Technical Memo

To: Mary Paulic, Florida Department of Environmental Protection

From: Laurel Webb, Project Manager, MSE Group, LLC

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Re: USACE Mobile District Contract #W91278-17-D-0001, Task Order W91278-18-F-6048
Proposed Protocol for Shoreline Stabilization TMDL Project Credit – Revision 2
Patrick Air Force Base, Florida

1.0 INTRODUCTION AND BACKGROUND

The United States Army Corps of Engineers (USACE), Mobile District retained MSE Group, LLC (MSE) under Contract Number W91278-17-D-0001, Task Order (TO) 0001, to provide technical support for the 45th Space Wing (45 SW) Civil Engineer Squadron (CES)/Environmental Quality Office (CEIE) at Patrick Air Force Base (PAFB), Florida. The 45 SW is currently constructing a 3-mile long shoreline stabilization project at PAFB and proposes the following protocol to the Florida Department of Environmental Protection (FDEP) to obtain Total Maximum Daily Load (TMDL) credit for this project.

2.0 RECOMMENDED PROTOCOLS FOR SHORELINE MANAGEMENT NUTRIENT LOAD REDUCTIONS

The recommended protocols for shoreline management pollution reduction are provided in the following subsections and have been adapted from protocols followed by stakeholders in the Chesapeake Bay TMDL (**Attachment 1**, Drescher et. al., 2015). The three protocols include:

1. Prevented Sediment
2. Denitrification
3. Marsh Redfield Ratio

2.1 Protocol 1 – Prevented Sediment

The prevented sediment protocol computes a mass reduction credit for prevented sediment by estimating the shoreline erosion rates and annual sediment loadings and converting the erosion rates to nitrogen and phosphorus loadings.

To estimate shoreline erosion rates, historical aerial photographs of the project site will be analyzed. The calculations discussed herein should be performed on a reach basis along the shoreline, if applicable. Submerged aquatic vegetation (SAV) can benefit from shorelines with low erosion rates; therefore, as part of this protocol the shoreline will be evaluated for the presence of SAV and this information along with the erosion rate will be provided to FDEP with the shoreline stabilization package for TMDL credit.

To estimate nutrient loading rates using actual data, the volume of prevented erosion must be determined using the following equation:

$$V=LEB$$

V = volume of sediment (cubic feet/year)
L = length of shoreline (feet)
E = Shoreline erosion rate (feet/year)
B = bank height (feet)

For new or current projects, length of the project and average bank height can be obtained from the project design specifications. For old projects, this data can be taken from engineering plans. The shoreline erosion (recession) rate was previously determined.

This equation yields a volume expressed in cubic feet per year. Cubic feet are converted to pounds using soil bulk density in pounds per cubic feet and then a sand reduction factor is applied. The sand reduction factor is calculated from the grain size analysis; the weight of the fines divided by the total weight of the sample. This sand reduction factor is multiplied by the volume of sediment found in the previous step. The resulting pounds of TN and TP is the prevented sediment credit from the shoreline stabilization project. The soil bulk density and total nitrogen (TN) and total phosphorus (TP) loading rates will be determined from obtaining and analyzing a representative soil sample from the shoreline or each reach, if applicable. The sampling plan provided in **Attachment 2** documents the sampling process, handling procedure, laboratory protocols and methods, and QA/QC protocols that will be followed during sampling.

Bank Instability Reduction for Prevented Sediment

Drescher et. al. recognized that tidal shoreline management projects that do not adequately address the critical angle of repose are at a continued risk of erosion due to waves and usual storm events, which impact the base of the bank. This means that Protocol 1 should be calculated and then reduced by 50% unless it is demonstrated that the project addresses the angle of repose through bank grading and stabilization.

A detailed bank stability analysis should be provided to the FDEP to document that no additional sediment and associated pollutants will enter the nearshore waters if a different reduction percentage is proposed. The following conditions should be provided: 1) the project was graded and vegetated so that the bank is stable and 2) excess sediment was removed offsite so that the sediment does not enter the nearshore waters. Bank analysis can demonstrate the site is stable with a minimum risk of erosion.

2.2 Protocol 2 – Denitrification

This credit is for marsh denitrification and based on the denitrifying capabilities of marsh soils. The pollutant load reduction is based on the square footage of wetland planting in conjunction with a shoreline management project. This credit applies to nitrogen and the evaluation for the presence of SAV also applies to this protocol.

The sampling plan provided in **Attachment 2** documents the sampling process, handling procedure, laboratory protocols and methods, and QA/QC protocols that will be followed during sampling to calculate the pounds of nitrogen removed through the denitrification process. Once the denitrification rate is known the process for determining the denitrification credit is as follows:

1. Determine the total post construction area of the net increase in marsh plantings and convert to acres. The area may be obtained from the restoration drawings after confirmation in the field through as-builts. Future credit should be based on field verification of survival of the initial planting and any expansion of the restored marsh area due to either re-enforcement planting or natural expansion.
2. Results from the laboratory will be provided in units of micromoles of Nitrogen (µmol N) per square meter (m^2) per hour. This rate shall be converted to pounds of Nitrogen (lb N) per acre per year using a conversion factor of 1.0947.
3. Multiply the acres of marsh planting by the unit denitrification rate for each sample area to determine the denitrification credit for the shoreline stabilization project.

2.3 Protocol 3 – Marsh Redfield Ratio

This protocol is based on vegetative uptake of nutrients for vegetative growth in marshes and should be applied after marsh plantings have been in place for one year. The pollutant load reduction is based on the square footage of wetland planting in conjunction with a shoreline management project. This credit applies to nitrogen and phosphorus and the evaluation for the presence of SAV also applies to this protocol.

Once the construction has been completed the area and density of marsh plantings shall be documented by photographs and field notes to assist with determining the increase in plantings after one year. Additionally, the application of nitrogen or phosphorus fertilizer, either in the nursery or during planting, shall be documented to include the date, fertilizer type, and amount applied. The sampling plan provided in **Attachment 2** documents the sampling process, handling procedure, laboratory protocols and methods, calculations, and QA/QC protocols that will be

followed during sampling to calculate the Marsh Redfield ratio for the marsh plantings. Once the TN and TP for the plantings is known the process for determining the marsh Redfield ratio reduction is as follows:

1. Determine the total post construction area of the net increase in marsh plantings in acres. This may be taken from the restoration drawings after confirmation in the field through as-builts.

2. Calculate the Marsh Redfield Ratio by completing the following:
   a. Determine the Nitrogen to Phosphorus ratio (N:P) by dividing the TN result by the TP result, this represents the nitrogen and phosphorus removed from the BRL per square meter of marsh plantings (i.e., for N:P of 23:1; 23 grams TN per square meter and 1 gram TP per square meter).
   b. Convert to pounds per acre to determine the pollutant load reductions (i.e., 205 pounds TN per acre and 9 pounds TP per acre).
   c. Annualize the pollutant load reduction over the expected life of the marsh (30 years; Drescher et. al., 2015) by dividing the result by 30. The resultant value is the unit Marsh Redfield Ratio value.
3. Multiply the acres of tidal marsh planting by the unit marsh Redfield ratio value calculated in the previous step to obtain the Marsh Redfield ratio credit.

3.0 ANNUAL REPORTING REQUIREMENTS

The sampling plan provided in **Attachment 2** documents the sampling requirements for each protocol which shall be used to establish average site-specific rates and ratios for calculating and reporting TMDL credits annually to FDEP as part of the Statewide Annual Report (STAR). Upon completion of the first year of quarterly sampling and establishing the site-specific rates and ratios for each protocol, additional sampling shall not be required. After the first year of sampling, a site visit shall be completed annually to document the status of the shoreline stabilization project and verify marsh planting acreage. Documentation of this site visit and subsequent TMDL credit calculations shall be submitted annually to FDEP as part of the STAR for TMDL credit verification purposes.

4.0 REFERENCES

Drescher, S., Stack, B. (2015). Recommendations of the Expert Panel to Define Removal Rates for Shoreline Management Projects. Center for Watershed Protection, Inc. http://chesapeakestormwater.net/2015/11/shoreline-management-practices-approved-for-credit/

ATTACHMENT 1

EXPERT PANEL ON SHORELINE MANAGEMENT PROTOCOLS FOR SHORELINE MANAGEMENT POLLUTION REDUCTION

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ATTACHMENT 2
SAMPLING PLAN

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Shoreline Stabilization Sampling Plan for TMDL Nutrient Reduction Credit

The objective of this sampling plan is to complete the required sampling for each protocol to receive TMDL nutrient reduction credit for a shoreline stabilization project.

For Protocol 1 the collected data will be used to estimate the prevented sediment from the implementation of the shoreline stabilization project. The equation in this protocol calculates the volume of prevented sediment in cubic feet per year. To convert cubic feet to pounds of nutrients for crediting purposes soil sampling must be completed to determine the soil bulk density and the concentration of TN and TP in the soil.

Protocol 2 consists of collecting samples of marsh soils for analysis of the denitrification rate to estimate the nitrogen reduction from denitrification of marsh soils per acre of marsh plantings. To use the equation in this protocol the denitrification rate is provided in units per area which is then multiplied by the total acreage of marsh plantings to calculate the nitrogen reduction credit.

Sampling of marsh plantings for analysis of TN and TP is completed for Protocol 3 to estimate the Marsh Redfield Ratio credit. The equation in this protocol consists of calculating the Marsh Redfield Ratio using the Nitrogen to Phosphorus ratio then multiplying by the acres of tidal marsh plantings to obtain the Marsh Redfield ratio credit.

The following sampling plan shall be followed to complete the objective.

1.0 Sampling Methods

1.1 FDEP Methods

Samples shall be collected and managed in accordance with the FDEP SOP's for Field Activities, (DEP-SOP-001/01). The samples shall be analyzed by a certified laboratory. A list of the pertinent FDEP SOP's can be found in **Exhibit 1.1**.

Exhibit 1.1: FDEP SOP's for Proposed Field Activities

SOP SECTION	TITLE
FC 1000	Field Decontamination
FD 1000	Documentation
FD 2000	Documentation of Cleaned Equipment, Sample Containers, Reagents and Supplies
FD 3000	Documentation of Equipment Maintenance
FD 4000	Documentation for Calibration of Field-Testing Instruments and Field Analyses
FD 5000	Documentation of Sample Collection, Preservation and Transport
FM 2000	Laboratory Scheduling
FM 3000	Trip Planning
FM 4000	Equipment and Supply Preparation
FQ 1000	Field Quality Control Requirements
FS 1000	General Sampling

SOP SECTION	TITLE
FS 2000	General Water Sampling
FS 2100	Surface Water Sampling
FS 3000	Soil Sampling
FS 4000	Sediment Sampling
FT 1000	Field Testing General

1.2 Sampling

1.2.1 Protocol 1

Soil Sampling

Surface soil samples shall be collected from the shoreline on a reach basis, or every 1,000 feet, from the mean high-water line at a depth of 6-12 inches below the ground surface. A global positioning system (GPS) device shall be used to capture the location of each sample so that the same area can be sampled each quarter. Samples will be collected following FDEP SOP FS 3000 for soil samples. A clean stainless-steel spoon shall be used to collect a sufficient amount of soil to fill the sample container(s). All sampling equipment shall be washed with an FDEP approved detergent (such as Luminox) between sample locations to prevent cross-contamination. Samples will be stored at 39-degrees Fahrenheit for transport to the laboratory and analyzed for soil bulk density, grain size, TN, and TP only.

1.2.2 Protocol 2

Sediment Sampling

Core samples of marsh sediment consisting of 8 inches of sediment and 8 inches of overlying water shall be collected for every 0.25 acres of plantings and be representative of the overall plant population. A global positioning system (GPS) device shall be used to capture the location of each sample so that the same area can be sampled each quarter. The sampling cores shall consist of 3-inch clear polyvinyl chloride (PVC) pipe, or similar, with one end sharpened to be used in a push corer or inserted by hand, then plugged and stored at 39-degrees Fahrenheit for transport to the laboratory. A new core will be used for each sample and any sampling equipment that will be reused shall be washed with an FDEP approved detergent (such as Luminox) between sample locations to prevent cross-contamination. A sample of the water at the site is also required for incubation during the analysis (5.5 gallons for every three cores). Samples shall be collected following FDEP SOP FS 4000 for sediment samples and will be measured for denitrification using membrane inlet mass spectrometry (MIMS; Inglett, 2013).

1.2.3 Protocol 3

Marsh Plant Sampling

Samples of marsh plantings shall be collected for every 0.25 acres of plantings and be representative of the overall plant population. A global positioning system (GPS) device shall be used to capture the location of each sample so that the same area can be sampled each quarter. Due to the lack of a current FDEP SOP for Plant Tissue Sampling (FS 6400) the following protocol will be followed:

When gathering the plantings new gloves and a clean container shall be used. A representative sample of the overall plant population in the sample area shall be collected by obtaining plantings of each plant type, chopping the plants using a clean stainless-steel blade, and mixing the plant material for laboratory analysis. The entire planting shall be collected including the roots and placed in a plastic pail or paper bag during collection. Plantings that are damaged by insects, mechanically injured, diseased, dead, or under moisture or temperature stress should not be sampled. Residue such as soil, fertilizer, dust, or spray shall be removed using a dry brush, wiping with a damp cloth, or washing with distilled or deionized water. Prolonged washing shall be avoided because it can leach nutrients out of the tissue. Samples shall be air-dried in the shade on clean plastic sheeting, not in the sun. To prevent contamination, mixed and dried samples shall be placed into clean paper bags or envelops for mailing to the laboratory. Samples shall be wet weighed, dry weighed, and analyzed for percent moisture, TN, and TP.

1.3 Sampling Equipment

Equipment needed to implement this sampling plan includes the following:

- Stainless-steel spoon
- Stainless-steel bowl
- Decontamination detergent, equipment, and gloves
- Core samplers
- Plastic pail, plastic sheeting, dry brush, and paper bags
- Stainless-steel blade
- Sample containers, labels, cooler(s), ice
- Measuring wheel

1.4 Cleaning Procedures

Equipment cleaning procedures shall be in accordance with FDEP SOP FC 1000.

1.5 Disposal of Cleaning Agents

All used cleaning agents shall be disposed of at the location of use, which is on site.

2.0 Sampling Handling and Custody

Sampling kits shall be pre-labeled and prepared for analyte collection in the field. Samples shall be collected in accordance with DEP-SOP-001/01. Samples shall either be transported to a local laboratory for analysis or sent via an overnight courier to non-local laboratories. Field staff shall ensure that Chain-of Custody documentation and sample preservation requirements are met prior to transport. The laboratory documents the transfer of sample custody when the samples arrive at the lab.

2.1 Sample Identification

The following information is included on the example sample label shown in **Exhibit 2.1**:

1. Sample ID (Samp ID)
    - The sample shall include a unique sample identification with the sample location and sample date. For example, the Area 1 sample ID would be Area1_01012019.
    - This is completed by field personnel performing the sample collection.
2. Lab ID
    - Completed by the laboratory and submitted on the printed label.
3. Client
    - MSE Group, LLC; submitted by the laboratory on the printed label.
4. Project
    - Completed by the laboratory and submitted on the printed label.
5. Project Number (Project #)
    - Provided by MSE personnel, completed by the laboratory, and submitted on the printed label.
6. Date/Time
    - Date/Time identified when the sample collection begins.
    - This is completed by field personnel performing the sample collection.
7. Initials of the person who collected the sample (Init)
    - This is completed by field personnel performing the sample collection.
8. Control ID (Ctr ID)
    - Completed by the laboratory and submitted on the printed label.
9. Parameters (presented in **Exhibit 3.1**)
    - This line will vary since the parameters vary for each protocol.
    - Completed by the laboratory and submitted on the printed label.

Exhibit 2.1: Example of Sample Label

Samp ID: **Area1_01012019**
Lab ID: **A403152-24B**
Client: MSE Group, LLC
Project: Shoreline Stabilization
Project #: 1002.M17.006
Date/Time:
Init: Ctr ID:
Parameters

2.2 Field Records

All field records shall be kept in a designated log book for each project. The following information shall be written in the log book:

- Date and time
- Data collection
- Sample collection
- Field observations

2.3 Chain of Custody

A chain of custody (COC) record shall be used to record the custody of the samples collected in the field and analyzed by the laboratory. The following information is information that is typically included on a COC form:

1. Client name, address, telephone number
2. Sample collector's name and signature
3. Project name and number
4. Purchase order number
5. Client reporting contact
6. Client billing contact
7. Site location/Time Zone
8. Requested analyses
9. Requested turnaround time
10. Preservation
11. Sample ID
12. Collection date
13. Collection time
14. Composite or grab sample
15. Matrix
16. Total number of containers
17. Relinquished by with date and time
18. Received by with date and time

3.0 Analytical Methods

All laboratory analyses shall be performed by a sub-contracted laboratory. The analytical methods for each protocol are identified in **Exhibit 3.1**.

Exhibit 3.1: Analytical Methods by Protocol

Matrix	Parameter	Analytical Method	Frequency	Blanks
Protocol 1				
Soil	bulk density	ASTM C29	Quarterly, every 1,000 feet	5% with 1 per project minimum
Soil	grain size	ASTM C136		
Soil	TN: TKN Nitrate and Nitrite	EPA 351.2 EPA 9056/ SM 4500		
Soil	TP	EPA 365.4		
Protocol 2				
Sediment	Denitrification rate	MIMS	Quarterly, every 0.25 acres of plantings	5% with 1 per project minimum
Protocol 3				
Solids (plant tissue)	TN: TKN Nitrate and Nitrite	EPA 351.2 EPA 9056/ SM 4500	Quarterly, every 0.25 acres of plantings	5% with 1 per project minimum
Solids (plant tissue)	TP	EPA 365.4		

4.0 Quality Control

All work, as applicable, is performed in accordance with the quality assurance requirements identified in Chapter 62-160 Florida Administrative Code (FAC), FDEP's "Requirements for Field and Analytical Work Performed for the Department of Environmental Protection Under Contract" (DEP-QA-002/02), and the Department of Environmental Protection Standard Operating Procedures for Field Activities (DEP-SOP-001/01) including water and soil samples that are collected in accordance with FQ 1000 Field Quality Control Requirements. Also, applicable laboratory activities are performed by certified laboratories.

4.1 Equipment Blanks

Five percent of the samples collected throughout the year, or one per year, shall be equipment blanks in accordance with FDEP SOP's LQ 1000 Laboratory Quality Control. All equipment blanks shall undergo the same process as the samples to ensure accuracy.

5.0 Instrument/Equipment Testing, Inspection, and Maintenance

Sampling equipment shall be inspected and maintained in accordance with the manufacturer's operating and maintenance instructions to ensure reliable performance and results. In addition, equipment required to collect, transport, and store samples shall be cleaned and handled to minimize cross-contamination and sample corruption.

5.1 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables shall be inspected upon receipt to ensure no obvious contamination or damage and if necessary, returned to the supplier in exchange for acceptable substitutes as required.

6.0 Non-Direct Measurements

This project will rely on several forms of non-direct measurements.

- Site location
- Identification of shoreline reaches for Protocols 1 and 2
- Evaluation of marsh plantings for Protocol 2 and 3 including area of coverage and plant types.

7.0 Data Management

7.1 Field Data

7.1.1 Data Integrity

Data integrity is the responsibility of the Field Team and the Engineering Technical Support. The Field Team Lead shall record and check all data entries from the field into the log book. The Engineering Technical Support checks and verifies all of the collected data, inserts it into corresponding spreadsheets, and does any necessary calculations. The Senior Project Manager and Senior Technical Staff will review the final data.

7.1.2 Data Validation

All field data is reviewed by at least four people. The Field Team Lead will collect and do the initial review of data. The Engineering Technical Support will transfer all data to the corresponding tables and do any calculations that are needed. The Project Manager and Senior Project Manager will do the final review of the data before submitting it to the client.

Digital photographs are taken to show each site and any problems that might occur. These photographs are retained as part of the record and will help explain any errors that might occur in the data.

7.1.3 Storage

The project field log books shall be stored in the project office and transported onsite every time someone goes to the project site. If data is collected electronically the initial data storage shall be placed on a field tablet and then transferred to a server for backup to prevent a loss of data. All paperwork shall be stored electronically on a server.

7.2 Laboratory Analysis

The results of the laboratory analyses are transferred directly from the laboratory database to am electronic laboratory report which shall be stored on a server to protect the loss of data.

8.0 References

Inglett, P.W., Kana, T.M. and An, S., 2013. Denitrification measurement using membrane inlet mass spectrometry. Methods in Biogeochemistry of Wetlands, (methodsinbiogeo), pp.503-517.