbor as they relate to various dissolved oxygen levels. The work will be an attempt to begin to understand how site-specific (ambient versus laboratory-derived), temporal and spatial circumstances can affect the presence, abundance and ability to thrive of marine organisms in areas of the Harbor which are not attaining the marine DO criteria, based primarily upon projected DO deficits. The proposed work will be somewhat limited in scope because the evaluation will rely entirely on existing information, data and model calculations/outputs; thus the conclusions drawn will be considered preliminary. As an important component of this program, the EPA Atlantic Ecology Division (AED) will provide assistance in relating Harbor dissolved oxygen levels to expected organism effects. The final report will provide a synthesis of the findings, and will recommend field work to validate the preliminary conclusions obtained through the proposed work.

PROBLEM DESCRIPTION

In November of 2000 the EPA issued "Ambient Aquatic Life Water Quality Criteria of Dissolved Oxygen (Salt Water): Cape Cod to Cape Hatteras". The criteria document established recommended salt water criteria for ambient Dissolved Oxygen (DO) to protect marine aquatic life. Based on this criteria, New York State (NYS) adopted a DO Standard for the open saline waters (NYS Classes SA, SB and SC) with an acute criterion of never less than 3.0 mg/l to protect juvenile and adult survival, and a chronic criterion of 4.8 to protect growth and larval recruitment, which requires that DO levels below 4.8 mg/l be limited in accordance with a time-dependent formula. EPA and the States of New Jersey and New York have agreed to assess current and projected DO conditions using the NYS standard, even though that standard has not been adopted for most of the Harbor estuary.

For over 15 years the Nutrient Work Group (NWG) of the NY/NJ Harbor Estuary Program (HEP) has been considering dissolved oxygen TMDL planning, development and implementation for the open waters of the NY/NJ Harbor for purposes of attaining the fishable and swimmable goals of the Clean Water Act. The NWG consists of individuals from EPA, the States of New York and New Jersey, environmental protection advocates, interested citizens and the permitted stakeholders (New York City Department of Environmental Protection (NYDEP) and the New Jersey Harbor Dischargers Group (NJHDG)). Through this Group under HEP water quality monitoring was performed, a dissolved oxygen model was developed and implementation strategies and options were discussed and evaluated.

Intermittent direct measurements (performed by NJHDG and NYDEP) of current DO concentrations in the Harbor complex indicate at least some degree of spatial/temporal non-attainment of these desirable DO levels in the Lower Hackensack River, Lower Passaic River, Newark Bay, Arthur Kill, Raritan River, Raritan Bay and Hudson River/Upper Bay. DO projections made by the Harbor DO model were, for the most part, consistent with the sampled DO results from intermittently-collected samples. Attainment of the NYS DO standard endpoints Harbor-wide would likely require meaningful reductions to the inputs of nitrogen and carbon to NY/NJ Harbor, and full attainment of this DO standard at all locations within the Harbor estuary has been projected to cost up to $10 billion. In part because of the well-understood high costs associated with nutrient and BOD reduction treatment options for the POTWs in the Harbor estuary, and in part because there is some skepticism on the part of the regulated community and others that the considerable investments would produce environmental improvements consistent with those investments, the interested parties have expressed interest in evaluating the full range of site-specific implementation options/flexibility before investing billions of public dollars in infrastructure improvements.

It is important for all stakeholders to understand that the 2000 marine DO criteria were developed entirely based upon laboratory data. And as important and meaningful as those data are, EPA and other marine scientists who had input to the marine DO criteria document recognize that laboratory aquatic toxicology data are a surrogate for (as opposed to a substitute for) site-specific conditions in the field. It is with this understanding that the "Implementation Section" of EPA's 2000 DO Criteria Document makes the point that: "This document provides the information necessary for environmental planners and regulators in the Virginian Province to address the question of whether *DO at a given site is sufficient to protect coastal or estuarine aquatic life"*. However, the document does **not** address how compensatory mechanisms such as organism avoidance or physiological adaptations can influence the response of local populations to seemingly adverse DO conditions. Neither does the document specifically address the issue of the temporal and spatial extent of low DO conditions. In other words, even if the DO at a site has been measured (or projected) to be sufficiently low to have an adverse effect on aquatic life at that site, the environmental manager has the flexibility (and responsibility) to judge whether the hypoxia meets a temporal threshold for negative effects, and is sufficiently widespread to represent an actual environmental concern. Finally, as with all criteria, the marine DO criteria document does not address changes in sensitivity to low DO that accompany other environmental variables such as temperature,

salinity extremes or toxic substances.

With the above in mind, this project will consider existing organism abundance and diversity in the open waters of NY/NJ Harbor as they relate to various dissolved oxygen levels in an attempt to begin to understand how site-specific (ambient versus laboratory-derived), temporal and spatial circumstances can affect the presence and abundance of marine organisms in areas of the Harbor which are not attaining the marine DO criteria, based upon actual DO measurements or projected DO deficits. As an important component of this program, the EPA Atlantic Ecology Division (AED) will provide assistance in relating Harbor dissolved oxygen levels to expected organism effects.

All parties involved with this program should understand that this project, although important and potentially revealing, is limited in terms of the depth of investigation for the various scope areas that is possible for the available funding. Ideally, based on the available information, upon completion of this program we will be in the position to recommend a field-oriented program that will focus on better understanding how site-specific circumstances can affect DO criteria implementation considerations.

OBJECTIVES

The goal of this project is to better understand the effects of current and projected DO levels on the living marine resources of the NY-NJ Harbor estuary, which would in turn provide insight that will be helpful in making future DO criteria implementation management decisions. Achieving this goal requires several specific objectives:

i. Develop an accurate historic and current list of marine species and their abundance in NY-NJ Harbor estuary waters, including adult and juvenile life stages;
ii. Identify critical locations and the associated resident marine life expected to be most impacted by low DO conditions based on existing data and existing model outputs;
iii. Develop a method to evaluate potential impacts of projected DO deficits at critical locations using existing models and data;
iv. Using the developed method, evaluate the spatial and temporal extent of low DO to inform management decisions;
v. Tabulate locations and times of DO deficit of biological concern;
vi. Project conditions in 2050 assuming a climate change scenario;
vii. Prepare detailed recommendations for future work to field-validate the results of this study.

METHODOLOGY

Accomplishing the goal and objectives of this project involves biological and water quality modeling technical activities and procedures associated with environmental data gathering, and data compilation and analyses to support the overall assessment. The effort requires the following specific primary Tasks and specific Subtasks:

TASK 1. DEVELOPMENT OF AN APPROVABLE QUALITY ASSURANCE PROJECT PLAN

No new data will be generated through this program. However, secondary data will be obtained, reviewed and evaluated. Therefore, a technically complete and well-conceived Secondary Data Quality Assurance Project Plan (QAPP) will be developed to guide the technical aspects of this project. Upon notification of Award, GLEC will work cooperatively with NEIWPCC to develop a Secondary Data QAPP which conveys all quality assurance (QA), quality control (QC) and technical activities and procedures associated with planning, implementing and assessing all environmental data operations and technical activities associated with this project. Upon completion, approval of the collaboratively-developed plan will be requested by the GLEC Project Leader (Mick DeGraeve) of the EPA Project

Officer, and EPA Quality Assurance Officer, the NEIWPCC project manager and the NEIWPCC Quality Assurance Program Manager. GLEC expects completion of the QAPP will require communication between GLEC's Quality Assurance Manager (Jennifer Hansen) and the NEIWPCC Quality Assurance Program Manager and possibly with designated researchers and QA/QC staff at EPA AED.

We will take advantage of our extensive experience developing and gaining QAPP approval from government and industrial clients on numerous similar projects involving the use of secondary data. Specifically, GLEC intends to use parts of our approved Secondary Data QAPP that we developed for producing a database of species from the Gulf of Mexico for use in EPA's Virginian Province Dissolved Oxygen Recruitment Model. That QAPP will be supplemented as needed to meet the specific goal and objectives of this project. GLEC expects that use of this pre-existing QAPP will facilitate completion of this required deliverable in an efficient and timely manner.

Recent examples of GLECs ability to develop comprehensive and technically sound approved-QAPPs for similar projects include: *Quality Assurance Project Plan for Discharges from Commercial Fishing Vessels and Other Non-Recreational Vessels Less Than 79 Feet,* Prepared for USEPA, Office of Wastewater Management - March 2, 2009.

Other project descriptions that demonstrate GLEC's experience in this and other relevant task areas are included as an Appendix to this proposal. No new modeling work will be performed on this project, so it is not necessary to develop a modeling QAPP. Already existing model outputs that will be used for this project were developed previously under modeling QAPPs approved by EPA and NEIWPCC.

TASK 2. COLLECT INFORMATION REGARDING HARBOR BIOLOGY AND DEVELOP A METHOD TO EVALUATE POTENTIAL IMPACTS OF PROJECTED DO DEFICITS

Task 2.1. Summary of qualitative and quantitative health of the existing aquatic life in the NY-NJ Harbor estuary - The NY/NJ Harbor lies at the confluence of three major bodies of water. The Harbor opens onto the New York Bight (Atlantic Ocean) to the southeast and the Long Island Sound to the northeast. Both of these water bodies are essentially marine water bodies but, compared to the Atlantic, the Sound is about 20-30% less saline (as an estuary), and the tide in the Harbor is about 3 hours later than that measured in the ocean, with as much as 70% more variation. The Hudson River adds a fresher, non-tidal inflow from the north, although the tide and brackishness extend well up the Hudson River. These three hydrological sources to the NY/NJ Harbor historically supported a diverse aquatic ecosystem. GLEC will carefully consider the effect of this complex estuary while collecting information regarding the Harbor biology and when evaluating potential impacts of projected DO deficits.

There are extensive data available that describe the diversity, abundance and distribution of aquatic life in the NY-NJ Harbor complex. GLEC will conduct a literature search and summarize the qualitative and quantitative health of the existing aquatic life in the NY-NJ Harbor Complex, based on this existing information. The literature search will summarize information on the diversity and abundance of species known to be found historically in the Harbor, as well as list the current species present in the Harbor. This information will allow us to develop a list of species that are absent from the Harbor but would normally be expected to be present.

The present day species lists will be developed based on data collected by EPA, USGS and NOAA. Historical species lists will be developed from natural history inventories and a review of early biological surveys conducted within the Harbor estuary. The literature search will likely identify data gaps, and those gaps will be described and outlined. The result of the work completed under this Subtask will be an interpretive summary of the health of existing aquatic life in the NY-NJ Harbor estuary; additional data needs will also be identified.

Task 2.2. Determine expected species and life stages in the Harbor, and salinity, temperature, and habitat preferences - GLEC will determine, based on fisheries populations in relatively less impacted nearby "reference" waters, which species and life stages would likely be present in the Harbor estuary in the absence of hypoxia and contaminants. Understandably, there have been permanent changes to the estuary that have eliminated some near-shore and deeper water habitats. GLEC will keep that in consideration while determining which waters to consider as "reference" areas. Examples of comparable estuaries that may support similar organism populations include lesser impacted water bodies with similar hydrologic inputs such as Delaware Bay, Outer Long Island Sound, Buzzards Bay to the north, Cape Cod Bay, and Sandy Hook Bay. This review will document salinity, temperature, and habitats for the known species and life stages. If available, the documentation will include a description of critical habitats/locations and time periods when juvenile/adult life stages are expected to be present. GLEC will review the life history requirements for aquatic life and document the temperature and salinity preferences for species and life stages that may choose to inhabit the Harbor waters in the future.

As a result of this task, GLEC will determine the expected aquatic community in the Harbor in the absence of hypoxia and contaminants, including the identification of critical habitats/locations and time periods when juvenile/adults life stages are expected to be present.

Task 2.3. Identify critical locations and time periods of current and projected DO conditions that might impact juvenile/adult aquatic life survival as well as larval recruitment and growth of juvenile and adult aquatic life - For this Subtask GLEC, with the assistance of HDR HydroQual, will use exiting outputs from the System Wide Eutrophication Model (SWEM) to document areas of NY/NJ Harbor where 24-hr average dissolved oxygen is either below 3.0 mg/L or between 3.0 and 4.8 mg/L. The "Revised Planned Improvements" SWEM simulation already completed for HEP will be used to define current DO levels for the Arthur Kill, the Hackensack River and the Hudson River/Upper Bay. The "Plan Run February 2013" SWEM simulation already completed for HEP will be used to define a management alternative as it represents a TMDL planning loading condition resulting from more than 2 years of deliberations by EPA and the States, and is a refinement over the 2010 "Revised Sub-Regional Plans" SWEM simulation. When this information has been collected and finalized, a conference call will be held with EPA AED to discuss the electronic transfer of the SWEM 24-hr dissolved oxygen calculations, including EPA AED's preferences for working with model outputs on a single grid cell single 10% depth layer basis (as has been used for TMDL planning), as opposed to depth or spatially averaged outputs, as well as EPA AED's preferred electronic format for receiving the model outputs. HEP and NEIWPCC will be copied on any information delivered to EPA AED. As the Subtask deliverable, a table will be prepared for NEIWPCC and HEP that identifies the critical areas and time periods that dissolved oxygen is below 3.0 mg/L and between 3.0 and 4.8 mg/L, for both current and management alternative conditions.

Task 2.4. Identify the aquatic life that would be most impacted by the DO conditions in the critical locations. Indicate the nature of the likely impact to the extent possible - The EPA dissolved oxygen criteria apply to both continuous and time-variable low DO conditions. If the DO conditions are always above the chronic criterion for growth (4.8 mg/L), the aquatic life at that location should not be harmed due to low DO (providing that there is not another stressor affecting the organisms). On the other hand, if the DO at a site has been measured or projected to be below the juvenile/adult survival criterion (3.0 mg/L), DO may be inadequate to protect aquatic life. When the DO levels persistent between these two values, EPA has stated in the marine DO Criteria Document that further evaluation of duration and intensity of low DO is needed to determine whether the existing level of oxygen can support a healthy aquatic life community (EPA 2000). It is important to emphasize that the majority of the data used to develop the saltwater dissolved oxygen criteria is laboratory-based with continuous exposure scenarios; consequently effects in the field in the DO range of 3.0-4.8 are largely unknown. GLEC will identify the aquatic life that would be most impacted by the DO conditions in the critical locations by evaluating the

species sensitivity, life stage and life history requirements of aquatic life resident in the Harbor.

Table 1 of the EPA Saltwater Dissolved Oxygen Criteria Document lists the acute sensitivity of 23 saltwater species, including fish, shellfish and invertebrates. That list will be compared to the fish and invertebrate inventory for the Harbor (Subtask 2.2), and surrogates will be chosen from the toxicity database to represent those species that are likely to reside in the critical locations. Using EPA's Biological Evaluation model, GLEC will list the species in the criteria document that are expected to reside in the critical locations of the Harbor in phylogenic order so that the surrogates will be similar to the genera and species of concern. With that information, GLEC will indicate the nature of the likely impact, to the extent possible, and will identify the aquatic life that would be most likely to be impacted by the low DO conditions in the critical locations.

Task 2.5. Based on existing information, develop, if possible, a method to assess the relative biological impact of different DO conditions - The Long Island Sound approach involved developing percentage reductions in various biological metrics (survival, biomass abundance, species richness) for every 0.5 mg/L increment of dissolved oxygen based on field and laboratory observations for a number of species. These percentages were coupled with model-calculated duration, surface areas and volumes of water affected by DO reductions of 0.5 mg/L DO increments to make calculations of metrics such as SAD (survival area days) and BAD (biomass area days). A key consideration for this Subtask will be whether or not we can identify existing information for the Harbor that mimics the information that was available from the field and laboratory studies conducted for the Sound. If the needed type of information is not available, alternate approaches will be researched, evaluated and implemented if found to be applicable and supported with available data. A corollary consideration for the approach we select to use relates to whether or not existing information for the Harbor supports a conclusion that the biological responses observed in the Sound are also applicable to the Harbor. These are the types of decisions that will involve input from EPA scientists familiar with effects of low DO in marine waters.

Task 2.6. Compile biological data requirements needed to evaluate significance of DO deficits in limited portions of the harbor - Based on the data and information collected in Tasks 2.1 and 2.2, GLEC will compile biological data requirements needed to evaluate the significance of DO deficits in the DO-limited portions of the Harbor. This evaluation will consider the species, distribution, life history requirements and physiology of the aquatic organisms. If required data are not available from measurements or credible projections, GLEC will design a monitoring program that would establish a sufficient database to achieve this goal. The implementation of a monitoring program will not be included under this contract.

Task 2.7. Identify any site specific or Use Attainability Analysis (UAA) Dissolved Oxygen Standards that have been approved by EPA - GLEC will perform a UAA-related literature search to obtain any information that is available online, although we recognize that UAA work performed by individual states or EPA may not be readily available through routine literature searches. However, because GLEC has had technical support contracts with EPA's Standards and Criteria Divisions for over 15 years, we have developed solid working relationships with EPA regional staff in every EPA Region, and with the NPDES permitting staff in most states. We will take advantage of those contacts by making calls to learn if there has been any DO/UAA-related work performed that is not generally available, and we will summarize all of the information that we collect.

An outstanding example of resource agencies addressing the low marine DO issue is down the coast about 100 miles from the NY/NJ Harbor—Chesapeake Bay. The Chesapeake Bay Program has been addressing DO problems in the Bay for over 10 years. The Program in the Bay is very active, including municipal and regional jurisdictions, sewerage agencies, states, environmental protection advocates and EPA. There is much to learn from that program; in fact, our proposed Project Leader (Mick DeGraeve) has a meeting

scheduled with Chesapeake Bay Program staff in late June 2013 to discuss HEP activities. Our Team will use that visit as an opportunity to reach out to the Chesapeake Bay Program and to other National Estuary Program offices to learn more about other activities in the area of UAAs as related to low DO. One interesting note: GLEC has investigated this topic over the course of the past year, and we have not been able to discover very much ongoing or past work on this topic, except of course in the Chesapeake Bay. However, in our review of the UAA work in the Chesapeake, we were unable to discover any detailed information about how DO-related UAAs have been conducted for Chesapeake Bay waters. Having said that, the Chesapeake Bay Program has developed site-specific DO criteria that have been implemented. Obviously, this topic warrants further investigation, which will take place through this program.

TASK 3. EVALUATE POTENTIAL BIOLOGICAL IMPACT OF PROJECTED DO DEFICITS.

Task 3.1. **Compare current conditions in critical areas to those conditions existing in similar areas of DO attainment -** GLEC will compare current conditions in critical areas to those conditions existing in similar areas of DO attainment, to determine if areas with low DO coincide with areas with impaired biological conditions. The Harbor Benthic Index of Biological Integrity (IBI) will be used for this comparison (Strobel et.al., 2001, Hale, et.al., 2001 and Llanso et.al., 2001). Existing Harbor Benthic IBI data and maps will be reviewed and, if appropriate, IBI will be calculated using existing benthic population data.

Once GLEC identifies impaired areas based on IBI, spatial and temporal SWEM projections will be used to provide the DO for those areas as well as identifying other locations in the Harbor Complex with similar DO levels. GIS data layer overlays will then be used to visually determine if areas with low DO coincide with areas with impaired biological conditions. Of particular importance to these tasks will be identifying different areas of the Harbor with comparable dissolved oxygen for purposes of answering the questions of whether or not the biological integrity at these locations is also similar and whether or not a sufficient number of the low dissolved oxygen areas actually also show biological impairments.

Task 3.2. Based on the methodology developed above, and the data collected in this section, develop a method to evaluate whether the spatial extent of low DO is widespread enough to warrant concern - Using the data collected in Task 2 and Task 3.1, GLEC will develop a conceptual model that describes the DO conditions in the NY/NJ Harbor complex, and will build upon existing GIS maps of the NY/NJ Harbor that describe water quality (physical and chemical condition) and biological conditions in the Harbor to evaluate the spatial extent of DO levels of concern in the Harbor.

Task 3.3. Apply the evaluation method to the information assembled above and tabulate the locations and times of DO deficit of biological concern - Using the fisheries data, benthic IBI data, and the information describing the spatial extent and duration of DO deficits, GLEC will tabulate the locations, times and duration of DO deficits and attempt to correlate that data with biological effects. This evaluation will help describe areas within the Harbor of greatest concern, and will allow us to develop maps of IBI and distribution and abundance data in a GIS format that show seasonal and other cyclical cycles. The basis of our conclusions will be discussed, as well as the associated uncertainty.

Task 3.4. Provide an evaluation of projected conditions in 2050 based on currently expected conditions as a consequence of climate change - Global climate change is expected to result in sea level rise, air temperature warming, water temperature warming, and precipitation changes. All of these changes would alter Harbor circulation patterns, Harbor stratification, dissolved oxygen saturation, and therefore the patterns of DO throughout the Harbor.

Numerous entities have made projections out to 2050 for the effects of global climate change. One example is the New York City Panel on Climate Change (NPCC) Climate Risk Information report. This

report is web accessible at: http://www.nyc.gov/html/om/pdf/2009/NPCC_CRI.pdf. In a very quantitative effort, the projected 2050 changes to sea level rise, air temperature, water temperature, and precipitation could be imposed on the SWEM hydrodynamic transport and eutrophication models to project dissolved oxygen conditions for 2050. It would be uncertain though whether the projected dissolved oxygen changes could be directly translated to biological effects given that 2050 conditions also include changes other than dissolved oxygen that would also have biological impacts. We would not know, for example, how an organism would react to lower dissolved oxygen and temperature with simultaneous changes in water depth and water velocity. However, the budget constraints associated with this project would not allow our Team to do any water quality modeling associated with climate change. Rather, we would perform a qualitative evaluation of how ambient DO would be affected in the Harbor based only on the generally expected increase in water temperature and sea level rise. In addition, we will make recommendations on how the existing hydrodynamic transport and eutrophication models could be used in conjunction with other modeling/statistical tools to more quantitatively predict the effects of projected climate change on DO patterns in the Harbor.

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ROLES AND RESPONSIBILITIES

GLEC offers with this proposal a highly-qualified and experienced project team. Successful execution of this Impact Evaluation will require the expertise and experience of mid- to upper-level professionals in the areas of aquatic biology and fisheries and water quality modeling. Additionally, we expect that the services of a biostatistician and GIS/mapping specialist may be needed for assistance with selected tasks. Below we present the roles and primary responsibilities of the technical team members. More details on the professional credentials of the individuals below can be found in the Resume section of this proposal, which is presented as an Appendix.

Mick DeGraeve will be GLEC's Project Leader for this Impact Evaluation. Mick is a senior aquatic biologist/toxicologist who has been working environmental effects-related research and problem-solving for over 40 years. Throughout his career he has worked for both the regulated and regulatory communities, working to develop cooperative interactions and synergisms to address complex environmental and regulatory issues. For over 20 years Mick has acted as the Technical Advisor to the New Jersey Harbor Dischargers Group on behalf of NJHDG, primarily on issues related to water quality in the Harbor. For the past 15+ years he has been a member of the Nutrients (DO) Work Group and involved in all aspects of TMDL development for addressing projected dissolved oxygen issues in the Harbor. He also has 30 years of aquatic life criteria development experience gained while working on 100+ Work Assignments for the Office of Water's Health and Ecological Criteria Division.

In Dr. DeGraeve, GLEC is pleased to offer our most experienced and qualified manager as a demonstration of our commitment to quality program management. Over a 17 year period, Mick has had responsibility (as Program Manager) for the technical and financial oversight of nine EPA Office of Water contracts, with a combined value of over $60 million, and has involved over 20 subcontractors. His vast experience as a Program Manager has required a range of technical and program management skills that will be most valuable to this proposed Impact Evaluation.

Dr. DeGraeve will be responsible for both the technical and financial management of this project. He will interact regularly with the Task Leaders to assure that technical progress is being made that is consistent with the scope of the program and according to the agreed-upon schedule. He will also serve as the primary point of contact between the GLEC Team and EPA/NEIWPCC.

Dennis McCauley will serve as GLEC's lead aquatic biologist for the Tasks related to the effects of low DO on marine resources in the Harbor. Dennis is a senior aquatic biologist/fisheries scientist with 30+ years of experience related to the effects of contaminants on aquatic life. He has performed field sampling in the Harbor, and is very familiar with EPA's marine DO criteria having reviewed the Saltwater Dissolved Oxygen Criteria Document under a work assignment with EPA's Office of Water. For this project Dennis will be the lead aquatic resources scientist for GLEC. In this role he will have responsibility, working collaboratively with John Waldman, Jim Stricko and Mick DeGraeve.

Jim Stricko is a senior fisheries biologist with over 20 years of field and laboratory assessment experience. He is particularly well-respected for his fisheries population assessment, taxonomy and fisheries taxonomy expertise. He is also very familiar with the use of the Harbor Benthic Index of Biological Integrity (IBI). For this program Jim will work directly with Dennis McCauley and John Waldman to perform the Tasks assigned to Dennis McCauley (above).

Greg Smith is a senior aquatic biologist/toxicologist with 30 years of experience in environmental chemistry and aquatic toxicology. Over the last 15 years much of Greg's work has been focused on the production and updating/refining of Aquatic Life Criteria Documents for EPA's Health and Ecological Criteria Division. He has a thorough understanding of the types of data required and the process involved in developing/refining criteria documents. His experience will be used to support Tasks 2.4 and 2.6.

Jennifer Hansen is GLEC's Quality Control/Quality Assurance Officer. Jennifer will be responsible for working with the appropriate GLEC staff to prepare the QAPP required for this project, and will also be responsible for assuring the quality of the GLEC deliverables generated for this project. Jennifer manages all of GLEC's Quality Systems. She has extensive professional experience in Quality Assurance, including the development and implementation of Quality Assurance Systems, data review and approval, laboratory auditing and approval, noncompliance investigations, and report development. An important component of her Quality Assurance experience is her exceptional professional and academic experience in laboratory and field operations. Jennifer has over 18 years of combined laboratory, field, and Quality Assurance experience, and degrees in both the biological and chemical sciences.

Tyler Linton is one of GLEC's most experienced aquatic toxicologists, specializing the effects of natural and anthropogenic substances/actions on aquatic organisms. Tyler specializes in developing and evaluating aquatic life criteria documents, and in developing site-specific criteria for limited substances; he has led the effort to develop two site-specific in the Harbor estuary (cyanide and nickel). For this effort we expect to use Tyler's experience for addressing any of the issues that arise related to the marine DO criteria document and related implementation issues

Keith Taulbee is GLEC's biostatistics specialist. He has over 15 years of aquatic toxicology and ecology

experience, and we anticipate taking advantage of his experience to take the lead on any statistical needs that evolve in the course of performing this project.

Doug Endicott is an environmental engineer with 25+ years of experience in water quality modeling. For this project Doug will work with Robin Miller (HDR-HydroQual) by providing quality assurance review of all model projections. He will likely also contribute to Task 3.4 (climate change projections).

John Waldman is an aquatic conservation biologist at Queens College; previously he worked for twenty years at Hudson River Foundation, most recently as senior scientist. For this project, Dr. Waldman will acquire and interpret existing data for the living aquatic resources of the Harbor Complex. His relevant expertise includes the environmental history and ecology of New York Harbor; fish biodiversity, including Atlantic marine and diadromous fishes; habitat restoration; alien species; and storm effects and climate change.

Robin Landeck Miller is a Professional Associate at HDR HydroQual and the Senior Water Quality Project Director. She has been an environmental scientist since 1988, focusing on water and sediment quality analysis, facility planning, and TMDL/WLA/LA development. Ms. Landeck Miller was Project Engineer and Project Manager responsible for the calibration of the System-Wide Eutrophication Model (SWEM) for NY/NJ Harbor and Project Director for TMDL/WLA Development in the NY/NJ Harbor and Long Island Sound. For this project, she will provide SWEM numerical model output projections for DO levels in the Harbor Complex as well as expert guidance regarding the model's calibration, comparison to observational data, scenario development, and output interpretation.

EXPECTED OUTPUTS AND OUTCOMES

The easily-defined expected outputs of the project are consistent with the Tasks and Subtasks outlined in the RFP and addressed in this proposal (Table 1). Less easily-defined at this time (and therefore less tangible), but hopefully most valuable, will be the contents of the final report. Our expectation is that this final product will summarize, characterize and synthesize the information collected (based entirely on existing information and data) in Tasks 1-3 of this project. Most importantly, we will use the collected information to develop and present a carefully-crafted and articulated understanding of whether/how site-specific conditions (in relation to low ambient DO concentrations) can affect the ability of aquatic life in the Harbor to survive, grow, reproduce and thrive. We expect to be able to draw preliminary (as opposed to definitive) conclusions about the prospects for developing DO site-specific criteria from this work, and based on the overall findings and preliminary conclusions we will make recommendations for further study to field-validate the preliminary conclusions in the final report.

Table 1. List and description of task-specific deliverables and end-products (in addition to the final project report) to be completed in this project.

Task	Deliverable	End-product
1	QAPP for the impact evaluation of projected DO deficits in the NY-NJ Harbor Estuary	Approved QAPP
2.1	Summary of health of existing aquatic life in the NY-NJ Harbor Complex, diversity and abundance of expected species, and identification of data needs	Section of final report with table(s) identifying data needs and information gaps
2.2	Review of the expected aquatic community in the Harbor Complex, including identification of critical habitats/locations and time periods when juvenile/adults life stages are expected to be present	Comprehensive Data (CD) spreadsheet file; narrative and tabulation to be included in the final report
2.3	Identification of critical areas and time periods for three	Tabulations of SWEM DO projections for

Task	Deliverable	End-product
	specific locations in the Harbor Complex where DO is or is projected to be below 3.0 mg/L and/or is below 4.8 mg/L but above 3.0 mg/L (projected current and management alternative conditions)	transmittal to EPA AED for estimation of impairment to larval recruitment and juvenile/adult survival. Evaluation of usefulness (final report).
2.4	Identify aquatic marine species that would be most impacted by the DO conditions in the critical locations & nature of likely impact(s)	Dedicated worksheet within CD spreadsheet file; narrative and tabulation to be included in the final report
2.5	Method to assess relative biological impact of different DO conditions (if possible) similar to Long Island Sound (1996) and identification of data gaps	Presented in final report with tables and figures generated as needed from CD Spreadsheet file
2.6	Compile biological data requirements needed to evaluate significance of DO deficits; note data gaps and design program to establish database	Dedicated worksheet(s) within CD spreadsheet file; narrative and tabulation to be included in the final report
2.7	Summarize site-specific or UAA Dissolved Oxygen Standards approved by USEPA	Dedicated worksheet(s) within CD spreadsheet file; narrative and tabulation to be included in the final report
3.1	Assess current biological conditions in low DO areas to similar areas of DO attainment using the Harbor Benthic IBI.	Dedicated worksheet(s) within CD spreadsheet file containing Harbor Benthic IBI matrix elements
3.2	Method to evaluate spatial extent of low DO to determine level of concern in the Harbor Complex	Maps generated as needed; narrative and tabulation to be included in the final report
3.3	Apply method (from Task 3.2) to identify locations and times of DO deficit of biological concern, including basis for conclusions and prepare a report on locations and times of DO deficit of biological concern.	Dedicated worksheet(s) within CD spreadsheet file identifying locations and times of DO deficit of biological concern
3.4	Conduct an evaluation of projected conditions in 2050 and recommended options for addressing impacts of global climate change impacts on DO	Written text document
4.0	Summary and Conclusions Document	Comprehensive project report for deliverables and products defined above.

TIMELINE: The proposed research anticipated to begin July, 2013 will be carried out following the timeline and milestones indicated below.

		Month								
Project Start	Activity	1	2	3	4	5	6	7	8	Project End
July 2013	Task 2.1: Summarize health and ID Gaps									March 2014
	Task 2.2: Determine species and life stages present									
	Task 2.3: ID critical locations and periods of DO									
	Task 2.4: Identify aquatic life most impacted									
	Task 2.5: Develop method to assess biol. impact									
	Task 2.6: Compile biological data requirements									
	Task 2.7: ID site specific or UAA DO Standards									
	Task 3.1: Compare critical areas vs. similar areas									
	Task 3.2: Method to eval. spatial extent of low DO									
	Task 3.3: Apply method to ID locs/times of concern									
	Task 3.4: Provide eval of projected conditions in 2050									
	Task 4.0: Provide Proj Summary and Conclusions									

PROJECT BUDGET		
BUDGET CATEGORY *(Add/remove itemizing lines below major categories as necessary, but do NOT delete major categories)*	***MATCH***	***GRANT REQUEST***
A. PERSONNEL (list individual names and titles below) **TOTAL:**	**$20,000**	**$31,700**
G.M. DeGraeve, Project Leader		
Dennis McCauley, Lead Aquatic Biologist		
Tyler Linton, Aquatic Toxicologist		
W.K. Taulbee, Biostatistician		
Gregory Smith, Aquatic Biologist / Toxicologist		
Douglas Endicott, Environmental Engineer		
James Stricko, Fisheries Biologist		
B. FRINGE BENEFITS _____% of _____ (e.g., 10% of total personnel costs) **TOTAL:**	**N/A**	
C. TRAVEL (estimate number/purpose of trips below) **TOTAL:**		**$2,300**
One trip for two persons from Traverse City, MI to New York, NY		
for client and subcontractor meetings (3 days/2 nights)		
D. EQUIPMENT (itemize below) **TOTAL:**	**N/A**	
E. SUPPLIES (itemize below) **TOTAL:**		**$1,000**
Literature search, acquisition		
F. CONTRACTS (identify & itemize below) **TOTAL:**		**$15,000**
HDR / HydroQual		7,000
Queens College		8,000
G. OTHER (identify & itemize below) **TOTAL:**	**N/A**	
H. TOTAL DIRECT COSTS (SUM OF A-G)	**$20,000**	**$50,000**
I. INDIRECT COSTS _____% of _____ (e.g., 10% of total direct costs) **TOTAL:**	**N/A**	
J. TOTAL PROJECT COST (SUM OF H+I)	**$20,000**	**$50,000**