SURVEY METHODOLOGY REPORT

November 21, 2019

STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY (CPRA)

RACCOON ISLAND SHORELINE PROTECTION/
MARSH CREATION (TE-48) PROJECT

TERREBONNE PARISH, LOUISIANA

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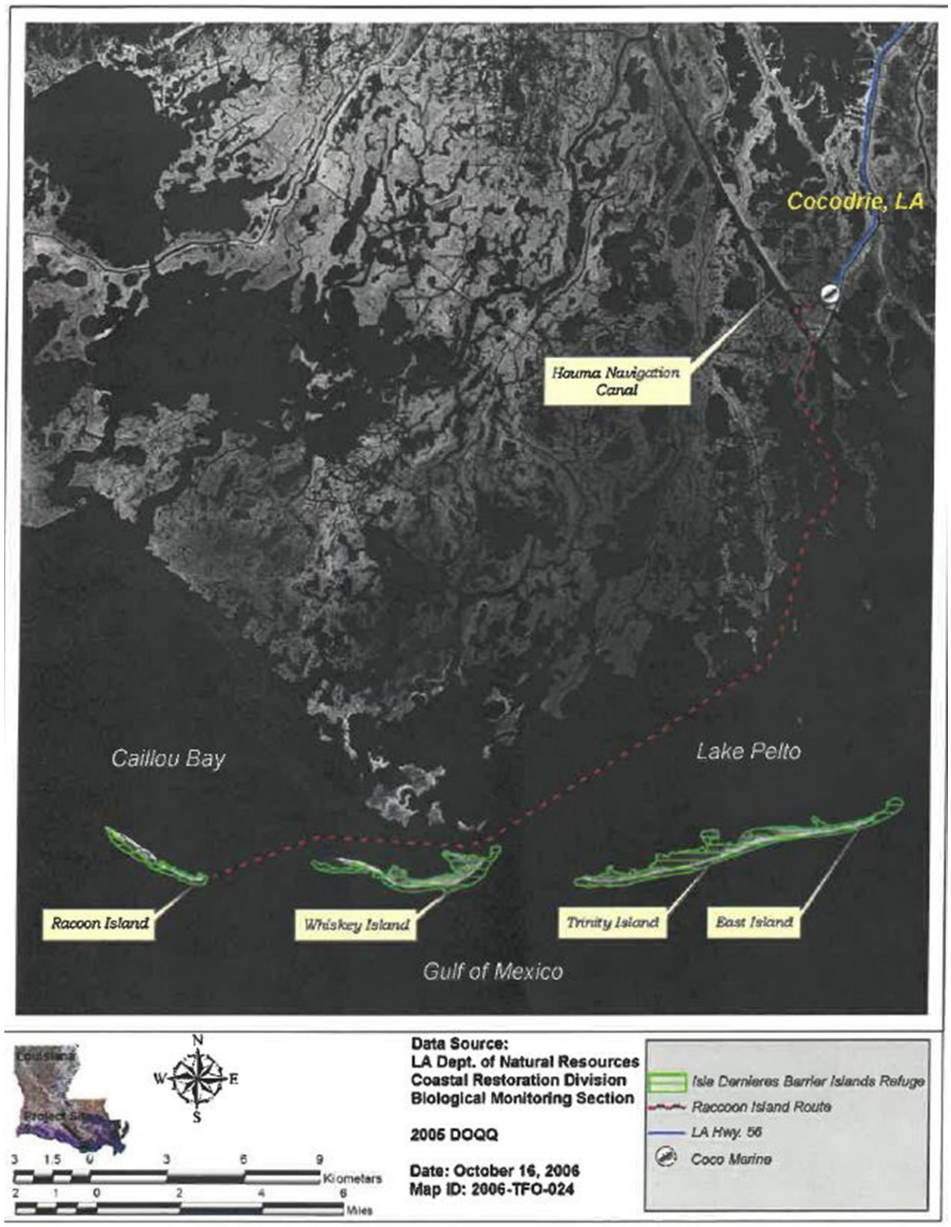
Table of Contents

Section 1: General Project Description

Project Overview

The Raccoon Island Shoreline Protection/Marsh Creation (TE-48) project is located within the Louisiana Department of Wildlife and Fisheries (LDWF) administered Isle Dernieres Barrier Islands Refuge, which is positioned southwest of Cocodrie in Terrebonne Parish, Louisiana. (See Figure 1). The TE-48 project area occupies 502 acres and includes the entire subaerial extent of Raccoon Island. Figure 1 also depicts the location of highway and boat access in the vicinity of this project.

Vicinity Map



(Figure 1)

The purpose of the project is to provide topographic and bathymetric orthometric height surveys of the littoral, beach, washover, marsh, and bay environments for the Raccoon Island Shoreline Protection/Marsh Creation (TE-48) project. Specifically, previously established cross-sectional breakwater field (T1-T10; T2A), spit (S1-S7), and marsh (M1-M10) transects were reoccupied and surveyed using Real Time Kinematic (RTK) methods and the Louisiana Coastal Zone (LCZ) GPS Network. Elevation data collected as part of this scope will be used to evaluate coastal structures and detect shoreface and island migration trends. This survey is the first post-construction survey for the marsh creation area

Project Timeline

Project #	Group	Date
TE-48	RECEIVED SCOPE OF SERVICE FROM CPRA	09/04/2019
TE-48	SUBMIT COST ESTIMATE TO CPRA	09/16/2019
TE-48	RECEIVE NTP FROM CPRA	09/17/2019
TE-48	INITIAL PROJECT SETUP	09/19/2019
TE-48	REQUEST LANDOWNER ACCESS PERMISSION FROM WILDLIFE AND FISHERIES	09/22/2019
TE-48	RECEIVE WILDLIFE AND FISHERIES ENTRY PERMIT	09/25/2019
TE-48	PREPARE AUTOCAD AND HYPACK BASE MAP AND DATA FILES FOR FIELD CREW	09/25/2019
TE-48	BEGIN SURVEYING BATHYMETRIC TRANSECT LINES	09/26/2019
TE-48	PROCESS AND QC DATA FROM 09/26/19	10/04/2019
TE-48	PREPARED REMAINING TRANSECT LINES TO BE SURVEYED FOR SURVEY FIELD CREW	10/28/2019
TE-48	COMPLETED SURVEYING BATHYMETRIC & TOPOGRAPHIC TRANSECT LINES	10/28/2019
TE-48	PROCESS AND QC DATA FROM 10/28/19	10/29/2019
TE-48	BEGIN PREPARING SUBMITTALS	11/07/2019
TE-48	CONTINUE PREPARING SUBMITTALS	11/08/2019
TE-48	CONTINUE PREPARING SUBMITTALS	11/11/2019
TE-48	CONTINUE PREPARING SUBMITTALS	11/12/2019
TE-48	CONTINUE PREPARING SUBMITTALS	11/13/2019
TE-48	COMPLETED PREPARING SUBMITTALS	11/14/2019
TE-48	SUBMIT PRELIMINARY DATA & SURVEY METHODOLOGY REPORT TO CPRA FOR REVIEW	11/14/2019
TE-48	REVISED LASARD DATA & SURVEY METHODOLOGY REPORT AS REQUESTED AND SUBMITTED TO CPRA FOR REVIEW	11/21/2019
TE-48	PREPARE AND SEND FINAL DELIVERABLES TO CPRA	TBD

Section 2: Project Planning

Reference Systems and Project Control

Horizontal Datum (Epoch): NAD 83 Louisiana South Zone (LA-1702) US feet.
Vertical Datum (Epoch): NAVD 88 GEOID 12A US feet.

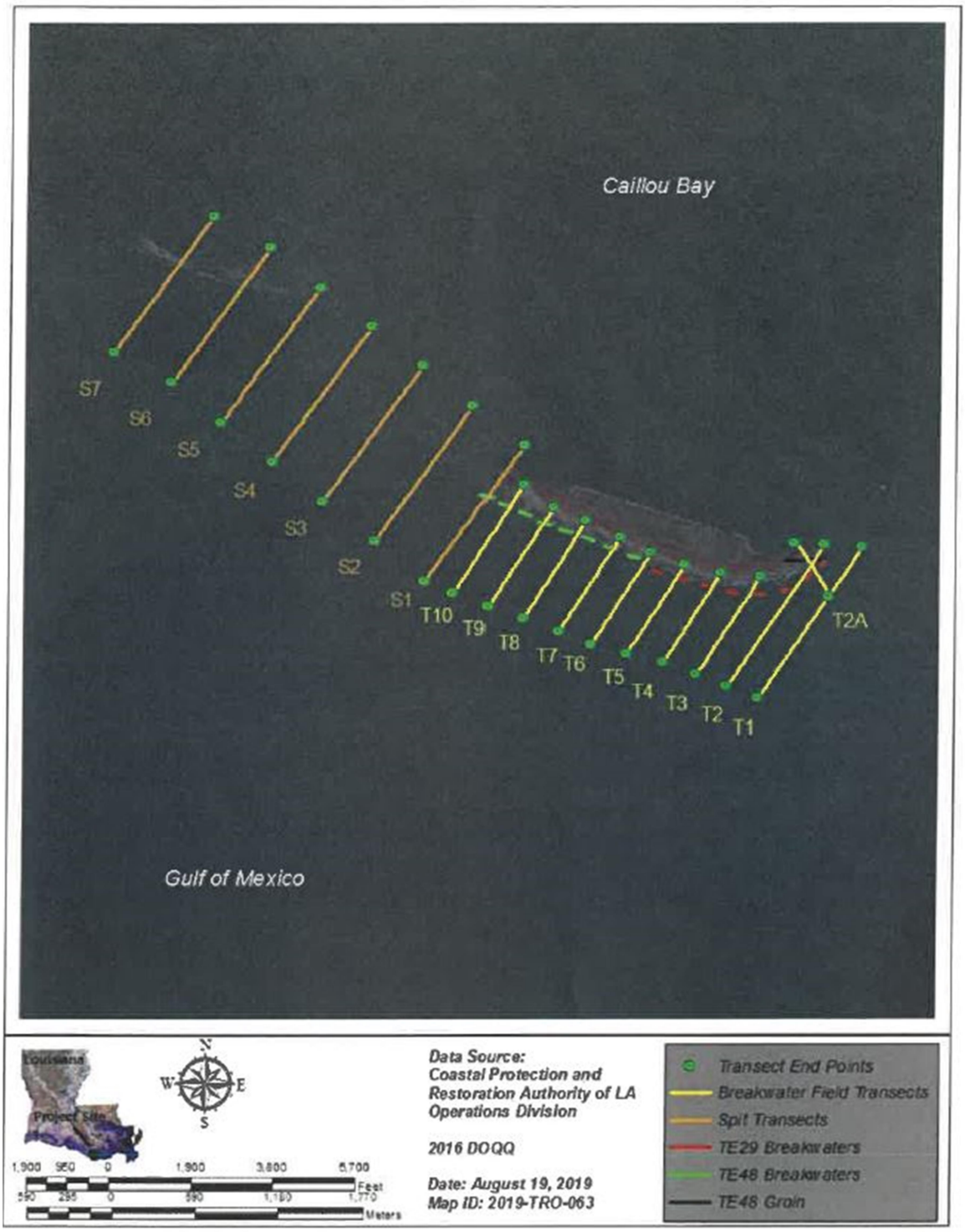
All elevation related surveys performed were adjusted and calibrated to the specified monument that is part of the CPRA – Louisiana Coastal Zone (LCZ) GPS Network. The monument is labeled as TE48-SM-01 (COON) (See Appendix A for Data Sheet) using industry accepted RTK GPS equipment and methodologies as outlined in this document.

Vertical Conversion Factor

The NAVD88 Geoid 12A elevation for the TE48-SM-01 (COON) monument is 1.488 feet, and the NAVD88 Geoid 99 elevation for the TE48-SM-01 (COON) monument is 2.132 feet. The conversion factor from Geoid 12A to Geoid 99 for the TE48-SM-01 (COON) monument is 0.644 feet.

Preparation of Survey Transects

All survey transects described in this "Report" were converted using AutoCAD Civil 3D© and HYPACK© to a digital format that is compatible with the surveyor(s) task-specific data collection equipment for the use of navigation and preparation. See Figures 2-5 for locations and positions of survey transects.


Caillou Bay
S7
S6
S5
S4
S3
S2
S1
T10
T9
T8
T7
T6
T5
T4
T3
T2
T1
T2A
Gulf of Mexico
Louisiana
Project Site
N
W
E
S
1,900 950 0 1,900 3,800 5,700
Feet
590 295 0 590 1,180 1,770
Meters
Data Source:
Coastal Protection and
Restoration Authority of LA
Operations Division
2016 DOQQ
Date: August 19, 2019
Map ID: 2019-TRO-063
Transect End Points
Breakwater Field Transects
Spit Transects
TE29 Breakwaters
TE48 Breakwaters
TE48 Groin

(Figure 2)

	BeginX_LSZ NAD 83 (ft)	BeginY_LSZ NAD 83 (ft)	EndX_LSZ NAD 83 (ft)	EndY_LSZ NAD 83 (ft)
T1	3413175.289	196971.172	3415635.684	200452.465
T2	3412478.066	197272.631	3414761.398	200506.396
T2A	3414847.110	199314.190	3414067.581	200554.352
T3	3411770.162	197551.668	3413268.500	199780.776
T4	3410994.492	197829.918	3412363.858	199897.638
T5	3410143.439	198055.417	3411517.504	200088.358
T6	3409325.474	198289.115	3410736.800	200377.082
T7	3408583.291	198601.644	3410014.419	200739.697
T8	3407775.115	198913.361	3409238.644	201134.266
T9	3406971.861	199204.142	3408482.612	201448.731
T10	3406149.677	199509.102	3407818.276	201989.318
S1	3405486.997	199796.208	3407815.208	202883.508
S2	3404333.541	200743.000	3406654.856	203833.873
S3	3403160.776	201674.448	3405485.529	204761.827
S4	3401993.203	202604.122	3404319.672	205691.441
S5	3400818.433	203516.511	3403139.719	206605.640
S6	3399673.593	204459.718	3401994.873	207545.400
S7	3398346.917	205190.376	3400669.982	208278.625

(Figure 3)


Caillou Bay
M10
M9
M8
M7
M6
M5
M4
M3
M2
M1
Raccoon Island
Gulf of Mexico
Louisiana
Project Site
N
W
E
S
410
820
1,230
Feet
140
280
420
Meters
Data Source:
Coastal Protection and Restoration Authority of LA Operations Division
2016 DOQQ
Date: August 9, 2019
Map ID: 2010-TFO-062
Transect End Points
Marsh Transects
TE-48 Marsh Creation Area

(Figure 4)

	BeginX_LSZ NAD 83 (ft)	BeginY_LSZ NAD 83 (ft)	EndX_LSZ NAD 83 (ft)	EndY_LSZ NAD 83 (ft)
M1	3412982.049	200650.259	3412762.971	200059.801
M2	3412323.500	200264.519	3412499.870	200802.891
M3	3412019.560	200962.659	3411806.511	200262.709
M4	3411354.499	200513.519	3411544.899	201121.049
M5	3411068.231	201266.149	3410900.201	200755.001
M6	3410383.050	200759.661	3410594.599	201428.151
M7	3409940.662	201019.400	3410112.281	201563.942
M8	3409492.949	201259.789	3409638.211	201720.481
M9	3409167.720	201888.290	3409045.250	201508.598
M10	3408899.010	201609.268	3409001.372	201931.948

(Figure 5)

Section 3: Topographic/Bathymetric Transect Survey

Equipment

Equipment utilized during survey:

- One (1) Trimble Survey Grade RTK System including but not limited to 5700, R7, R8-2, R8-3 and R-10 Receivers (Includes Base and Rover and accessories) and/or C4G Net. Calibrated to the project control.
- One (1) Teledyne Odom MK III Fathometer with 200kHz Transducer
- One (1) YSI Cast Away CTD Probe (Velocimeter)
- One (1) Desktop Computer with Hypack© Navigation Software.
- One (1) 8' pole with 6" diameter plate on bottom
- One (1) Closed Cabin Survey Vessel.

The manufacturer's specification sheets for each item can be found in **Appendix B** at the end of this document.

Methodology

Survey Control

Before the survey commenced the location and verification of the project monument TE48-SM-01 was completed. Once the project monument was located, visually inspected for integrity, and deemed undisturbed and suitable for use, a base receiver was set on the monument and static surveys were performed to check the validity of the elevation for the monument being used.

Data Acquisition for Breakwater Field & Spit Transects

Surveys were performed along the cross-sectional transects in the project area using the real-time kinematic (RTK) method. The project area consists of eleven (11) breakwater field, seven (7) spit, and ten (10) marsh transects. Ten of the breakwater field transects (T1-T10) are separated by 750 feet intervals (Figure 2), and transect T2A was established using the coordinates provided in Figure 3. The spit transects (S1-S7) are separated at 1,500 feet intervals (Figure 2). Nine of the marsh transects (M1-M9) are separated by 500 feet intervals, while M10 is separated from M9 by approximately 170 feet. The average length of the marsh transects is 566 feet (Figure 4). The points along the cross sections were taken no more than twenty-five (25) feet apart unless there was an abrupt change in elevation along the transect. Abrupt changes in elevation are considered to be greater than or equal to 0.5 feet. Survey points were also acquired where there was a change in project features. Breakwater field and spit transect lines were surveyed beginning at the -9 foot NAVD88 contour on the gulf side of the island for all transects except T2A. The beginning points provided in Figure 3 served as guidelines for transects T3-T10. The breakwater field transects T1, T2, and T2A terminated at the end points listed in Figure 3, while transects T3-T10 merged with the topographic survey at the land/water interface. The spit transects (S1-S7) ended at the -4 foot NAVD88 contour of the bay. The end points provided in Figure 3 for the spit transects were also only guidelines. Therefore, the spit transects extend from the -9 foot NAVD88 contour of the Gulf of Mexico to the -4 foot NAVD88 contour of Caillou Bay. Approximately 25-50 feet of overlap between topographic and bathymetric data was obtained. Although several of the breakwater field and spit transects intersect coastal structures, no elevations were established on the rock structure.

Data Acquisition for Marsh Transects

Surveys were performed along the cross-sectional transects in the project area using the real-time kinematic (RTK) method. The marsh transects consist of ten (10) transects (M1-M10) (Figure 4). The marsh transects begin and end at the coordinates listed in Figure 5. All topographic points were collected at the significant breaks in the slope (i.e., containment dikes; shoreline edges; and at all changes in elevation of 0.5 feet or greater, etc.) so that the resulting data accurately depicts the island morphology. Survey points were no more than 25 feet apart.

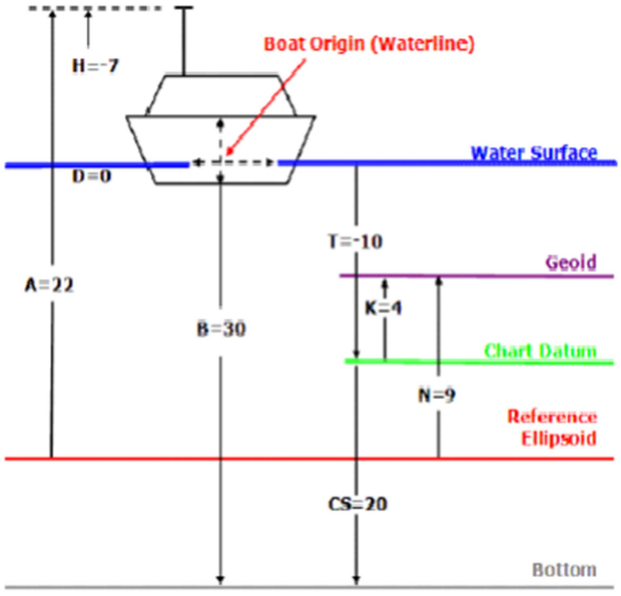
Data Processing

All topographic data was processed using Trimble Business Center (TBC) software version 4.00.

All bathymetric data was processed using Hypack© software version 2018.

All processed data was represented visually using an AutoCAD Civil 3D software version specified in the specifications for analysis.

Equipment Calibration for Bathymetric Surveys



Once the survey control is verified, the RTK system and the echo sounder transducer will be hard mounted to the survey vessel using specially designed mounts welded to the hull on the bow or stern of the vessel.

The RTK antenna and transducer positional offsets are then measured and entered into the Hypack© Navigation Software for the tide and draft corrections to be applied.

A "Bar Check" of this system is then performed. A velocity probe is lowered into the water within the project site down to the sea floor to obtain velocities throughout the water column and determine an average. The average water velocity is then entered into the echo sounder and set. Then, a minimum 1'x1' plate is lowered below the transducer at 5' increments down to the deepest survey depth to obtain the correct draft and index of the transducer and to calibrate the water velocities at each 5' increment. The "Bar Check" is recorded electronically in the Odom E-chart Software.

Section 4: Deliverables

Preliminary Submittals

In addition to the deliverables requested in this scope of services, an electronic set of 11" x 17" preliminary drawings shall be delivered to the Project Engineer, for technical review and comment.

Final Submittals

Two electronic copies of final deliverables that include half size (11" x 17") plan view drawings showing all survey lines and hazard survey results as well as cross section plots. Final deliverables should include:

- Drawing files in AutoCAD 2010 (.dwg) or later format Copy of the field notebook records
- Excel file of survey transects, including point number, northing, easting, elevation, and description
- Field Notebook Records
- Methodology Report
- GPS Survey Report

Drawing Files

The drawing files shall conform to CPRA AutoCAD Standards. The plan views shall be plotted over aerial photograph. Also, a table will be included with benchmark names and horizontal and vertical datums on which the survey is based. The state project name and number shall be shown on all drawings.

Certification

All deliverables shall be certified by a professional land surveyor licensed by the State of Louisiana.

The deliverables described above shall be submitted to the following CPRA representative:
Glen Curole
1440 Tiger Drive, Suite B
Thibodeaux, LA 70301
glen.curole@la.gov
(985) 447-0991

APPENDIX A SURVEY CONTROL

VICINITY MAP **Scale: 1" = 2,000'** Reproduced from 2013 GOOGLE Earth Aerial Image

Station Name: "TE48-SM-01"

Monument Location: Located in Terrebonne Parish, Louisiana, on the north side of Raccoon Island in Isles Dernieres, and is approximately 24 miles southwesterly of Cocodrie, Louisiana.

Monument Description: NGS style floating sleeve monument; datum point set on 9/16" stainless steel sectional rods driven 88 feet to refusal, set in sand filled 6" PVC pipe with access cover set flush with the ground.

Stamping: "COON"

Installation Date: January 2005

Monument Established By: John Chance Land Surveys, Inc.

For: *La. Dept. of Natural Resources, CRD*

Date of Survey Update: March 10-12, 2015

Monument Updated By: T. Baker Smith, LLC

Adjusted NAD 83 (2011-Epoch 2010) Geodetic Position
Lat. 29° 03' 14.79114" N
Long. 90° 55' 59.37394" W

Adjusted NAD 83 Datum LSZ (1702) Feet
N= 201,740.531
E= 3,408,702.132

Adjusted NAVD88 (2011-Epoch 2010.0) Height
Elevation = 1.488 feet (0.454 mtrs.) (Geoid12A)

Ellipsoid Height = -23.624 mtrs.
Geoid12A Height = -24.078 mtrs.

Adjusted position determined by T. Baker Smith, LLC for Coastal Protection and Restoration Authority

APPENDIX B EQUIPMENT DATA SHEETS

DATASHEET

TRIMBLE R8 GNSS SYSTEM

KEY FEATURES

Advanced satellite tracking with **Trimble 360 receiver technology**

Includes Trimble Maxwell 6 chips with **440 channels**

Unmatched GNSS tracking performance

Web user interface and remote configuration

Base and rover communications **options to suit any application**

THE INDUSTRY LEADING TOTAL GNSS SOLUTION

The Trimble® R8 GNSS system has long set the bar for advanced GNSS surveying systems. Through advanced Trimble 360 tracking technology and a comprehensive set of communication options integrated into a flexible system design, this integrated GNSS system delivers industry-leading performance. For surveyors facing demanding RTK applications, the Trimble R8 is an invaluable GNSS partner.

TRIMBLE 360 RECEIVER TECHNOLOGY

Future-proof your investment

Powerful Trimble 360 receiver technology integrated in the Trimble R8 supports signals from all existing and planned GNSS constellations and augmentation systems providing unmatched GNSS tracking performance. With this leading-edge technology, it is now possible for surveyors to expand the reach of their GNSS rovers into areas that were previously too obscured, such as under trees and in dense urban areas.

With two integrated Trimble Maxwell™ 6 chips, the Trimble R8 offers an unparalleled 440 GNSS channels. Also capable of tracking carrier signals from a wide range of satellite systems, including GPS, GLONASS, Galileo, BeiDou (COMPASS), and QZSS, the Trimble R8 provides a robust solution for surveyors.

The CMRx communications protocol in the Trimble R8 provides unprecedented correction compression for optimized bandwidth and full utilization all of the satellites in view, giving you the most reliable positioning performance.

Designed with the future in mind, Trimble 360 technology is optimized to receive future planned signals as the number of available satellites continues to grow. With Trimble 360 technology, the Trimble R8 delivers business confidence with a sound GNSS investment for today and long into the future.

FLEXIBLE SYSTEM DESIGN

The Trimble R8 combines the most comprehensive feature set into an integrated and flexible system design for demanding surveying applications. Connect directly to the controller, receive RTK network corrections, and connect to the Internet via comprehensive communication options. With a built-in transmit/receive UHF radio, the Trimble R8 enables ultimate flexibility for rover or base operation. As a base station, the internal NTRIP caster provides you customized access[1] to base station corrections via the Internet.

Trimble's exclusive Web UI™ eliminates travel requirements for routine monitoring of base station receivers. Now you can assess the health and status of base receivers and perform remote configurations from the office. Likewise, you can download post-processing data through Web UI and save additional trips out to the field.

AN INDUSTRY LEADING FIELD SOLUTION

If you're seeking the industry leading field solution, pair the Trimble R8 GNSS receiver with one of our powerful Trimble controllers, such as the Trimble TSC3, Trimble CU or Trimble Tablet Rugged PC featuring Trimble Access™ field software. These rugged controllers bring the power of the office to the field through an intuitive Windows-based interface.

Trimble Access field software offers numerous features and capabilities to streamline the flow of everyday surveying work. Streamlined workflows such as Roads, Monitoring, Mines, and Tunnels—guide crews through common project types and allows crews to get the job done faster with less distractions. Survey companies can also implement their unique workflows by taking advantage of the customization capabilities available in the Trimble Access Software Development Kit (SDK).

Need to get data back to the office immediately? Benefit from real-time data sharing via Trimble Access Services, now available with any valid Trimble Access maintenance agreement.

Back in the office, seamlessly transfer your field data using Trimble Business Center. Edit, process, and adjust collected data with confidence.

The Trimble R8 GNSS system—the industry leader for GNSS surveying applications.

1 Cellular modem required.

Trimble.

DATASHEET

TRIMBLE R8 GNSS VRS ROVER

KEY FEATURES

Proven GNSS technology from Trimble

Internal GSM/GPRS modem for fast Internet connection and data transfer

Lightweight, ergonomic, and cable free

Designed to optimally support the Trimble GNSS infrastructure solution

The Trimble® R8 GNSS VRS™ Rover is a multi-channel, multi-frequency GNSS (Global Navigation Satellite System) receiver, antenna, and data-link radio combined in one compact unit. The VRS rover combines advanced receiver technology with a proven system design to provide maximum accuracy and productivity.

TRIMBLE R-TRACK TECHNOLOGY FOR COMPREHENSIVE GNSS SUPPORT

Powered by an enhanced RTK engine, Trimble R-Track™ technology in the Trimble R8 GNSS VRS Rover supports the modernized GPS L2C and L5 signals as well as GLONASS L1/L2 signals. This extensive GNSS support is capable of providing surveying professionals with real field benefits.

With the world's GNSS' in constant development, surveying businesses small and large can be confident that investment in a Trimble GNSS system is protected. Trimble, already proven in GPS technology, will continue to lead the industry in GNSS support.

PROVEN SYSTEM DESIGN

From its powerful Trimble field software and controller to the receiver itself, the Trimble R8 GNSS VRS Rover's overall design has been tried, tested, and proven. It's rugged, lightweight and cable free for unsurpassed ergonomics and productivity in the field. Additionally, the Trimble R8 GNSS VRS rover consumes very little power and includes internal memory. These features also assist you in the field, enabling you to work longer without changing batteries or transferring data.

The Trimble R8 GNSS VRS Rover works optimally with Trimble controllers such as the Trimble CU or Trimble® TSC2® controller. Both controllers run industry-standard Microsoft® Windows™ operating systems, which are familiar and easy to use. They are also flexible for running both Trimble field software and other specialized applications.

The VRS rover includes an internal GSM/GPRS cell modem for wireless connection to the Internet via NTRIP (Networked Transport of RTCM via Internet Protocol). Quickly and easily access GNSS data from a Trimble GNSS infrastructure solution over the Internet. No additional cellphone or external modem is required.

AN IMPORTANT COMPONENT OF A TRIMBLE GNSS INFRASTRUCTURE SOLUTION

Trimble® GNSS Infrastructure is the most established and widely used GNSS infrastructure solution available. Additionally, all components of Trimble GNSS infrastructure—including the Trimble R8 GNSS VRS Rover—are designed to work together. This means the solution is scalable; that is, it will grow with you as your business needs change. And the solution is part of Trimble's Connected Site model, where products, techniques, services, and relationships combine to take your business to all-new levels of achievement.

With numerous fully modeled networks all over the world and dedicated GNSS infrastructure engineers on hand to support your unique needs, Trimble GNSS infrastructure solutions are always a wise investment. Surveying professionals like you can rely on Trimble's experience and expertise in this field, and be confident that choosing a Trimble GNSS infrastructure solution is the right decision.

Trimble

ECHOTRAC™ MKIII

MODEL DF3200

- Interchangeable paper chart or color LCD
- Frequency agile (both channels)
- Internal data storage and playback with color LCD
- Four serial ports and Ethernet interface
- Optional built-in DGPS
- AC/DC power input

TELEDYNE
ODOM HYDROGRAPHIC
A Teledyne Technologies Company

NEW

The CastAway™-CTD

with profiling and analysis software

The YSI CastAway-CTD is a lightweight, easy to use hydrographic instrument designed for quick and accurate conductivity, temperature, and depth profiles. Starting with a unique six-electrode array and a flow-through cell, the CastAway makes use of commercial Bluetooth and GPS technology to make an instrument that is as usable as it is accurate.

The CastAway is a multi-functional tool that incorporates the most modern technology available - yet is simple to use. It is designed for CTD profiling down to 100 m and is easy to deploy.

The palm-sized CastAway-CTD can easily be deployed by hand. Each cast is referenced with both time and location using its built-in GPS receiver. Latitude and longitude are acquired both before and after each profile. Plots of conductivity, temperature, salinity and sound speed versus depth can be viewed immediately on the CastAway's integrated color LCD screen in the field.

Raw data can be easily downloaded via Bluetooth to a Windows computer for detailed analysis and/or export at any time. Rugged, non-corrosive housing, AA battery power and tool-free operation reflect the technician-friendly pedigree of the CastAway-CTD. So do the simple, intuitive features – everything an operator needs to know about deploying the CastAway-CTD, viewing data and downloading the files fits in the lunchbox-sized carrying case.

Best used in:

- Coastal Oceanography
- Hydrology
- Aquaculture/Fisheries

When needed for:

- Saltwater Intrusion
- Surveying/Hydrography
- Sound Velocity Profiles
- Field Sensor Verification
- Estuarine Research

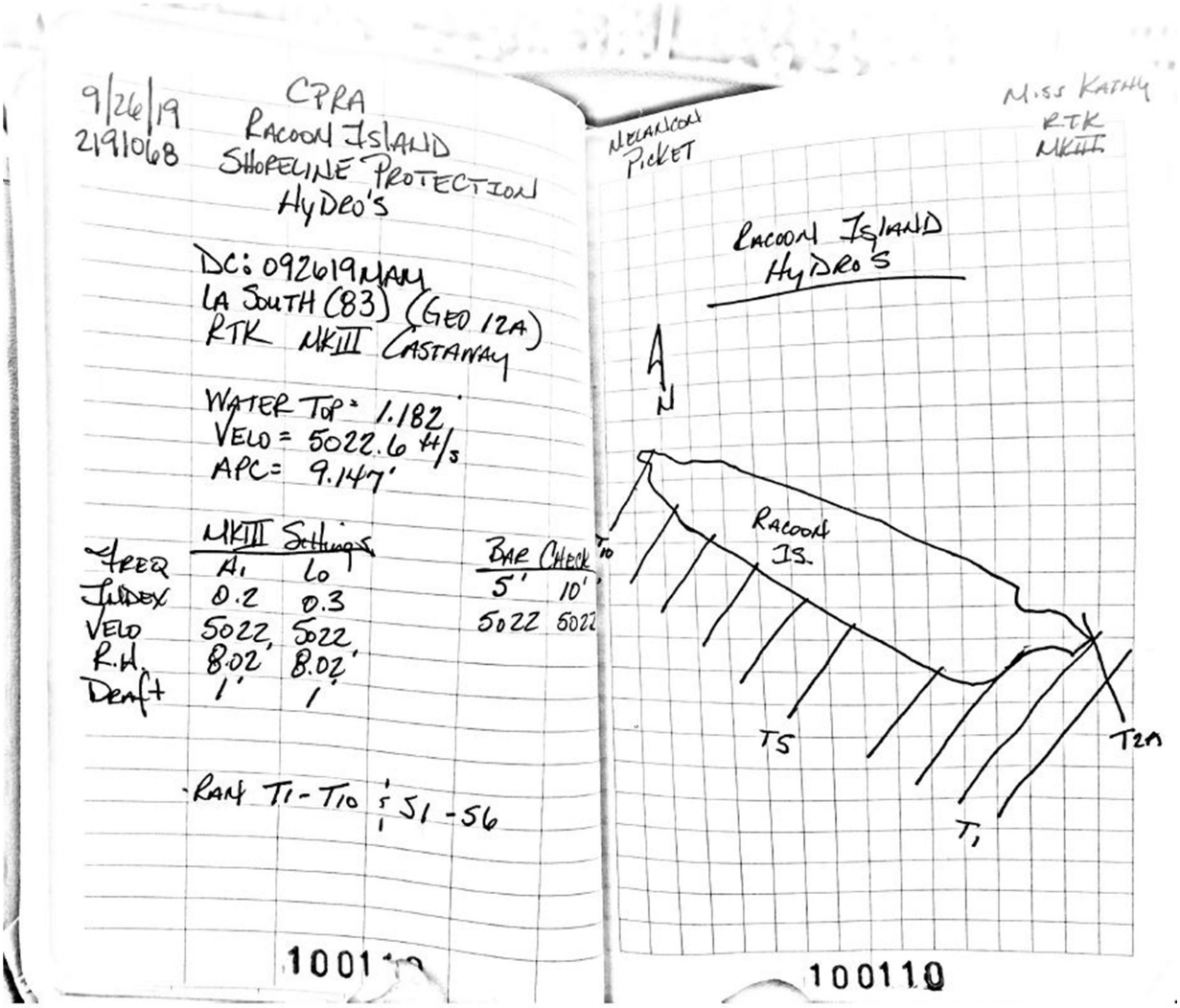
The CastAway-CTD
Instant, reliable data in the palm of your hand!

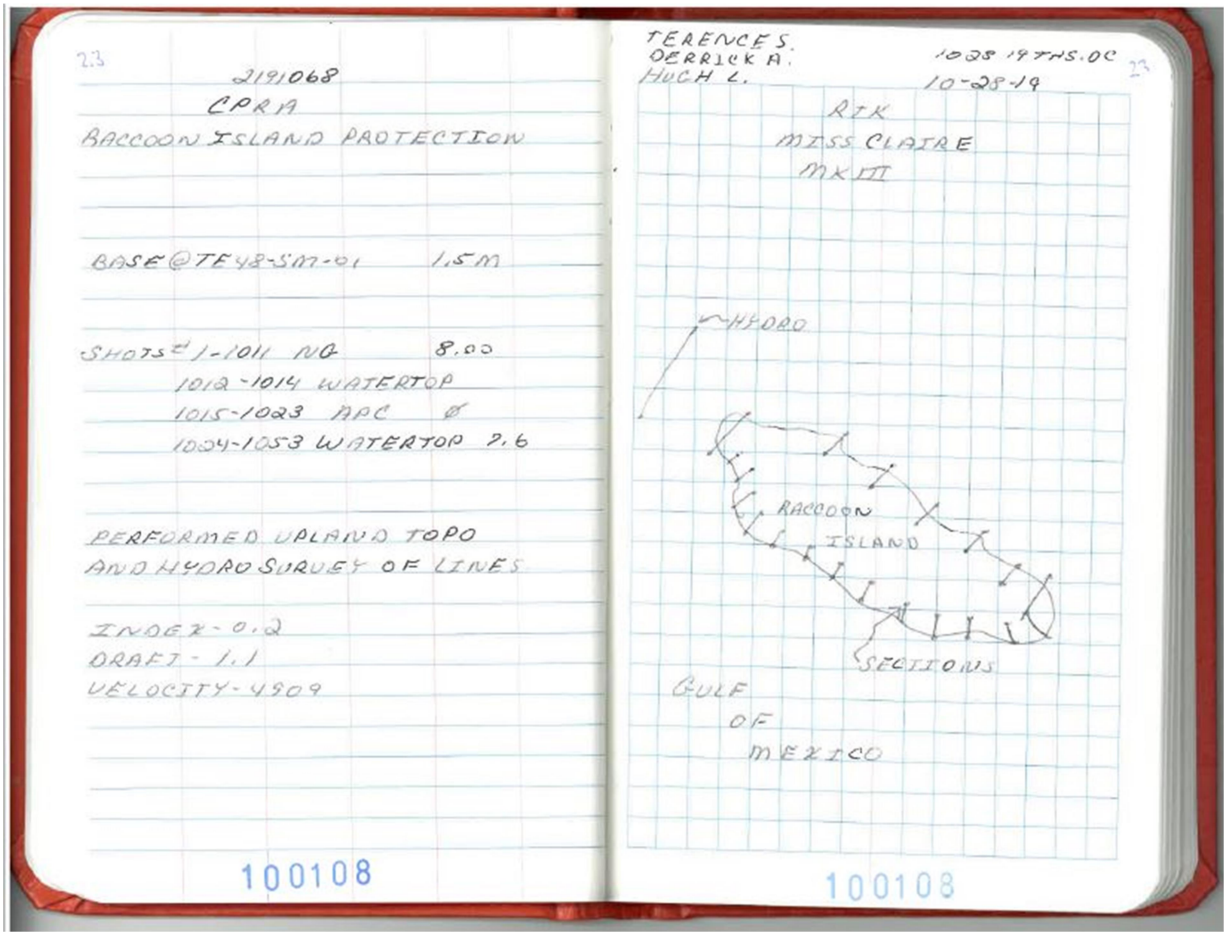
- *GPS position, date and time*
- *Fast sampling and sensor response*
- *Waterproof interface works in and out of the water*
- *Bluetooth wireless communication*
- *No user calibration required*
- *No tools, computers or cables required!*

Pure Data for a Healthy Planet.®

www.ysi.com/castaway

APPENDIX C FIELD NOTES




23
219/068
CPRA
RACCOON ISLAND PROTECTION
BASE @ TE48-SM-01 1.5M
SHOTS 1-1011 NO 8.00
1012-1014 WATERTOP
1015-1023 APC Ø
1024-1053 WATERTOP 2.6
PERFORMED UPLAND TOPO
AND HYDRO SURVEY OF LINES
INDEX - 0.2
DRAFT - 1.1
VELOCITY - 4909
100108
TERENCE S.
DERRICK A.
HUGH L.
1028 19 THS.OC
10-28-19
23
RIK
MISS CLAIRE
MK III
HYDRO
RACCOON
ISLAND
SECTIONS
GULF
OF
MEXICO
100108