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June 9, 2023

Mr. Robert Weber, Coastal Program Manager
Town of Palm Beach Public Works Department
951 Old Okeechobee Road
West Palm Beach, FL 33401

Re: Proposal for the 2023 regulatory hardbottom monitoring and report required by the Beach Management Agreement (BMA) for the 2020 Mid-Town Beach Nourishment Project and 2022 Palm Beach Harbor Operations and Maintenance Project in Reach 2

Dear Mr. Weber:

Coastal Eco-Group is pleased to provide the Town of Palm Beach with the following proposal for the 2023 regulatory monitoring required by the BMA for the 2020 Mid-Town Beach Nourishment Project and the 2022 Palm Beach Harbor Operations and Maintenance Project in Reach 2. The specific scope of work to be implemented in 2023 is based on FDEP's revised Cell-Wide Monitoring and Mitigation Plans (Appendix B of the BMA). This proposal is being submitted to the Town on a Time and Materials–Not to Exceed basis for the services as described herein.

This scope covers the 2023 Year 3 post-construction regulatory monitoring for the 2020 Mid-Town Beach Nourishment Project and data analyses/report preparation of the 2023 annual report. The 2023 report will include evaluation of potential project-related effects of the 2020 Mid-Town Beach Nourishment Project relative to variability documented at the BMA transects (data/report to be provided by others) in the evaluation of project-related effects. The 2023 survey is the first post-construction survey of the two regulatory transects for the Palm Beach Harbor Operations and Maintenance Project in Reach 2.

The specific scope of work to be implemented is based on the 2021 BMA Cell-Wide Monitoring and Mitigation Plans. Methods repeated directly from the BMA cell-wide monitoring plan are shown in italics below.

Nearshore hardbottom edge survey
The nearshore hardbottom edge adjacent to the Mid-Town project area (FDEP control monument R-87 south to R-105) and Palm Beach Harbor Operations and Maintenance Project (Palm Beach Inlet south to R-82) will be mapped by CEG divers. The nearshore hardbottom edge is defined as the western border of exposed hardbottom areas, or the position of the landwardvisible border between sand and hardbottom defined by emergent biota. Survey

mapping methods are compliant with the BMA cell-wide monitoring plan for mapping of the nearshore hardbottom edge.

A two-person dive team (one scuba diver/one snorkeler) will follow the nearshore edge; one diver will follow the edge on the bottom and collect digital video documentation while the snorkeler on the surface pushes a float with a SP60 GNSS receiver directly above the diver on bottom. The SP60 GNSS Receiver transmits continuous, corrected positions to an XDL Rover 2 radio on the survey vessel. These positions are transmitted to a handheld tablet on the vessel via Bluetooth technology. This system allows the dive team to map the hardbottom edge untethered to the vessel. The positions are simultaneously viewed and stored as a shapefile in ArcPad on the tablet during the field survey.

The hardbottom video and relief characterization points will be georeferenced in the field. The video diver will record periodic relief measurements along the hardbottom edge. The snorkeler will signal to the vessel to record a GPS point at the location of each relief measurement, and each point will be assigned a number, which is then relayed back to the diver on bottom. Coordinates will also be taken to georeference the video record; the snorkeler will signal the boat at the beginning of each video segment, and a coordinate will be recorded. In the office, navigational data collected from the vessel-based mapping system will be imported into ArcGIS 10.7.1 and exported as a single line shapefile containing numerous line segments. Relief measurements will be exported as a separate point shapefile. The final video record will be georeferenced with the video reference points, and the video will be hyperlinked in the attribute table of the GIS point shapefile. An ArcMap document with video hyperlinks will be submitted to the FDEP and Town on an external hard drive.

Permanent Transects
Mid-Town Project Area
Table 1 provides a list of the regulatory benthic and sediment transects in the Mid-Town Project monitoring area that will be monitored during the 2023 BMA regulatory survey. The regulatory transects extend for a maximum distance of 150 m from the nearshore hardbottom edge. The updrift/downdrift transects at R-88 and R-103 and two former BMA transects within the Mid-Town Project area, R-94 and R-95 natural, were re-classified as Mid-Town regulatory transects in 2021 and will be used to evaluate project-related effects. CEG will sample the entire artificial reef transect at R-95 Breaker's Rockpile; the transect extends approximately 185 m from the shoreline. In consultation with FDEP staff, the 60-m natural hardbottom transect at R-95, which starts immediately waterward of the Breaker's Rockpile transect, will re-numbered as 0 to 60 m since the transect begins at the natural hardbottom edge at R-95.

Reach 2 Project Area
Two transects in Reach 2, R-80.5 (installed on June 22, 2015) and R-82 (installed on August 2, 2022), are regulatory transects for the 2022 Palm Beach Harbor Operations and Maintenance Project. The 2023 survey is the first post-construction survey of these two transects.

Table 1. Town of Palm Beach Mid-Town Regulatory Benthic and Sediment Transects

Transect	Length (m)	Date of Installation	Baseline Survey Date
R-88	150	10/30/2014	12/17/2014
R-90	150	10/20/2014	12/16/2014
T-14	150	10/3/2014	12/14/2014
T-13	150	10/2/2014	12/15/2014
R-91	150	10/3/2014	12/16/2014
R-92	150	10/17/2014	12/15/2014
R-93	150	10/17/2014	12/15/2014
R-94	150	10/29/2014	12/17/2014
R-95- Breaker's Artificial Rockpile	185	10/22/2014	12/17/2014
R-95 Natural	60	10/22/2014	12/17/2014
T-9	150	10/2/2014	12/14/2014
T-8	56	10/1/2014	12/14/2014
T-7	62	10/1/2014	12/13/2014
R-97	75.2	10/22/2014	12/15/2014
T-6	83	10/1/2014	12/13/2014
R-98	94	10/20/2014	12/15/2014
T-5	78	9/30/2014	12/13/2014
R-99	95	10/20/2014	12/16/2014
T-4	90	9/30/2014	12/13/2014
R-100	117	10/22/2014	12/16/2014
R-101	107	10/22/2014	12/16/2014
R-103	151	10/29/2014	12/17/2014

Note: Because the total length of Transect R-103 is 151 m, CEG will sample the final quadrat at 150.5 m and provide the data to CPE for evaluation of the BMA transect data.

BMA ENVIRONMENTAL MONITORING SURVEY METHODS

Line Intercept Survey

In order to document larger areas of uninterrupted sand (physical transitions along the monitoring transects between sand and hardbottom) and to track changes in sediment cover on the hardbottom, line-intercept surveys shall be conducted along all permanent transects. During each monitoring event, the landward and seaward position of each sand patch/trough at least 0.5 m in length shall be recorded along each transect by reference to transect tape meter marks. Meter mark references will be to one decimal place (e.g., patch from 2.4 to 3.2 m).

Interval Sediment Depth Measurements

In order to track changes in sediment depth associated with changes in sediment cover, each monitoring event will include collection of interval sediment depth measurements along each permanent transect. Sediment depth shall be measured and recorded to the nearest centimeter at

two (2) meter intervals (e.g., 0m, 2m, 4m, etc.) along the length of each transect. For each measurement, a ruler graduated in centimeters (0 to 30 cm) shall be pressed through the

sediment until the ruler reaches the surface of hard substrata or is totally immersed in sand. Depth measurements shall be rounded to the nearest cm (i.e., sediment thickness of less than 0.5 cm will be recorded as "0 cm", while thickness greater than 0.5 cm but equal or less than 1 cm shall be recorded as "1 cm", etc.). Measurements greater than 30 cm will be recorded as ">30 cm". Measurements may be truncated to the first and last few meters of each trough in areas of Mid-Town known to contain large, deep sand troughs.

Video Transect Survey

Video survey data collected as part of required biological monitoring functions as an archival dataset that can be used for general reference purposes or to help resolve potential impacts suggested by quadrat and sediment survey data. As such, video data could be reviewed and compared between surveys and must be of a quality sufficient to allow for post-collection quantitative image analysis using point count procedures.

Video surveys shall be conducted along all permanent monitoring transects using a digital video camera. Video of the seafloor along each transect shall progress no faster than 5 meters per minute over hardbottom and 10 m per minute over large sand patches (troughs). A convergent laser guidance system shall be used to indicate the precise height of the camera at 40 cm from the bottom. The transect line shall be clearly visible in all video so that locations may be accurately referenced. A 360° panoramic view at an angle of roughly 30° to the horizon shall be recorded both at the beginning and end of each transect from an elevation of roughly 1 m above the bottom. At the beginning and end of each transect, a standard underwater display shall also be recorded and integrated directly onto the digital video track. The standard display shall report: 1) the BMA transect number; 2) the survey date (e.g., 06/25/2021); 3) the water depth in meters for both the beginning (transect meter 0) and end (final meter) of the transect (e.g., start depth = 2 m, end depth = 4.5 m); and 4) any pertinent notes (e.g., poor visibility, large swell, etc.). Video data (files) will be supplied to FEDP during raw data submittal. Video shall be reviewed at the end of each transect surveyed to ensure the quality is acceptable for general characterization of the benthos; poor quality video shall be re-filmed.

Quadrat Sampling

Table 2 shows the number of quadrats that will be sampled at the Reach 2 and Mid-Town regulatory transects. All quadrats measure 0.5 m^2 (0.7 m x 0.7 m) in area.

Benthic communities and their habitats will be characterized quantitatively using the quadrat method, which samples benthic habitat and assemblages within permanently positioned quadrats along all nonregulatory transects and along each biological regulatory transect. This method ensures the same quadrats (same location, same size) are sampled in each monitoring event in order to document changes in hardbottom/sediment and benthic communities over time. The sampling protocol is similar to that used in the Benthic Ecological Assessment for Marginal Reefs (BEAMR) (Lybolt and Baron, 2006). Similar to all other non-invasive and non-consumptive methods of sampling, the quadrat method is limited to physical characteristics and organisms that can be visually recorded and identified in the field. As described below, three (3) main benthic characteristics will be assessed in each quadrat during sampling: physical

structure, planar percent cover of sessile benthos, and coral (scleractinian and octocoral) size and density.

Table 2. Number of quadrats to be sampled at each regulatory transect.

Transect	Total No. of Quadrats	Length (m)
R-80.5	15	150
R-82	5	24
R-88	24	150
R-90	25	150
R-91	20	150
R-92	22	150
R-93	22	150
R-94	23	150
R-95 Breaker's Rockpile	9	185
R-95 Natural	20	60
R-97	20	75.2
R-98	20	94
R-99	20	95
R-100	20	117
R-101	20	107
R-103	25	151

Physical structure

Maximum topographic relief and mean sediment depth (average of five [5] depth measurements) shall be measured (in centimeters) within each quadrat to document physical structure.

Cover (Percent) of Functional Groups

The distribution of substrata and composition of the benthic community within each quadrat shall be documented by estimating the planar cover (percent) of functional groups. Specifically, the following 15 major functional groups shall be assessed: sediments, bare hardbottom, macroalgae, turf algae, encrusting red algae, sponges, scleractinian corals, octocorals, zoanthids, hydroids, hydrocorals Millepora sp., sessile worms (including wormrock, Phragmatopoma spp.), bivalves, bryozoans, and tunicates. Each functional group shall be assigned a cover value (percent) from 0%-100%, with the total of all functional groups in each quadrat equaling 100%. Macroalgae with at least 1% cover shall be identified to genus and the cover (percent) of each genus shall be recorded. Unattached or floating macroalgae shall be disregarded and shall be removed from quadrats prior to sampling. The cover (percent) of cyanobacteria shall also be assessed but will be recorded separately from other cover estimates (i.e., not included with the main 15 functional groups).

Coral Size and Density

Monitoring staff shall also measure and record to the nearest centimeter (cm) the maximum dimension (height or width) of each scleractinian coral and octocoral colony within each quadrat. The smallest size recorded shall be one (1) cm; for colonies less than one (1) cm in size, the measurement recorded shall be "< 1 cm". Each colony within each quadrat shall also be enumerated and identified (by species for scleractinians, by genus for octocorals) to determine coral density and composition. Abnormal colony conditions shall also be recorded (e.g., bleaching, disease, predation, etc) when encountered.

Data Analyses

The 2023 Mid-Town and Reach 2 regulatory data survey data deliverables (Microsoft Access database of monitoring data, Excel summary sheets, and electronic library of raw monitoring data (scanned field datasheets), GIS shape files, still photos and video shall be prepared according to the requirements of the BMA cell-wide monitoring plan. The survey data will be entered into the BMA Access database with two rounds of QAQC review of all entered data by different observers. The data will be exported and summarized in individual Excel spreadsheets. The survey data deliverable shall be submitted to the FDEP and the Town on an external hard drive within 45 days of survey completion.

According to the regulatory monitoring described in the BMA cell-wide monitoring plan, *temporal comparisons by way of univariate and multivariate tests will be confined to data collected during the most recent monitoring event (current event) and the baseline monitoring event (i.e., statistical tests will not be used to compare results between different post-construction monitoring events). Such a comparison represents repeated measures and, depending on the statistical test, these data are to be analyzed accordingly (e.g., paired T-test, repeated measures*

ANOVA/ANCOVA, linear mixed-effects models, MANOVA, etc.). Multivariate analysis by way of PRIMER does not require such repeated measures tests, due to the non-parametric permutation-based nature of its routines. Comparison among all monitoring events should solely be through descriptive/summary statistics, presented in graphical or tabular form in the report. The Breaker's artificial reef regulatory transect should be assessed separately from other Midtown regulatory transects due to its proximity to shore.

Statistical Tests

The following includes a list of suggested data treatments and statistical analyses to be performed with each single survey dataset to effectively compare between annual surveys as well as between annual survey and the Habitat Map of Hardbottom. Temporal comparisons by way of univariate and multivariate tests shall be confined to data collected during the 2023 monitoring event (current survey) and the baseline survey. Statistical tests will not be used to compare results between different post-construction monitoring events. All data treatment and statistical analyses will be conducted according to the 2021 BMA cell-wide monitoring plan.

Descriptive Statistics

Unlike inferential statistics (hypothesis tests [see univariate and multivariate tests below]), descriptive statistics aim to provide simple quantitative summaries of a sample (i.e., they describe the main features of a collection of information). Such summaries may be either quantitative i.e., summary statistics) or visual (i.e., straightforward graphics). These statistics generally include measurements of central tendency (e.g., mean, median, and mode) and dispersion (e.g., variance and/or standard deviation). Numerical descriptors like mean and standard deviation are good for summarizing continuous data (like the density [n/m^2] of a particular species), while frequency and percentage are more useful in terms of describing categorical data.

*One of the most useful and effective statistical calculations is the estimation of percentage change. For example, in the assessment of change in percent cover, size class distribution, and sediment depth over time. The following example provides the formula for calculating percent change over time for sediment depth: %Change = ((Depth F – Depth I)/Depth I)*100; where Depth F is the final sediment depth (depth during the most recent monitoring event), and Depth I is the initial sediment depth (depth during the baseline survey). Changes expressed as percentages provide useful summaries for changes occurring in hardbottom communities as a result of beach nourishment. Percent change may be presented in tabular and/or graphical form, and can be used as the dependent variable in analyses of sediment depth, sand patch size, percent cover, etc.*

Univariate tests

These consist of both parametric and non-parametric hypothesis tests. While the results of such tests are useful in determining whether impacts from nourishment have occurred, the statistical significance of change in the absolute value of a parameter or in percentage does not necessarily reflect a critical, biologically meaningful threshold. Thus, while tests can indicate significant differences, non-significant differences can still be meaningful. Several useful univariate tests

are provided below.

T-test
Simple hypothesis test that operates on the mean. One-sample, Two-sample, and Paired tests are possible; Homoscedastic (equal variance) and Heteroscedastic (unequal variance) tests are also available. Programs should provide a p-value to compare to a pre-determined alpha (usually 0.05). While inappropriate for other, more complex statistical tests, Microsoft Excel may be used to run T-tests.

ANOVA
More advanced hypothesis test that also operates on means. In the event assumptions of general linear models are not met, non-parametric Analysis of Variance (ANOVA), generalized linear, or mixed-effects models may be used to account for the nature of the data. Analysis of covariance (ANCOVA) may also be useful. Repeated measures (i.e., violation assumption of independence) must be handled appropriately.

Multivariate Statistics
These statistics encompass the simultaneous observation and analysis of more than one outcome/dependent variable. Multivariate analysis of variance (MANOVA) models may be used, though analysis via PRIMER routines is more common. Various PRIMER routines are described in 1-6 below. MANOVA and PERMANOVA are suggested for complex multivariate hypothesis tests.

Similarity Matrix
The original data matrix should include data from the current survey as well as from the baseline survey. Bray-Curtis similarity should be used to produce the resemblance matrix. In order to even out the influence of dominant and rare species, data should be square root, fourth root, or log (x+1) transformed prior to producing the resemblance matrix.

Cluster Analysis with Similarity Profile (SIMPROF) Test
Based on simple agglomerative hierarchal clustering, creates a dendrogram from a similarity matrix. Group average linking should be used. Similarity profile analysis (SIMPROF) should be used in conjunction with cluster analysis (tree production). The pi statistic and the results of the associated hypothesis test should be presented in the results section of the monitoring report.

nMDS Ordination
A technique for mapping samples in a low dimensional space (typically 2-D) such that the distance between samples approximately reflects (to one degree or another) similarity in community structure. Model checking should include interpreting the resultant Shepard Diagrams (smooth increasing curves are best) and Stresses (2-D and 3-D), which provide information on the distortion between the ranked dissimilarities and corresponding distances in the plot. Stress scores are to be reported; as a rule of thumb, a score of: < 0.05 suggests excellent representation; < 0.1 suggests a good fit; < 0.2 suggests the pattern is still useful, but should not be completely trusted; and > 0.3 suggests the pattern is little better than random points.

Analysis of Similarity (ANOSIM)
Compares the variation in species abundance and composition among sampling units in terms of grouping factors (or experimental treatment levels). The histogram, R-statistic, and p-values provided as outputs should be reported.

Similarity of Percentage (SIMPER)
Used to determine the role of individual taxa in contributing to the separation (dissimilarity) between two groups of samples (e.g., Artificial vs. Natural, Baseline vs. Year 1 post-construction).

Second Stage Analysis (2STAGE)
Provides a succinct summary in a 2-d picture of the relationship between the multivariate sample patterns under various choices.

Reporting

The 2023 report will include hardbottom distribution maps based on interpretation of 2023 aerial photography (GIS shape files provided by others) with the summer 2023 diver-mapped hardbottom edge survey as an overlay; sediment analyses including bar graphs depicting sediment patch data and average sediment depths of transects and depth zones; benthic community analysis and change, and statistical analyses. The final report presenting the 2023 Mid-Town and Reach 2 hardbottom survey regulatory results, interpretations, and comparison to the baseline survey data and 2023 BMA transect data (provided by others) will be submitted within 120 days of the completion of the 2023 survey. The final report will be submitted as a PDF file to the Town and FDEP.

The total estimated cost of this proposal is **$135,139** and is submitted on a Time & Materials – Not to Exceed basis. The commencement dates of the surveys will be reported to the FDEP approximately 7 days prior to beginning the work effort, and the FDEP will be notified of survey completion.

Thank you for the opportunity to work with the Town of Palm Beach. Please contact me at 954-591-1219 or via email at cmiller@coastaleco-group.com if you have any questions regarding this proposal.

Sincerely,

Cheryl L Miller

Cheryl L. Miller
President, Principal Scientist
Coastal Eco-Group, Inc.