Nutrient Sensor Challenge

Beta Test Protocols for In Situ Nutrient Analyzers as part of the Nutrient Sensor Challenge

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ALLIANCE FOR COASTAL TECHNOLOGIES

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1. Background and Objective

The Nutrient Sensor Challenge (www.nutrients-challenge.org) is a market stimulation and innovation effort to accelerate the development, adoption, and use of affordable, reliable, and accurate nitrate and orthophosphate sensors. The goal is to accelerate the development of cost effective (< $5,000 purchase price) new technologies to commercial availability by 2017.

As a resource to all registered participants in the Challenge, the Alliance for Coastal Technologies (ACT, www.act-us.info) is offering the opportunity for optional, no-risk (i.e., no release of instrument performance data or reports) beta testing of prototype nutrient sensors being developed to meet Challenge target criteria (Table 1). This exercise is designed to serve as an internal assessment of these sensors under actual deployments in natural coastal and riverine environments prior to final Challenge verification testing and ultimate commercial instrument production. At this beta-test stage, the sensor should have already passed through a first level of internal, alpha-testing, with obvious defects removed and limitations addressed. However, since emerging technologies may still have minor problems when deployed under varying natural environmental conditions or operated by a third-party, this series of beta-tests will allow participants to identify remaining instrument imperfections or weaknesses. The following protocols describe how ACT will work with registered Challenge participants to carryout a beta test of in situ nutrient sensors at three distinct field sites under realistic deployment scenarios. Reference data collected by ACT will be provided to the beta test participants at each site to be used for their internal improvement processes.

2. Introduction to Technology

This beta-testing opportunity is designed as a resource to enhance the ability of all registered participants to achieve the goal of developing next-generation in situ nutrient sensors and to prepare for final Challenge verification testing in 2016. In order to score highly in the overall Challenge, competing nutrient sensors must be affordable and easy to use, operate over a wide range of concentrations, and meet stated levels of accuracy and precision. Final judging protocols with specific scoring procedures based on commonly accepted practices will be detailed in the final ACT Verification Test Plan. Target instrument features and how points will be weighted are summarized in Table 1. Points will be assigned using weights to assess both exceedance and partial attainment of the targets.

Table 1. Target Nutrient Sensor Features

Measurement Criterion	Nitrate (± nitrite)	Orthophosphate	Weights
Accuracy	± 5 % or 0.01 mg/L - N (at upper range) from reference value	± 5 % or 0.005 mg/L - P (at upper range) from reference value	**20%**
Precision	± 5 % or 0.01 mg/L - N (at upper range) from reference value	± 5 % or 0.005 mg/L - P (at upper range) from reference value	**15%**
Range	0.005 - 60 mg/L – N	0.005 - 2 mg/L – P	**15%**
Deployment Length	3 months (at 15 minute sampling interval)		**25%**
Cost	Less than $5,000 purchase cost Bill of materials for sensor and package		**25%**

For the purposes of this Challenge, "**nutrients**" are defined in terms of the dissolved nitrate (NO_3^-) and/or soluble reactive orthophosphate (PO_4^{3-}) concentration in water. Nitrate concentrations may be inclusive of nitrite (NO_2^-) but must be disclosed. Final verification testing in 2016 will be used to determine accuracy, precision, range, deployment length, and cost according to the targets and weights in Table 1.

- **ACCURACY:** Closeness of the agreement between the result of a measurement and reference values. Estimated by repeated comparisons between instrument measurements and reference water samples. Reported as percent difference (or absolute difference, for high limits of quantification) between reference and measured values.

- **PRECISION:** Closeness of agreement between independent test results obtained under stipulated conditions. Determined by high-frequency, repeated measures during laboratory tests with instruments placed in, or exposed to, known stable conditions. Reported as percent difference (or absolute difference, for high limits of quantification) between repeated samples as compared to one another.

- **RANGE:** Upper and lower limits of quantification. Determined by collecting instrument readings on a known (prepared, sampled, and analyzed) dilution series of the measurement parameter.

- **DEPLOYMENT LENGTH:** Amount of time the instrument can operate in a submerged deployment setting at a depth of one meter below the surface without needed maintenance or recalibration. Successful deployment requires the sensor to perform within the required ranges of accuracy (see Table 1) throughout the deployment duration. Determinations on details such as acceptable levels of instrument drift and/or data loss will be finalized during the Verification Testing Protocol Development Workshop.

4. Beta Testing Approach

These beta testing protocols are based a prior ACT Demonstration of in situ nutrient analyzers (2007) and recommended by ACT Technical Advisory Committee and staff. A consensus was reached that the beta testing protocols will:

- utilize standard, approved laboratory analytical methods to provide best possible measure of the 'true' nutrient concentration from field samples, which will serve as performance standards against which instrument estimations can be compared internally by the individual developer;
- employ USEPA Method No. 365.5 for phosphate as applied in Standard Operating Procedures of the Nutrient Analytical Services Laboratory (NASL) at the Chesapeake Biological Laboratory (CBL), Solomons, MD, where all reference sample analysis will be conducted to determine true nutrient concentrations;
- employ USEPA Method No. 353.4 for nitrate, as modified in the Standard Operating Procedures of NASL to utilize an enzymatic reduction step instead of cadmium

reduction, where all reference sample analysis will be conducted to determine true nutrient concentrations; and

- include moored (up to two weeks in duration) field trials under a wide range of environmental conditions including freshwater, estuarine and marine ecosystems and to the extent possible nutrient concentrations and water quality characteristics (e.g. turbidity).

All ACT personnel involved in this beta test will be properly trained on standardized water sample collection, storage and shipping methods. ACT staff will also be available to assist in the physical deployment and recovery of instrument. However, Challenge participants will be responsible for all other aspects of operation of their instrument(s), including: initial set-up and calibration of the instrument(s), instrument retrieval, and instrument data management. All laboratory nutrient analyses of periodic reference samples will be conducted at the CBL Nutrient Analytical Services Laboratory using standardized automated wet chemistry. All numerical data will be recorded to two significant decimals where appropriate and nutrient concentrations will be reported in either elemental mass units (mgN/L and μgP/L) or as micromoles per liter (μM) for NO_3^- or PO_4^{3-}. These data will be provided in a timely manner following beta testing to each participant to allow them, and them alone, to conduct individual, internal assessments of their instrument's performance.

Each participant may submit up to two instruments for beta-testing (one design for N and one designed for P) for up to two weeks deployment at each of the three beta-test locations within the dates provided below. Selection of specific sites and lengths of deployment are at the discretion of the manufacturer. Field site descriptions are provided below in Section 10. Beta-testing opportunities include the following dates and locations:

- August 13 – 28, 2015: Chesapeake Biological Laboratory, Solomons MD (brackish/estuarine).
- September 14 – 25, 2015: Hawaii Institute of Marine Biology, Coconut Island, Oahu, HI (marine).
- October 19 – 30, 2015: University of Michigan, Huron River, MI (freshwater).

4.1. Phosphate (Orthophosphate) Analysis of Reference Samples

Phosphate concentrations for all reference and quality control samples will be determined by the Nutrient Analytical Services Laboratory at CBL following their Standard Operating Procedures Manual (CEES, UMD, Publication Series No. SS-80-04-CBL). The methodology is based on U.S. EPA Method 365.1, *in* Methods for chemical analysis of water and wastes. (United States Environmental Protection Agency, Office of Research and Development. Cincinnati, Ohio. Report No. EPA-600-4-79-020 March 1979). In brief, ammonium molybdate and antimony potassium tartrate react in an acidic medium with dilute solutions of phosphate to form an antimony-phospho-molybdate complex. The complex is reduced to an intensely blue-colored complex by ascorbic acid. The color produced is proportional to the phosphate concentration present in the sample.

All laboratory nutrient analyses will be conducted on an Aquakem 250 auto-analyzer. A statistically-determined method of detection limit for this instrument has been established at 0.0007 mgP/L by prior laboratory studies. The typical working concentration range for the method and SOP is between 0.0035 and 1.48 mgP/L. The system contains an auto-dilutor to bring any higher concentrations down to the established linear calibration range. A sample reagent blank is analyzed in conjunction with every sample as part of the routine operation of the Aqaukem 250. Approximately 40 samples per hour can be analyzed. All internal standards will be verified and calibrated using certified external nutrient standards (such as Spex Certi-Prep or NIST). In addition, Field Trip Blanks and Field Sample Spike Additions (defined below) will be conducted once per week as part of established quality assurance/quality control (QA/QC) protocols.

4.2. Nitrite + Nitrate Analysis of Reference Samples

Nitrate concentrations for all reference and quality control samples will be determined by the Nutrient Analytical Services Laboratory at CBL following their Standard Operating Procedures Manual (CEES, UMD, Publication Series No. SS-80-04-CBL). The methodology is based on U.S. EPA Method 353.2, *in* Methods for chemical analysis of water and wastes. (United States Environmental Protection Agency, Office of Research and Development. Cincinnati, Ohio. Report No. EPA-600-4-79-020 March 1979), but modified to use an enzymatic reduction of nitrate instead of the traditional cadmium reduction method (Campbell, W.H. E.R. Campbell, and L. Egan 2006. Green Chemistry Nitrate Determination: An Alternative Nitrate Analysis Method. American Laboratory, February 2006). In brief, nitrate in the sample is reduced enzymatically to nitrite in a buffered solution. The nitrite is then determined by diazotizing with sulfanilamide and coupling with N-1-naphthylethylenediamine dihydrochloride to form a color azo dye. The absorbance measured at 540 nm is linearly proportional to the concentration of nitrate + nitrite in the sample. Nitrate concentrations are obtained by subtracting nitrite values, which have been separately determined without the enzyme reduction procedure.

All laboratory nutrient analyses will be conducted on an Aquakem 250 auto-analyzer. A statistically determined detection limit for this method has been established at 0.0007 mgN/L and 0.0006 mgN/L for nitrate and nitrite respectively, by prior laboratory studies for a wide range of salinities. The typical working concentration range for the nitrate method and SOP is between 0.0049 – 5.6 mgN /L. The typical working concentration range for the nitrite method and SOP is between 0.0042 – 0.28 mgN /L. The system contains an auto-dilutor to bring any higher concentrations down to the established linear calibration range. A sample reagent blank is analyzed in conjunction with every sample as part of the routine operation of the Aqaukem 250. As noted above, approximately 40 samples per hour can be analyzed. All internal standards will be verified and calibrated using certified external nutrient standards (such as Spex Certi-Prep or NIST). In addition, Field Trip Blanks and Field Sample Spike Additions (defined below) will be conducted once per week as part of established QA/QC protocols.

4.3. Deployment

Beta tests of instruments in a moored application will be conducted at three ACT Partner Institution sites covering freshwater, estuarine, and marine conditions (site descriptions below). Up to two nutrient sensors from each participant will be deployed for up to two continuous weeks at one or more of the available test sites. Deployment time is at the discretion of the participant, but must occur in the two-week windows identified. As described above, Challenge participants will be responsible for setting up and calibrating their individual instruments as required at the field sites. Instruments must be programmed to record data based on a time interval that will allow for sampling intervals of at least every 15 minutes after the hour (e.g. 12:00, 12:15, 12:30, 12:45, etc). Internal clocks should be set to local time and synchronized against the time standard provided by www.time.gov.

Instruments can be deployed for a minimum of a few hours to a maximum of 14 days at each site and ACT staff can assist in the physical deployment and recovery, as needed. However, participants must work with ACT staff and be prepared with the materials and hardware needed (cords, cables, weights, etc.) to deploy their instrument(s) off docks. Any servicing required during deployment is the responsibility of the participant. Instruments should be set-up as self-recording but participants may add a real-time telemetry component to the test instrument, should they choose. The participant will be responsible for adding this additional component including all required hardware and software (e.g., power, data logging, etc.). ACT staff will work with the instrument developers to design an appropriate sensor deployment at each site and will arrange instruments in a manner so that a single representative field sample can be collected without the potential of interference between instruments. The deployments will also be arranged so that all of the instruments remain at a fixed depth of 1 m below the water surface (using a float system or fixed dock in environments not affected by tidal changes or strong wave action).

The sampling frequency (i.e., the specific timing of when reference water samples will be collected) will be left up to ACT personnel at the individual sites. However, a minimum of two distinct reference water samples, separated by at least 2 hours, will be collected each working day of the week (Monday through Friday). In the event of weather limitations or un-avoidable schedule conflicts it will be permissible to miss a single-timepoint on one day and collect an extra sample the following day to keep a similar number of reference points for each test site. All sampling days and times will be recorded on logsheets and entered into a database of reference sample values.

A standard 2L Van Dorn bottle will be used at each site to collect water samples for laboratory nutrient concentration analysis. These samples will be used as the reference samples for examining instrument performance and stability over time. The sampling bottle will be lowered to the same depth and as close as physically possible to the instruments. The sampling bottle will be allowed to soak at sampling depth for 1 minute prior to sampling. If water is not flowing the bottle will be moved to ensure that it is being flushed with the ambient water. The bottle will be triggered to close at the same time that the test instrument are initiating sample uptake, to ensure that the same water mass is being compared with regards to nutrient concentrations. All environmental reference samples will be processed while wearing clean laboratory gloves to minimize potential sources of contamination. The entire water sample will

be transferred to an acid washed 2L polypropylene bottle. The bottle will be rinsed 3x with small amounts of the sample before filling. The sample will be immediately processed into individual sampling tubes that are ready for respective nutrient analysis or storage. In brief, the field sample will be filtered through a 0.22 µm Nylon filter into chemically clean (acid washed) 20ml polypropylene scintillation vials. Six vials are needed for each reference sample to accommodate 2 separate analytical runs (N and P) at NASL, each of which is performed in triplicate. All filtration devices and sample storage vials should be rinsed with each new sample before a final sample is captured. Filtration will be done either immediately in the field using a chemically clean BD disposable syringe and pre-assembled syringe filter units, or within 10 minutes of collection back at the laboratory using pre-assembled Nalgene, sterile, filtration flask equipped with larger diameter 0.22 µm Nylon filters. The latter arrangement may be required for sites with high particle loads in order to generate a sufficient amount of filtrate. The field sample will be kept on ice in the dark during transport to the lab. Each field sample will be processed in triplicate for each of the nutrient analyses to be performed. Vials will be filled no more than ¾ full to allow adequate headspace for freezing. Filtered samples will also be stored on ice in the field and during transport, and frozen at -20 ºC immediately upon return to the laboratory. Vials will remain upright during the freezing processes, and caps will be re-tightened after the water has frozen as they may loosen during freezing.

Between each consecutive sample taken on the same day, sample bottles and filtration equipment will be rinsed with the new sample water. Filtration apparatus and sample storage vessels will be cleaned daily by acid washing with 10% HCl and copious rinses (5x) with high purity deionized water back at the laboratory.

Samples will be shipped frozen to NASL at CBL for nutrient analysis after each week of beta testing at the three sites. Samples will be shipped using either dry ice or liquid nitrogen dry shippers if deemed necessary. Each test site will conduct a preliminary 'shipping test' to ensure that samples will remain frozen under either convention. Shipping containers will be sent for next morning delivery, or the soonest possible delivery time possible from a given shipping location. All samples, including the condition shipped and received, will be recorded onto Chain of Custody (COC) forms and a copy will be sent with the samples. The laboratory will confirm receipt and condition of samples within 24 hours of their arrival by signing and faxing a copy of the form to the test site. Original copies of these forms will be maintained on site.

4.5. Ancillary Environmental Data

Basic water quality ancillary data will also be collected during field deployments to both fully characterize the different field conditions during testing and to provide qualitative comparisons as to whether particular environmental parameters correlate with instrument nutrient measurements. At each of the mooring test sites, a calibrated CTD package will be positioned at the same depth as the test instruments to provide an independent record of conductivity and temperature measured at similar 15-minute intervals. All CTD data, collected from each site, will also be provided to all participants.

5. Data Collection, Review and Distribution

A variety of data will be acquired and recorded electronically and manually by ACT staff in this beta test. Results from the reference method and ancillary measurement will generally be documented in a field/laboratory record book and on the data sheet/chain-of-custody forms (see Table 2). An electronic copy of these raw data will be transferred to the ACT Chief Scientist, who will organize and store the study data. The results from the individual test instruments will only be viewed or handled by the corresponding Challenge participant.

Table 2. Summary of ancillary and reference method information to be recorded by ACT staff during each field deployment as part of the beta-test.

Data to be Recorded	**Responsible Party**	**Where Recorded**	**How Often Recorded**	**Purpose of Data**
Dates, times of sampling events	Each ACT Site	Field record books/data sheets	Each reference sample collection and laboratory analysis	Used to organize/check test results; manually incorporate data into spreadsheets - stored in study binder
Test parameters (site conditions)	Each ACT Site	Field record books/data sheets	Each reference sample collection	Used to define site characteristics; manually incorporate data into spreadsheets - stored in study binder
Reference analytical results	CBL Nutrient Analytical Services Lab	Laboratory record Book/data sheets	At the conclusion of each analytical sample batch.	Used to check test results; manually incorporate data into spreadsheets - stored in study binder
Reference calibration data	CBL Nutrient Analytical Services Laboratory	Laboratory record books/data sheets	Whenever zero and calibration checks are done	Document correct performance of reference method

All data will be recorded directly in the field/laboratory record book as soon as they are available. Records will be written in water-proof ink, written legibly, and have any corrections initialed by the person performing the correction. Any corrections will be crossed out with a line (not blackened or white-out), and the correction made, with initials and date of correction. These data will include electronic data, entries in field/laboratory record books, operating data from the test sites, and equipment calibration records. Records will be spot-checked within one week of the measurement to ensure that the data are recorded correctly. The reviewer will not be the individual who originally entered the data. Data entries will be checked in general for obvious errors and a minimum of 10 percent of all records shall be checked in detail. Errors detected in this manner will be corrected immediately. The person performing the review will add his/her initials and the date to a hard copy of the record being reviewed. ACT staff will place this hard copy in the files for this beta-test. In addition, data generated by each ACT test site will be provided to the ACT Chief Scientist and reviewed before they are distributed to participants.

6. Quality Management

All technical activities conducted by ACT comply with ACT's Quality Management System (QMS), which includes the policies, objectives, procedures, authority, and accountability needed to ensure quality in ACT's work processes, products, and services. ACT's QMS meets the requirements of ISO/IEC 17025:2005(E), *General requirements for the competence of testing and calibration laboratories*; the American National Standards Institute (ANSI)/American Society for Quality (ASQ) E4-2004 *Quality Systems for Environmental Data and Technology Programs*; and U.S. Environmental Protection Agency, quality standards for environmental data collection, production, and use.

6.1. Quality Control for Field Sample Handling and Laboratory Analyses

Field quality control represents the total integrated program for assuring the reliability of measurement data. It consists of the daily field logs, quality control samples, and sample custody procedures.

Standard, uniform field logs will be maintained for all fieldwork. These logs will report name of staff conducting fieldwork, date (month, day, and year), operating status of all equipment, and manual readings of environmental conditions. All reference samples will be accompanied by the sample collection sheet and Chain-of-Custody (COC) forms. The COC specifies time, date, sample location, unique sample number, requested analyses, sampler name, time and date of transaction between field and laboratory staff, and name of receiving party at the laboratory. Proper labeling of sample bottles is critical. The COC is a mechanism by which a sample can be tracked through the various phases of the process: collection, shipping, receiving, logging, sample prep/extraction, analysis and final data QA review.

All collected reference samples at each test site will be handled in the same manner. All environmental reference samples will be processed while wearing clean laboratory gloves to minimize potential sources of contamination. Each reference sample will be dated and coded according to site and sample sequence. The actual sample container will be labeled with a number for identification. The reference sample number will be used in all laboratory records and COCs to identify the sample. Transfer of reference samples from field personnel to laboratory personnel is also recorded on the COC, and records are maintained in the laboratory with the names and signature of persons leaving and receiving the custody. Samples stored for any period of time will be routinely inspected by the ACT Technical Coordinator to assure proper preservation and label integrity. The storage containers and storage devices (i.e. freezers and refrigerators) must be visually inspected on a routine basis to assure proper operation and integrity. Results of all inspections will be included in the sample records. All logs will be duplicated weekly. The original will be retained at the ACT Partner site and a copy will be sent to the ACT Chief Scientist.

As part of laboratory QC, all laboratory instrumentation at NASL used to measure nutrient concentrations of the reference samples will be calibrated by a highly trained technician using established SOPs that have met both State of Maryland and ACT audit checks. NASL will maintain a log of all calibration and reference QC samples analyzed during the Demonstration. The logs will include at least the following information: name and identification number of

instrument, date of calibration, and calibration results. These logs will be provided to the ACT Chief Scientist and maintained in a master calibration file as part of the QA/QC records. QA/QC samples will include:

- Internal Nutrient Calibration Standards - Solutions prepared from stock standard solutions to calibrate the laboratory instruments with respect to analyte concentrations. Five standards will be measured in duplicate during each set of analyses. Consistency in absorbance values for each standard will be compared to long-term daily records.
- External Certified Nutrient Standards - An external certified nutrient standard will be prepared and analyzed in duplicate during each set of analyses. External standards are used to verify the accuracy and consistency of the internal calibration standards.
- Laboratory Reagent Blanks - an aliquot of reagent water that is treated exactly as the laboratory calibration standards including exposure to glassware, equipment, and reagents

6.2. Quality Assurance Technical Assessments

Technical assessments are used to check that data collection is conducted to produce data of the type and quality to meet the purpose of the test. ACT uses several types of technical assessments: Technical Systems Audits (TSA), Audits of Data Quality, and Performance Evaluation Audit (PEA).

A TSA is a thorough, systematic, and qualitative evaluation of the sampling and measurement systems associated with an ACT Verification Test. A different type of TSA – surveillance - will be performed for the Nutrient Sensor Demonstration. Surveillance is an oversight activity that field and laboratory procedures. It is less formal than a TSA. The objective of surveillance is to provide confidence through real-time observations that an activity has been performed in accordance with the approved and specified methods and procedures described in these Protocols and relevant SOPs. At the end of the surveillance, the AC QA Manager will present an informal summary of the findings to the ACT Chief Scientist.

7. Beta-Test Schedule

- Deadline for participants to confirm which specific sites and dates they will be taking part in beta testing – May 29, 2015.
- Conference call(s) to discuss beta testing logistics – TBD June, 2015
- Beta-test 1: Chesapeake Biological Laboratory, Solomons MD (brackish/estuarine) – August 13 - 28, 2015
- Reference sample and ancillary data from beta-test 1 provided to participants – September 11, 2015
- Beta test 2: Hawaii Institute of Marine Biology, Coconut Island, Oahu, HI (marine) – September 14 - 25, 2015

- Reference sample and ancillary data from beta test 2 provided to participants – October 16, 2015
- Beta test 3: University of Michigan, Huron River, MI (freshwater) – October 19 - 30, 2015
- Reference sample and ancillary data from beta test 3 provided to participants – November 20, 2015

8. Roles and Responsibilities

The ACT Chief Scientist has the overall responsibility for ensuring that the technical goals and schedule established for the beta test are met. The ACT Chief Scientist will:

- Prepare the Beta Test Plan in consultation with ACT TAC and staff.
- Coordinate testing, measurement parameters, and schedules at each ACT Partner institution testing site.
- Ensure that all quality procedures specified in the test/QA plan are followed.
- Respond to any issues that may arise during the beta tests.
- Serve as the primary point of contact for participants and ACT staff.
- Provide reference sample and ancillary data to participants.
- Ensure that confidentiality of proprietary participant technology and information is maintained.

The ACT QA Manager will:

- Review the Beta Test Plan.
- Review at least 10% of the reference sample data.
- Verify implementation of any necessary corrective action.
- Ensure that confidentiality of proprietary manufacturer technology and information is maintained.

ACT Technical Coordinators at each ACT Partner institution will:

- Assist in developing the Beta Test Plan.
- Allow facility access and provide working space to the participants during the field test periods.
- Select a secure location for the beta tests.
- Support participants in the deployment and recovery of instruments as needed.
- Perform sample collections and analyses as detailed in the test procedures section of the beta test plan.
- Provide all test data to the ACT Chief Scientist electronically, in a mutually agreed upon format.

The Nutrient Analytical Services Laboratory at CBL will:

- Perform reference sample measurements.
- Perform all QA/QC analysis as detailed in this beta test plan.
- Provide the ACT Chief Scientist and QA Manager access to and/or copies of appropriate QA documentation of test equipment and procedures (e.g., SOPs, calibration data).

Challenge participants will:

- Commit to a specific set of locations and dates for beta testing according to this test plan.
- Setup, calibrate, deploy, operate, maintain and recover test instruments at the locations and dates agreed to.
- Provide all materials, supplies and equipment needed to setup, calibrate, deploy, operate, maintain and recover test instruments.

Note: ACT reserves the right to dismiss any participant from beta testing if they do not comply with agreed upon schedules or requirements.

Nutrient Analyzer Technical Advisory Committee will:

- Review and comment on Beta Test Plan.
- Provide specific advice during testing, as needed.

9. Nutrient Challenge Technical Advisory Committee

- Suzanne, Bricker, National Oceanic and Atmospheric Administration
- Brian Pellerin, U.S. Geological Survey
- Dwane Young, U.S. Environmental Protection Agency
- Matt Cohen, University of Florida
- R. David Holbrook, National Institute for Standards and Technology
- Chris Gross, U.S. Department of Agriculture NRCS
- Joe Rudek, Environmental Defense Fund

10. Field Test Site Descriptions

Chesapeake Biological Laboratory

The ACT Partner at Chesapeake Biological Laboratory (CBL), University of Maryland Center for Environmental Science, has established a Technology Verification Field Test Site on a fixed pier (Lat: 38°19.039 N, Lon: 76°27.065 W, with an average depth of 7 ft) at the mouth of the Patuxent River, a tributary of the Chesapeake Bay. The Chesapeake is a nutrient rich estuary with a watershed that encompasses portions of six states and the District of Columbia. Water temperatures at the testing location can range from 0° to 35°C (likely 28° to 32°C in August) and salinities range from 5 to 20 psu depending on season, rainfall, wind, and other external factors.

University of Michigan

The ACT Partner at the University of Michigan will establish a mooring on a fixed dock located within the Huron River just north of the city of Ann Arbor, MI. The water depth at the mooring location is xx meters and the mean river flow during September is expected to be about 200 cfs. Water temperatures at this site can be expected to vary between 20 – 25 oC. The Huron River runs for a total of 125 miles before discharge into Lake Erie with a watershed of approximately 900 square miles. The drainage are includes seven Michigan counties with a mixture of land uses ranging from natural preserves, farmland, urban, and suburban and a population of 500,000.

Hawaii Institute of Marine Biology

The ACT Partner at the Hawaii Institute of Marine Biology (HIMB) is part of the University of Hawaii with a field site will be on the Kaneohe Bay Barrier Reef flat (157°48'W, 21°28.5') in waters ~2 m deep. Kaneohe Bay sits on the northeast, or windward, side of Oahu. The barrier reef acts as a physical divider separating coastal waters from the Kaneohe Bay lagoon and coastal ocean, as well as impeding the passage of surface wave energy into the bay interior. Water temperatures at this site vary between 21 and 29°C and salinities are between 34 and 36 psu.