**STANDARD OPERATING PROCEDURES**

**for**

**REAL-TIME VECTRINO VELOCIMETER OPERATION**

# INTRODUCTION

Uncertainty remains on the ecological necessity to completely backfill canals as a part of marsh restoration efforts. This Standard Operating Procedure (SOP) addresses one aspect of this uncertainty; the role of flow in shaping the south Florida landscape. It is hypothesized that particulate erosion and transport are key processes required to restore and maintain the ridge and slough patterned landscape (Larsen and Harvey, 2011 and Larsen et al., 2007, 2010, 2011). When Critical Entrainment Velocity (CEV) values are combined with in situ Acoustic Doppler Velocimeter (ADV) measurements of depth-averaged velocities for different habitat types the spatial and temporal likelihood of particle entrainment can be accurately assessed (Harvey et al. 2009),

# METHOD SUMMARY

This SOP details the established procedures for real-time Vectrino Velocimeter manufactured by Nortek (***Figure 1***). The purpose of the real-time Vectrino data is to determine both flow velocity through time at a specific location and how flow velocity and magnitude vary with flow depth at a specific location. The Nortek Vectrino is a single point, high resolution, 3-Dimensional current meter that operates on the Doppler principle to measure the velocity of water. For more information on the Doppler shift and Vectrino use and configuration, please refer to the Vectrino Velocimeter User Guide by Nortek, which is referred to throughout the SOP as Nortek, 2009.



Figure 1. Vectrino Velocimeter field probe

# SITE SELECTION AND SAMPLE COLLECTION LOCATION

ADVs can be deployed in a variety of aquatic environments, including rivers, estuaries, and oceans. We will use the ADVs in the DPM pocket within the impacted and control reaches. The Vectrino will be deployed at a number of temporary locations that represent the range of variability in vegetative resistance and flow conditions. Temporary locations will typically be monitored for 2-24 hours, and data will be used to cross-validate other measures of flow, such as those generated from tracer tests. The Vectrino will also be deployed repeatedly (but still for 2-24 hours of time) at permanent stands set up at an impacted ridge and slough paired site (RS2), a control ridge and slough paired site (C2), and slough sites just downstream of the canal treatments (DB1-3).

# EQUIPMENT AND SUPPLIES

* Nortek Vectrino Velocimeter
* Power/signal cable
* Deep cycle marine battery
* Folding table or cooler attached to PVC rods with bungee cords (for keeping laptop and battery out of water)
* Tripod or stand with attachment for Vectrino
* Generator or power inverter
* Laptop computer
* Handheld compass
* Global Positioning System (GPS)
* Ruler
* Black pen
* Notebook or data sheets
* Vectrino software

# FIELD CREW COMPOSITION, QUALIFICATIONS AND TRAINING

The monitoring activity should be overseen by a dedicated coordinator, who is directly responsible for ensuring that survey methods, data collection, and management are standardized throughout the region. The coordinator is responsible for writing a comprehensive, public access report in a timely manner (annually). The field coordinator shall work with one or more of the staff while collecting data; thus data collections are directly checked by the field coordinator. Field crew members must have previous experience in field sampling projects, good recommendations, and a proven ability to work in the field reliably and independently. All field crew members must undergo documented training by the field coordinator prior to collecting data. All field crew members must have training documentation in vehicle operation and field safety. Field crew members will be provided with a handbook of protocols and safety procedures prior to initiating the sampling event.

# FIELD PROCEDURES

## Instrument Set Up

1. Connect the Vectrino to the computer using the external power/signal cable.
2. Power the instrument via the AC/DC voltage transformer (in the field, plug transformer into a generator or power inverter).

## Instrument Testing

1. Connect to the instrument using Vectrino software by double clicking on the Vectrino software icon and selecting the correct COM port. Accept the default baud rate settings (19200 baud), and click the toolbar button labeled “Connect.”
2. Instrument time is automatically synced with computer.
3. Probe check.
   1. Ensure the probe is submerged in water and select Data collection > Start Probe Check.
   2. All four receiver beams should peak in approximately the same location.

## Configure and Deploy the Instrument

1. **IMPORTANT**: Record the compass bearing of the red probe with a hand-held compass and record the exact measurement of the height of the probe head; add this information to the log file.
2. Select Data collection > edit configuration. Use the following settings:
   1. Sample volume: 8.5 mm
   2. Nominal velocity range: +/- 0.03 m/s
   3. Sampling rate: 10 Hz
   4. Power level: Low
   5. Transmit length: 1.8 mm
   6. Coordinate system: XYZ.
   7. Speed of sound: Measured salinity
   8. Output sync: for Vectrino
   9. Check the box for data recording, and enter the filename.
3. After editing configuration settings, click “Apply.” Real-time data collection will begin; data will automatically be recorded to the file(s) designated in the configuration settings.
4. If recording a velocity profile, begin with the probe near the water surface and record data at descending levels. Collect data for two minutes at each level and record each relative level. If recording data at a fixed level, record the relative probe height.
5. For extended deployments (1+ hours), alter the power settings of the laptop computer so that the computer never sleeps and the hard drive never shuts off. These settings can be changed by right-clicking on the battery icon in the lower right of the computer screen and selecting “Change power settings.”

# QUALITY ASSURANCE AND QUALITY CONTROL

## Data Entry, Validation and Verification

* + 1. Open the Vectrino software. In the toolbar, select Data collection > Data Conversion. Click on Add file, and navigate to the saved .vno ouput file(s). Also select the directory where you want the converted .dat file(s) to be saved.
    2. Ensure that Checksum control is checked, and click the blue arrow.

1. Accept the default options, and click OK.
2. Select Done, and exit out of the software.
3. Open the Matlab script “Vectrino\_processing\_final.m”.
4. In the top section of the script, labeled USER INPUT SECTION, enter the filename of the .dat file output by the Vectino software, the filename of the processed, QA/QC’d data to save, the number of columns in the .dat file, and additional information as explained in the Matlab script comments.Default values to use are:
   1. afterGN = ‘n’
   2. corr\_cutoff = 40
   3. SNR\_cutoff = 5
   4. Pct\_diff\_cutoff = 50
   5. Abs\_diff\_cutoff = 0.002
   6. Threshold\_pd\_cutoff = 0.1.
5. Run the script by hitting the green arrow button. The script performs data validation and QA/QC using the following criteria and procedures:
   1. A plot of the raw data time series will first be produced. The user is to zoom in on the plot to identify periods within the data in which the probe was out of the water or being moved (e.g., to another point to sample when performing vertical profiles). These periods are identifiable by data that oscillates between positive and negative values and is characterized by unreasonably high velocity magnitudes. The user enters whether the time series needs to be truncated and then enters the time periods to exclude, based on the graphical analysis.
   2. Data is automatically removed that does not meet the percent correlation cutoff (40%).
   3. Data is automatically removed that does not meet the signal-to-noise ratio cutoff (5).
   4. Since the Vectrino contains a redundant probe, two z-direction velocity values are computed. The script removes datapoints in which there is a large discrepancy between the two computed z-direction velocities (i.e. the percent difference cutoff AND absolute difference cutoff are both exceeded).
   5. Spikes in the velocity data are removed in accordance with the Goring and Nikora (2002) threshold despiking algorithm.
   6. Velocity data are transformed from beam to XYZ coordinates, and redundant z-direction velocities that pass the criteria above are averaged.

# DEFINITIONS

* Beam – main axis of the sound wave generated at a known frequency by the transmitter which propagates through the water. As the pulse passes through the sampling volume, the acoustic energy is reflected in all directions by particulate matter. Some portion travels back along the receiver axis, where it is sampled by the ADV and processing electronics to measure the change in frequency. The Doppler shift is proportional to the velocity of the particles along the axis of the transmitter and receiver.
* Probe – “consists of four receive transducers and a transmit transducer” (Nortek, 2009).
* Vectrino software – software manufactured by Nortek for real-time data acquisition from the Vectrino.

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