



Nutrient Sensor Challenge

Guidelines

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1. ABOUT

These Guidelines summarize the requirements and rules of the Nutrient Sensor Challenge (hereafter “Challenge”). The requirements herein are binding on participants as provided in the Participant Agreement. The Challenge has been developed with input from the Technical Advisory Committee (TAC) as described in Section 11. From here forward the Challenging Nutrients Coalition including the Alliance for Coastal Technologies (ACT) will be referred to as “the organizers.”

2. GOALS AND INCENTIVES

The Nutrient Sensor Challenge 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 these affordable (< \$5,000 purchase price) new technologies to commercial availability by 2017.

Benefits to Challenge participants include:

- **Being at the lead of an emerging market.** Technologies participating in the competition will be highly visible to potential buyers looking for cost-effective solutions to monitor nutrients.
- **High-visibility exposure.** Winners will demonstrate robust and creative technical approaches that showcase expertise and leadership within the industry. The most successful developers will garner credibility and publicity with academic, environmental, industry, and technology leaders.
- **Verified performance.** Participants will benefit from no-cost beta testing and independent verification testing that can be used to promote and market sensors and as a foundation for future instrument approval or certification.
- **Access to resources.** Participants will gain access to experts in the field, the end user community, entities that certify and approve methods and instruments, and potential innovation partners and/or supporters.

3. CHALLENGE CRITERIA

A complete description of verification testing procedures will be provided in the Final Verification Plan that will be prepared and adopted by the organizers and will be provided to each participant as an attachment to these Guidelines following the Protocol Workshop. Please see Section 8 for details on verification testing and evaluation criteria.

In order to score highly in the Challenge, entries must be affordable and easy to use, operate over a wide range of concentrations, and be both accurate and precise. Judging protocols with specific scoring procedures based on commonly accepted practices will be detailed in the final verification plan. Table 1 (below) summarizes how points will be weighted. Points will be assigned using weights to assess both exceedance and partial attainment of the targets. In the event that no sensors meet all of the target sensor features, awards will still be given to first, second, and third place performers in both the nitrate and phosphate categories.

Table 1. Target Nutrient Sensor Features

Measurement Criterion	Nitrate (\pm nitrite)	Orthophosphate	Weights
Accuracy	$\pm 5\%$ or 0.01 mg/L - N (at upper range) from reference value	$\pm 5\%$ or 0.005 mg/L - P (at upper range) from reference value	20%
Precision	$\pm 5\%$ or 0.01 mg/L - N (at upper range) from reference value	$\pm 5\%$ 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^-) if disclosed.

Entries will be judged on 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.
- **COST:** Total cost as demonstrated by the Bill of Materials submitted in the Application for Verification Testing for item 1, sensor components (including enclosure) and item 2, package for unattended, continuous operation of the instrument. Components in item 2 must include the equipment for data storage and management, power, and anti-fouling accessories required for an unattended three-month deployment. Evaluation of cost will be based primarily on the

sensor components (item 1) and secondarily on the total package cost (items 1 and 2) relative to the other sensors in the verification testing phase.

To quantify instrument performance, nutrient *reference samples* will be collected and analyzed, to produce *reference values*, using agreed-to, EPA-approved standard methods.

4. CHALLENGE PHASES

The Challenge will occur in four phases. Participants will only be scored during verification testing.

Table 2. Challenge Timeline

Registration	
Challenge registration opens	December 2014
Challenge registration closes	March 2015
No-Risk Beta Testing (Optional)	
Beta testing plans, locations, and schedules released	June 2015
Challenge Summit	August 2015
Beta testing at Sites A - C	August - October 2015
Verification Testing (Required)	
Protocol Workshop for verification testing	February 2016
Laboratory verification testing	April 2016
Field verification testing at Sites D - F	May - September 2016
Judging and Awards	
Final verification reports published and awards announced	December 2016

Note: *Specifics on the above testing dates and locations will be confirmed following the close of Challenge registration. Number and location of sites are subject to change depending on the availability of federal funding. Sites are likely to include locations such as riverine, estuarine, and coastal oceanic systems.*

5. PARTICIPATION

The Challenge is open to technology developers globally. To be eligible to compete, participants must comply with all the terms of these Challenge Guidelines and will be required to sign a Participant Agreement, which registrants will receive upon submission of a completed Registration Form. This agreement contains restrictions and requirements for applicants that are intended to prevent conflicts of interest and provide a transparent, open process.

The Challenge organizers reserve the right to limit, or restrict upon notice, participation in the Challenge to any person or entity at any time as set forth in the Participant Agreement. Similarly, applicants may

withdraw as set forth in the agreement. Individuals may form teams, and teams may merge, reorganize, collaborate and/or share technical assets during the course of the Challenge in order to create the most effective submissions with the highest likelihood of winning the Challenge, subject to the terms and conditions in the Participant Agreement. The Challenge is void in those countries where prohibited or restricted by law. Participation in the Challenge does not require any licensing or transfer of intellectual property, which will remain with the owners.

6. REGISTRATION

Participation in the Nutrient Sensor Challenge will begin upon participant's submission and the Challenge's receipt of the Registration Form.

6.1 REGISTRATION FORM. The Registration Form is available for download on the Challenge website (<http://www.nutrients-challenge.org/>). Each completed Registration Form must be submitted by 5 pm ET on March 16, 2015 to info@nutrients-challenge.org. The Registration Form provides the following:

- Nitrate/Phosphate Indication: Are you registering as a nitrate and/or phosphate sensor developer?
- Technology Name: Including commercial state and any trade names of the technology.
- Participant(s) Information: Including contact information and any existing patent/license agreements.
- Beta Testing Intent: Do you plan to participate in the no-cost, no-risk beta testing during August-October 2015?
- Technology Description: Including basic operating principle and specifications but excluding any proprietary or confidential information.
- Operating Information: Intended use, deployment mode, and environment.

6.2 APPROVAL OF REGISTRATION. Registration must be approved and accepted by the Challenge organizers by the deadline in order for an individual/team to compete and be eligible to receive any awards. The Challenge organizers may refuse registration for any reason, including, but not limited to, the organizers' determination that a prospective entrant: (i) lacks the understanding of the financial or technical means required to present a viable entry; (ii) is not or will not remain an eligible entity; (iii) is not likely to comply with the terms of the Participant Agreement; or (iv) is likely to disrupt relationships with the other entrants, sponsors, or otherwise unreasonably endanger the administration of the Challenge or related activities. The Challenge organizers will review registration materials for completeness and for compliance with the principles and rules of the Challenge using all available information. The Challenge organizers may pose additional questions or request clarification to supplement the registration materials as part of its evaluation. All rejection or acceptance decisions by the Challenge organizers will be final and in its sole and absolute discretion.

7. NO-RISK BETA TESTING

No-risk beta testing is optional and open to all participants. The organizers strongly encourage new developers to take advantage of beta testing opportunities. The specific sites and dates for beta testing will be released to participants in June 2015 and publicized on the Nutrient Sensor Challenge website

(<http://www.nutrients-challenge.org/>). Following the release of testing site details, participants will be asked to indicate at which beta testing location(s), if any, they would like to participate via email to info@nutrients-challenge.org.

7.1 CHALLENGE SUMMIT. A Challenge Summit will be held in the Washington, D.C., area in August 2015 in coordination with the first beta testing. The purpose of the Challenge Summit is to provide learning and networking opportunities for participants. Activities at the summit will include strategies for fundraising and sponsorship, guidance on instrument certification and approval processes, and opportunities for networking and team-building among participants. Costs associated with travel to and from the Challenge Summit will be the responsibility of the participants. Participants not engaging directly in beta testing are also encouraged to attend.

7.2 BETA TESTING. Beta testing will be available at three sites from August through October 2015 and will include a freshwater lake or river, a brackish estuary, and a coastal ocean environment. Location and other details will be finalized in June 2015, as described above.

Beta testing will be available within a two-week window at each site. During beta testing, reference samples will be collected by ACT partners at least once daily Monday-Friday. Collection, handling, and analyzing samples by ACT partners will conform to standard EPA methods. Participants are responsible for the preparation, deployment, maintenance, and recovery of their own sensors. Following beta testing at each site, participants will be provided with the ACT laboratory analysis results, against which they can compare their sensor's performance. The organizers will not compare sensor results to reference samples or publicize any participant's performance. All beta testing activities are subject to the availability of funding. Some funds to support participant travel to beta testing sites may be available.

8. VERIFICATION TESTING

Verification testing consists of laboratory tests for sensor performance and field tests for both performance and durability. All verification testing activities are subject to the availability of federal funding. Participants shall have no right to observe other participants' testing or evaluation, or to be informed of other participants' calculations, measurements, and results, unless such information is made publicly available by the organizers.

8.1 APPLICATION FOR VERIFICATION TESTING. In winter 2015, participants must submit an application to participate in verification testing. The application will be available on the Nutrient Sensor Challenge website and must be submitted by email to info@nutrients-challenge.org. This application includes the following components:

- Detailed description of the sensor methodology: detailed engineering drawing, specifications, photo of sensor prototype.
- Technical data (accuracy, precision, range) from prior laboratory- and/or field-based testing. Results from Nutrient Sensor Challenge beta testing may be used for this section.
- Estimates for cost:
 - Bill of Materials – to include:
 - Item 1: The essential components for the sensor (including the enclosure).

Item 2: Any peripheral instruments and/or accessories necessary for deployment and continuous, real-time data transmission (data storage and management, power, and anti-fouling accessories required for a three-month unattended deployment). The Bill of Materials will be verified prior to laboratory testing. Discrepancies between the submitted Bill of Materials and the actual sensor and package components are grounds for disqualification from the Challenge.

- Estimated consumer price if (a) 50 and (b) 1000 units were produced.
- Estimated annual operations costs to consumer, including expected manufacturer servicing intervals, post-warranty repairs, and any required consumables for one year of continuous operation.
- A technical guide to calibration, preparation for deployment, and operation.
- A description of expected effort for calibration, deployment, operation and maintenance, and expected sensor lifetime.

Application materials will be reviewed prior to acceptance into verification testing. Verification testing may be restricted to the 16 entries (8 nitrate and 8 phosphate) that have the lowest estimates for sensor cost (Bill of Materials item 1, sensor components including enclosure).

8.2 TESTING PROTOCOL DEVELOPMENT WORKSHOP. In winter 2015, the Draft Verification Testing Protocol will be available on the website during the open application period for verification testing. Upon acceptance into verification testing, participants will engage in a one-day Protocol Development Workshop (location to be announced at a later date). This workshop will build consensus among the participants regarding the specific details of the testing protocol. The Final Verification Plan will be published on the Nutrient Sensor Challenge website prior to laboratory verification testing.

At the conclusion of the Protocol Development Workshop, participants will be required to sign an Agreement to the Final Verification Plan. This plan will also stipulate that sensors must be tested at all verification test sites and that results will be made public through a series of ACT reports developed for each sensor. Proprietary information (including Bill of Materials and purchase price estimates) will not be included in the reports. All data collected during verification testing by the instruments are the property of the participant and cannot be used by any other party without consent.

8.3 SENSOR TRAINING. For laboratory testing, participants must send at least one and no more than two representatives to laboratory verification. Participants will be given up to four hours to provide training to ACT technicians on the use, maintenance, calibration, and preparation for deployment for their sensor. Participants may stay for the duration of laboratory verification but are not required to do so.

Participants should design their sensors to be easily prepared for field deployment within four hours by a skilled research technician who has a non-engineering bachelor's degree, has received training from the participant, and has access to a participant-provided operator's manual. Participants will have the opportunity to train technical personnel on preparation for field deployment, maintenance, and use of their sensor during the laboratory verification testing period. Technicians will thereafter prepare, maintain, and operate sensors during both laboratory and field verification testing.

8.4 LABORATORY TESTING will be held in April 2016 in coordination with the first field verification test site. Accuracy, precision, and range of sensors will be measured during laboratory testing. Laboratory results for accuracy will be pooled with results from field testing (see Section 8.5 below) for a composite score. Participants are required to cover their own costs for travel to the laboratory testing, though their presence is not required after the initial training phase. Exclusive of training time, laboratory testing is expected to last for approximately one to two weeks.

8.5 FIELD TESTING will occur May - September 2016, beginning immediately following laboratory testing. Accuracy and deployment length will be measured and scored during field testing. Field testing results for accuracy will be pooled across sites and with results from laboratory testing for a composite score. Two field sites will test the sensors for one month, and one field site will test the sensors for three months. All field testing will be done at a depth of one meter below the surface.

9. JUDGING

In addition to meeting the technical criteria, participating technologies will be evaluated by an independent Judging Panel. The Judging Panel will consider all the testing results and additional documentation and make recommendations to the Technical Advisory Committee (TAC) (described in Section 11). ***ACT will only provide the independent, third-party performance data for each participating instrument and will not be involved in judging or the selection of Challenge winners.***

9.1 SELECTION OF JUDGES. The Judging Panel will be composed of highly qualified and impartial judges. The duties and responsibilities of the Judging Panel will include, but not be limited to: (i) evaluating participant compliance with the Agreement and these Guidelines for the purposes of the Challenge; and (ii) the awarding of points and selection of participants and entries. The organizers, in their sole and absolute discretion, will recommend Judging Panel candidates to the TAC for its review and consideration. The TAC will select the candidates it believes are best suited to serve on the Judging Panel. Each judge will enter into a Judging Agreement with the organizers that will: (i) outline the judge's duties and obligations; (ii) require each judge to maintain confidentiality of ACT's and participant's confidential information in accordance with the Participant Agreement; and (iii) require each judge to acknowledge that he or she shall make no claim to participant's intellectual property.

9.2 POINTS. Points will be assigned to participants by the Judging Panel according to the weights described in Table 1. Points will be awarded by the Judging Panel based on accuracy, precision, range, deployment length, and cost. Precision and range will be solely evaluated from laboratory verification results. Accuracy will be evaluated based on a pooled sample of laboratory and the three field verification testing results. Deployment length will be evaluated based on a pooled sample of field verification testing results. Cost will be evaluated based on Table 1 and as defined in Section 3. Quantitative scores for each of these categories will be based on commonly accepted practices.

Members of the Judging Panel will also have access to all of the information provided in the application for verification testing.

Participants shall cooperate with the organizers and the Judging Panel in all verification activities. It is expected that deployed sensors will conform to the judging activities, including having no impact

or interference with other devices. Excessive interference may be cause for removal from the assessment and/or the Challenge. Application of the judging criteria to eligible Challenge entries shall be at the Judging Panel's sole and absolute discretion.

9.3 INDEPENDENT JUDGING PANEL. The Judging Panel will be independent of the organizers and all participants. No judge, nor any member of judge's immediate family, shall participate, nor have any financial or other material interest, in any participant. All members of the Judging Panel shall promptly disclose to the organizers any such current, former, or expected future conflict of interest with the organizers and/or any participant.

9.4 GROUNDS FOR JUDGING PANEL DECISIONS. Official recommendations made by the Judging Panel will be approved by a majority of the judges who vote on each such decision after careful consideration of the testing protocols, procedures, guidelines, rules, regulations, criteria, results, and scores set forth in the judging agreement. If any vote of the judges results in a tie, then the Judging Panel shall determine, in its sole and absolute discretion, the mechanism to settle the tie. Similarly, if one or more participants or entries are tied at any stage during the Challenge, the Judging Panel shall have the sole and absolute discretion to settle the tie. If no sensor meets the criteria for any award, then the -will retain sole and absolute discretion to declare or not declare a winner of the Challenge and/or otherwise allocate or choose not to allocate one or more of the awards and/or any other award associated with the Challenge.

9.5 RECOMMENDATIONS FROM THE JUDGING PANEL. Judging Panel shall have sole and absolute discretion: (i) to allocate duties among the judges; (ii) to determine the degree of accuracy and error rate that is acceptable to the Judging Panel for all Challenge calculations, measurements, and results, where not specified; (iii) to determine the methodology used by the Judging Panel to render its decisions; and (iv) to recommend Challenge winners to the organizers. The organizers and participants agree not to dispute any decision or recommendation of the Judging Panel, including decisions regarding the degree of accuracy or error rate of any Challenge calculations, measurements, and results.

10. AWARDS AND RECOGNITION

Awards will be based on recommendations from the Judging Panel for meeting and/or exceeding the targets listed in Table 1. Awards of first, second, and third place will be given to the top performing sensors in both the nitrate and phosphate categories. These awards will be based on either:

- The highest aggregate scores for sensors exceeding all targets, with weighted assignment of points based on relative performance across all sensors that met targets.
- The highest aggregate scores for sensors meeting some subset of targets, with weighted assignment of points used to assess partial attainment of targets.

Challenge Recognitions will also be given to all those sensors that meet all targets but do not receive first, second, or third place awards in their respective categories. The Judging Panel may take into account the following characteristics in final decision-making:

- Innovative approach
- Estimates of price to consumer and total annual operating costs

- Sensor performance across aquatic environments

Awards and Recognitions will be announced in December 2016 at a venue to be announced at a later date. The organizers reserve the right to re-assess the judging criteria and targets in the event they are determined to be unnecessarily stringent and/or unattainable.

11. TECHNICAL ADVISORY COMMITTEE

The Technical Advisory Committee (TAC) will provide expert oversight and guidance on Challenge structure, judging criteria, and testing protocols of the Challenge. All members of the TAC and ACT Testing Team will be required to sign non-disclosure or similar agreements, as well as statements acknowledging that they have no conflicts of interest and make no claim to the Intellectual property developed by participants or relevant participant sponsors or partners. The TAC will remain in place throughout the Challenge and will continue to advise the organizers regarding the scientific elements of the Challenge.

Technical Advisory Committee:

- U.S. Environmental Protection Agency
- National Oceanic and Atmospheric Administration
- U.S. Department of Agriculture
- National Institute for Standards and Technology
- U.S. Geological Survey
- Non-profit organizations
- Universities

The TAC is independent of the organizers and all participants. No TAC member, nor any member of the TAC member's immediate family, shall participate, nor have any financial or other material interest in any participant. All members of the TAC shall promptly disclose to the organizers any such current, former, or expected future conflict of interest with the organizers and/or any participant.

12. BRANDING AND STYLE GUIDE

12.1 USE OF MARKS. Except as expressly set forth in the Participant Agreement or in these Guidelines, participants shall not use the names, trademarks, service marks, logos, insignias, trade dress, or any other designation of source or origin subject to legal protection, copyrighted material or similar intellectual property ("Marks") of the organizers or other Challenge partners, sponsors, or collaborators in any way without such party's prior written permission in each instance, which such party may grant or withhold in its sole and absolute discretion.

12.2 OFFICIAL NAME. Participants acknowledge the Challenge's official name is the "Nutrient Sensor Challenge" and that this name is subject to the restrictions set forth in these Guidelines. Participants agree to exclusively and accurately use the Challenge's name when referring to the Challenge, including, without limitation, in all news coverage, Challenge media, advertising, public relations, and marketing materials that reference the organizers or the Challenge.