STATE OF LOUISIANA
COASTAL PROTECTION AND RESTORATION AUTHORITY

DWH BARATARIA BASIN RIDGE AND MARSH CREATION PROJECT - SPANISH PASS INCREMENT BA-203
DESIGN LEVEL SURVEY
NEAR VENICE
PLAQUEMINES PARISH, LOUISIANA

FINAL REPORT

December 7, 2018

CPRA Contract No. 4400013273

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Survey Report

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DWH BARATARIA BASIN RIDGE AND MARSH CREATION PROJECT - SPANISH PASS INCREMENT BA-203 DESIGN LEVEL SURVEY NEAR VENICE PLAQUEMINES PARISH, LOUISIANA

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1.0 INTRODUCTION

The Coastal Protection and Restoration Authority (CPRA) is responsible for monitoring, maintaining, and operating projects that restore, create, enhance, and maintain coastal wetlands in Louisiana. Tasked with these functions, CPRA is planning to restore the Spanish Pass Increment of the BA-203 Barataria Basin Ridge and Marsh Creation Project. During the 15% Design - Reconnaissance Survey and 30% Design Level Survey phases for the Fill Areas of the project updated survey control was established, a RTK Topographic & Bathymetric Survey, and a Magnetometer Hazard Survey was performed in the project area for the initial planning and design of the project. The surveys used Real Time Kinematic (RTK) methods and the Louisiana Coastal Zone (LCZ) GPS Network.

2.0 PROJECT OVERVIEW

The Barataria Basin Ridge and Marsh Creation Project (BA-203) is funded through DWH NRDA. The proposed project consists of building 120 acres of earthen ridge and 1,134 acres of marsh creation. This proposed scope includes the creation of approximately 120 miles of earthen ridge west of Venice in the Barataria Basin. The proposed 1,134 acres of marsh creation will be located on the south/north of the earthen ridge. This scope of services involves topographic surveys, bathymetric surveys of access channels, and magnetometer hazard surveys within the marsh fill area, ridge, and access routes.

Morris P. Hebert, Inc. (MPH) performed a GPS Network Adjustment survey to update the survey control during the 15% Design - Reconnaissance Survey for the project. MPH then performed topographic & bathymetric surveys of the proposed ridge and marsh creation fill areas to provide sufficient data to aid in the 15% design phase of the project. Once the 15% Design - Reconnaissance Survey data was reviewed and the project area was adjusted for feasibility a new design plan was established. A new scope of work which provided for densification of survey data from a transect spacing of 2500-ft intervals through the proposed fill area to a new spacing of 250-ft intervals.

3.0 DATA COLLECTION SUMMARY

3.1 15% Design - Reconnaissance Survey

During the period of December 5, 2017 through December 22, 2017 MPH performed a static resurvey of 876 849 A TIDAL, CRMSBA SM 14, and 15-067C-1 to verify the horizontal and vertical control on the monuments. This included establishing updated data sheets for monuments. For the purpose of this project, the elevation of the monuments are referenced to Geoid12B.

During the period of December 5, 2017 through December 22, 2017, MPH collected field data throughout the BA-203 project. All field work on the Reconnaissance Survey was completed on December 22, 2017. The office work began in advance of the fieldwork. A total of nineteen (19) transects, running north to south, were surveyed during this reconnaissance survey phase of the project. The transects were spaced at 2500-ft intervals and extended 1000-ft north and south of the proposed fill area. In addition, four (4) of these transects were extended to the limits of the project footprint. Survey transects were laid out in the open water, broken marsh, and across pipeline canals. Position, elevation, and water depth were recorded at a minimum of every 100-ft along each transect, where possible. An appropriate topo shoe was attached to the bottom of the survey rod to prevent the rod from sinking. The Conventional Survey Crews utilized an airboat and a Trimble RTK/GPS base and rover setup for positioning and real-time corrections.

The bathymetry survey was performed along the proposed access channels that were identified via desktop research prior to mobilization. Multiple offset survey lines were performed within these channels, where possible. The bathymetric survey points were collected utilizing Trimble DSM 232 DGPS rover and Odom HydroTrac Echo sounder in conjunction with the Hypack software. A sampling rate of 5 Hz (5 points/second) was used during data collection. The Hydrographic Survey Crew used a 19’ boat with outboard marine engine.

MPH performed a magnetometer hazard survey along the same transects established during the topographic and bathymetric survey. The magnetometer lines were run during the same time frame as the bathymetry survey lines when applicable. In addition to performing the magnetometer survey along the same transects as the topographic and bathymetric survey, MPH also performed a survey along transects that ran east to west in the proposed project area. These survey transects were spread at 1500’ intervals. The magnetometer survey was completed utilizing a Trimble RTK/GPS and Geometrics G-882 Cesium Magnetometer. All data was collected and processed with Hypack software. The Magnetometer work was performed using an airboat.

3.2 30% Design Level Survey

During the period of May 14, 2018 through November 30, 2018, MPH collected field data throughout the BA-203 project. All field work on the Design Level Survey was completed on November 30, 2018. The office work began in advance of the fieldwork. A total of one hundred fifty-nine (159) transects, running north to south, were surveyed during this design level survey phase of the project. The transects were spaced at 250-ft intervals and extended north and south to the boundary provided by W.F. Baird. Survey transects were laid out in the open water, broken marsh, and across pipeline canals. Position, elevation, and water depth were recorded at a minimum of every 50-ft along each transect, where possible. An appropriate topo shoe was attached to the bottom of the survey rod to prevent the rod from sinking. The Conventional Survey Crews utilized an airboat and a Trimble RTK/GPS base and rover setup for positioning and real-time corrections.

The bathymetry survey was performed along the survey transects were water depths were greater than 2-ft. The bathymetry survey overlapped the topographic survey a minimum of 50-ft. The bathymetric survey points were collected utilizing Trimble DSM 232 DGPS rover and Odom HydroTrac Echo sounder in conjunction with the Hypack software. A sampling rate of 5 Hz (5 points/second) was used during data collection. The Hydrographic Survey Crew used a 16' boat with outboard marine engine.

MPH performed a magnetometer hazard survey along the same transects established during the topographic and bathymetric survey. The magnetometer lines were run during the same time frame as the bathymetry survey lines when applicable. In the upland areas within the project, the magnetometer survey was performed utilizing an airboat. The magnetometer survey was completed utilizing a Trimble RTK/GPS and Geometrics G-882 Cesium Magnetometer. All data was collected and processed with Hypack software.

4.0 METHODOLOGY

4.1 Static GPS Network Planning

The Static GPS Network was designed to incorporate three (3) CORS "Continuously Operating Reference Stations" from the Center for GeoInformatics at LSU. The three CORS used for this survey were "BVHS", "GRIS", and "SBCH". They are located in Boothville, Grand Isle, and Shell Beach respectively. Since these stations are continuously collecting data, simultaneous data was collected for all three CORS during the time of the static survey of each of the three monuments "876 0489 A TIDAL", "CRMSBA SM 14", and "15-067C-1". A Static GPS Survey was run on one monument each day during the RTK Survey on a rotational basis throughout the job. On that day a three (3) minute observed control point was measured utilizing a bipod/tripod on the other two monuments at the beginning and ending of each day. [This process was repeated each day rotating the GPS Base for the six (6) days the project ran with the same static and RTK survey procedure described above used to

measure the other two at the beginning and ending each day.] This yielded sufficient data to correlate the 3 monuments to one another. Due to the project length being 6 days, we were able capture different site and atmospheric conditions in order to generate independent and redundant observations. Each static survey was performed for a period of at least 6 hours with the exception of day two (December 6) due to a wintery mix of sleet and rain for the remainder of the day. The static surveys were performed concurrently with the field topographic cross sections. All data collected is referenced to the Lambert Conformal Conic Projection, Louisiana State Plane Coordinate System (South Zone), the North American Datum of 1983 (NAD83) and the North American Vertical Datum of 1988 (NAVD88), Geoid12B. The GPS Session Schedule can be seen in Appendix 3. A map depicting the GPS Network can be seen in Appendix 2.

4.2 GPS Static Survey

The GPS Static Survey was performed using Trimble R8/R10 GPS receivers equipped with fixed height tripods. The GPS receivers were set to collect L1 and L2 data at a 15 second epoch rate with a 10-degree elevation mask. Static GPS data was collected at the benchmark for a minimum of 6 hours per session with the exception noted above on December 6. A total of six data collection sessions (Two at 876 0849 A TIDAL, Three at CRMSBA SM 14, & One at 15-067C-1) were performed on different days during the RTK Topographic Surveys.

4.3 Data Processing and Network Adjustment

The static GPS data was downloaded from the receiver and imported into Trimble Business Center (TBC) for processing and QA/QC. Each setup was checked to verify that the antenna height and station name matched the corresponding field log sheet. GPS data files were also sent to OPUS to determine approximate position. These OPUS positions were checked against the log sheet to determine any setup errors.

Each baseline was processed using a 15-degree elevation mask and all baselines achieved a fixed solution with no editing. Next, a 3-D minimally constrained least squares (free) adjustment was performed holding one CORS "Continuously Operating Reference Station" from the Center for GeoInformatics at LSU named "BVHS" located in Boothville fixed in latitude, longitude, and ellipsoid height. This adjustment used Geoid12B as the basis for determining orthometric heights of adjusted ellipsoid heights. The network was found to fit existing control within acceptable limits, and all primary control was found to be consistent with respect to differences in published and computed elevation values. The Initial and Weighted Free Adjustment Report can be seen in Appendix 5. Once the Free Adjustment passed the Chi Square Test, a fully constrained least squares adjustment was performed holding all CORS fixed in latitude, longitude, and ellipsoid height. The Fully Constrained Network Adjustment report and final adjusted positions can be seen in Appendix 6. A summary of the residuals of adjusted positions versus OPUS positions can be seen in Appendix 4.

5.0 SURVEY CONTROL

Benchmarks used as a control are tied into the CPRA – Louisiana Coastal Zone (LCZ) GPS Network and U.S.A.C.E. – United States Army Corps of Engineers Network. MPH conducted all surveying activities using the "876 0849 A TIDAL" (Primary LCZ control monument), "CRMSBA SM 14" (Secondary LCZ control monument), and "15-067C-1" (USACE control monument), which were updated by performing a GPS Network Adjustment into the LCZ GPS network using the Geoid12B model. These benchmarks are identified by the Louisiana State Plane Coordinate System (South Zone), the North American Horizontal Datum of 1983 (NAD 83), and the North American Vertical Datum of 1988 (NAVD88) geoid 12B. The USACE monument "15-016C-1" was provided by W.F. Baird and was taken from the Budmat 2 project. The information for the other two monuments was gathered from CPRA's CIMS website and existing LCZ GPS Network.

6.0 QA/QC Procedures

MPH conducted topographic, bathymetric, and magnetometer surveys for the DWH Barataria Basin Ridge and Marsh Creation Project – Spanish Pass Increment (BA-203) as per the practices set forth in CPRA's January 2016 version of "A Contractors Guide to the Standards of Practice". MPH furnished the necessary equipment, software, supplies, labor and transportation, including fuel, needed to complete the work as outlined in the Reconnaissance Field Data Collection plan provided to CPRA prior to the commencement of the surveying activities within the fill area. All fieldwork associated with these surveys were conducted under the direct supervision of a Professional Land Surveyor.

All field and office work performed was completed utilizing the in-house developed Operating Procedures and Quality Control/Quality Assurance Manual. This manual was developed to define appropriate standards of practice and accepted operating procedures and performance criteria to be used to provide consistency, accuracy, and reliability of services and products. These practices included: checking into secondary monumentation at the beginning and ending of each day to ensure GPS quality assurance, performing bar checks and sound velocity checks at the beginning and ending of each day for the bathymetry surveys, performing a calibration line with the magnetometer to ensure proper functionality and offset values, etc. All equipment used on the project checked for proper calibration prior to the start of the project. Field survey data was also analyzed in the office on a daily basis to ensure accuracy and quality.

7.0 HORIZONTAL AND VERTICAL CONTROL

7.1 15% Design - Reconnaissance Survey

MPH performed a GPS survey utilizing RTK OTF methods. The GPS Total Station survey equipment included the use of a Trimble R10 Dual Frequency receiver as a rover and a Trimble R8 Model 3 Dual Frequency receiver as a base. The base station occupied one of the three survey control monuments "876 0849 A TIDAL" (Primary LCZ control monument), "CRMSBA SM 14" (Secondary LCZ control monument), and "15-067C-1" (USACE control monument) and rover units were used to collect horizontal and vertical data along the transects. [For quality control, the GPS Base Receiver was set up on an existing project control point with an established horizontal position and elevation while the Rover Receiver was used to observe the other two existing project control points checking. This observed position was checked against the newly established position of the control points to verify that it was within an accepted tolerance. This QA/QC process was performed daily throughout the duration of the project.] Survey data was downloaded and processed utilizing Trimble Business Center. The complete RTK Total Station survey method yields nominal accuracies of 1 cm horizontal and 2 cm vertical. The monuments which were used for control, are referenced to the Lambert Conformal Conic Projection, Louisiana State Plane Coordinate System (South Zone), the North American Datum of 1983 (NAD83) and the North American Vertical Datum of 1988 (NAVD88).

7.2 30% Design Level Survey

MPH used the above mentioned updated Static Control data that was established during the 15% Design – Reconnaissance Survey throughout the 30% Design Level Survey phase of the project.

8.0 RTK TOPOGRAPHIC & BATHYMETRIC SURVEY

8.1 15% Design - Reconnaissance Survey

MPH performed topographic and bathymetric surveys within the proposed area in an effort to aid in the design of the marsh creation area(s) and attempt to identify possible access routes that could be used during possible construction activities. The survey transects for the reconnaissance level topographic and bathymetric survey that were performed and developed based on feedback from CPRA and W.F. Baird. A total of (19) transects, running north to south, were surveyed during this phase of the project. The transects were spaced at 2500-ft intervals and extend 1000-ft north and south of the proposed fill area. In addition, (4) of these transects extended to limits of the project footprint. Survey transects were laid out in the open water, broken marsh, and across pipeline canals. Position, elevation, and water depth were recorded at a minimum of every 100 ft. along each transect, where possible. The topographic survey was completed utilizing a Trimble

RTK/GPS base and rover setup. A 6-inch diameter topo shoe was attached to the bottom of the survey rod to prevent the GPS antenna rod from sinking. In areas, where water depths were too deep for the use of the GPS antenna rod a level rod was used to take soundings.

The bathymetric survey was performed within the possible access routes that were determined via a desktop analysis of current aerial imagery. The points were collected utilizing Trimble DSM232 DGPS and Odom HydroTrac Echo sounder in conjunction with the Hypack software. A sampling rate of 5 Hz (5 points/second) was used during data collection. A bar check and sound velocity cast was performed at the start of work each day. A top of water elevation shot was also recorded through the day when the bathymetry work was performed.

8.2 30% Design Level Survey

MPH performed topographic and bathymetric surveys within the proposed redefined fill area in an effort to aid in the design of the marsh creation area(s). The densification of the survey transects for the 30% design level topographic and bathymetric survey that were performed and developed were based on feedback from CPRA and W.F. Baird. A total of one hundred fifty-nine (159) transects, running north to south, were surveyed during this phase of the project. The transects were spaced at 250-ft intervals and extended north and south to the boundary provided by W.F. Baird. Survey transects were laid out in the open water, broken marsh, and across pipeline canals. Position, elevation, and water depth were recorded at a minimum of every 50 ft. along each transect, where possible. The topographic survey was completed utilizing a Trimble RTK/GPS base and rover setup. A 6-inch diameter topo shoe was attached to the bottom of the survey rod to prevent the GPS antenna rod from sinking. In areas, where water depths were too deep for the use of the GPS antenna rod a level rod was used to take soundings.

MPH performed topographic surveys within five (5) additional areas at the mouth of natural bayous labeled Sites “A thru E” in an effort to aid in the design of the marsh creation area(s). A total of thirty three (33) transects, running in various directions pending on the site location, were surveyed during this phase of the project. The transects were spaced at approximately 50-ft intervals and extended various directions as provided by W.F. Baird. Survey transects were laid out in the open water, broken marsh, and across pipeline canals. Position, elevation, and water depth were recorded at a minimum of every 50 ft. along each transect, where possible. The topographic survey was completed utilizing a Trimble RTK/GPS base and rover setup. A 6-inch diameter topo shoe was attached to the bottom of the survey rod to prevent the GPS antenna rod from sinking. In areas, where water depths were too deep for the use of the GPS antenna rod a level rod was used to take soundings.

MPH performed topographic survey of the DDDD Borrow Area on the east bank of the Mississippi River. A total of twenty-five (25) transects, running perpendicular to the bankline of the Mississippi River. The transects were spaced at approximately 1000-ft intervals and extended approximately 300-ft onto the bank as provided by W.F. Baird. Position, elevation, and water depth were recorded at a minimum of every 50 ft. along each transect, where possible. The topographic survey was completed utilizing a Trimble RTK/GPS base and rover setup. A 6-inch diameter topo shoe was attached to the bottom of the survey rod to prevent the GPS antenna rod from sinking. In areas, where water depths were too deep for the use of the GPS antenna rod a level rod was used to take soundings.

The bathymetric survey was performed was performed in the open water and where water depths were greater than 2-ft. The points were collected utilizing Trimble DSM232 DGPS and Odom HydroTrac Echo sounder in conjunction with the Hypack software. A sampling rate of 5 Hz (5 points/second) was used during data collection. A bar check and sound velocity cast was performed at the start of work each day. A top of water elevation shot was also recorded through the day when the bathymetry work was performed. The bathymetry data overlapped the topographic data approximately 50-ft. All data was was processed in Hypack software. A QA/QC analysis was performed on the collected data and the overlapping data was compared to the topographic dataset when applicable.

9.0 MAGNETOMETER HAZARD SURVEY

9.1 15% Design - Reconnaissance Survey

MPH performed a magnetometer hazard survey within the proposed access channels and along the same transects established during the topographic survey. In addition, survey transects were performed east to west within the project area at 1000-ft offsets. The magnetometer survey within the proposed access channels was performed concurrently with the bathymetry survey. The magnetometer survey was performed utilizing a Trimble DGPS and Geometrics G-882 Cesium Magnetometer. All data was collected and processed in Hypack software. At the start and end of each day a calibration line was performed in opposite directions to ensure proper functionality and offset values.

9.2 30% Design Level Survey

MPH performed a magnetometer hazard survey within the proposed access channels and along the same transects established during the 30% Design Level Topographic survey. The magnetometer survey within the proposed access channels was performed concurrently with the bathymetry survey. The magnetometer survey was performed utilizing a Trimble DGPS and Geometrics G-882 Cesium Magnetometer. All data was collected and processed in Hypack

software. At the start and end of each day a calibration line was performed in opposite directions to ensure proper functionality and offset values.

9.3 Hazard Investigation Survey

Once field data collection was completed, magnetic anomalies were determined from processing magnetometer data and interpretation. The magnetometer gamma baseline during the field geohazard survey was 46,620 gammas. The Geometrics model G-882 last certified manufacturer (dated 3/13/18) depth calibration = 0.016483 (salt water) and bias = -1.65. The altimeter calibration scale = 0.01016 and bias = -1.27. Combined altitude and depth of the towfish were compared to the echo sounder (post-bar check and sound velocity cast) to insure depth accuracies were acceptable.

Anomaly targets identified during editing of data, was determined for coordinate position and characteristics such as target ID, description, gamma peak, intensity, etc. Total intensity of each magnetic signal is noted at every position after the ambient is removed. The intensity and signature width of a magnetic deflection are dependent on a variety of factors which include object size, configuration, ferrous content, and distance to the sensor

The magnetometer dataset was processed using the Single Beam Editor in HYPACK®. Magnetic anomalies were selected on the basis of fifty (50) gammas or higher. The tools in Single Beam editor were able to give such information as: peak, duration, distance over ground, line number, date, etc. All magnetic anomalies are detailed in the data table in Appendix 10 of this report

MPH submitted all the magnetomter data to W.F. Baird and after a review of all magnetometer survey data, W.F. Baird requested that MPH perform an anomaly investigation within 9 areas, provided by W.F. Baird, that would most likely contain significant objects that may present a hazard to construction. Prior to performing hazard investigation survey, MPH submitted a ticket to Louisisna One Call in an effort to allow any companies with utilities within these area to contact MPH and provide feedback prior to commencing the survey. The log of all companies that contacted MPH about the One Calls can be found in Appendix 15. MPH investigated the anomalies or utilities identified from the magnetometer hazard survey by manual probing methods. If an anomaly is found, it was recorded for horizontal position, elevation, and mud cover. If we are unable to determine the source of the magnetic anomaly, the location was recorded “unknown anomaly.” MPH did not physically mark and/or flag any anomaly investigations. MPH began the Anomaly Investigation as described above on November 19th, 2018. The investigation took approximately 17 days due to weather delays. The anomalies investigated and the corresponding features (if known) are shown on the Magnetometer Investigation Areas map in Appendix 7.

10.0 Chronological Summary of Work

10.1 15% Design - Reconnaissance Survey

Project #	Group	Date
BA-203	FILL AREA SURVEY	12/5-22/2017
BA-203	ACCESS CHANNEL SURVEY	12/4-6/2017
BA-203	MAGNETOMETER SURVEY	12/11-14/2017

10.2 30% Design Level Survey

Project #	Group	Date
BA-203	FILL AREA SURVEY - DELTA'S	5/14-11/21/2018
BA-203	DISCHARGE PIPE SURVEY & TIDEWATER ROAD	9/17-19/2018
BA-203	FILL AREA SURVEY - EASTERN EXPANSION	11/05-28/2018
BA-203	DDDD BORROW AREA SURVEY	11/14-16/2018
BA-203	MAG INVESTIGATION SURVEY	11/19-30-2018

11.0 Deliverables

As requested in the CPRA of Louisiana Scope of Services the following deliverables are being submitted:

11.1 A report describing the survey methodology employed in the field.

11.2 Two sets of 11" x 17" size plan view drawings showing an overlay of the Lambert Conformal Conic Projection Louisiana State Plane Coordinate System South Zone NAD 83 and drawings showing all survey control points utilized in the survey. Two sets of 11” x 17” size plan and profile drawings, depicting the results of the topographic and bathymetric surveys.

11.3 Two digital copies of drawing files on separate CD disks or jump drives in AutoCAD (*.dwg) format.

11.4 A copy of the XYZ survey data will be provided in a coma-delimited ASCII format. The data is referenced to the Louisiana Coordinate System (South Zone) and North American Datum of 1983 (NAD 83) in U.S. Survey Feet. Elevations are referenced to the North American Vertical Datum of 1988 (NAVD 88) in feet. RK topographic data collected will have the following headers: Date, Point_No., Easting_unit, Northing_unit, Elevation_NAVD88_GEOID12B_unit, Description, Station, Benchmark_ID, and Ellp_hgt_unit (which is ellipsoid height).

11.5 Two printed copies of the survey data.

11.6 Two printed copies of the field notebook records.

12.0 CERTIFICATION

I hereby certify that the report, data and drawings referenced herein were prepared from a field survey conducted on the ground by me or under my direct supervision and control and that the report, data and drawings accurately depict the result of said survey.

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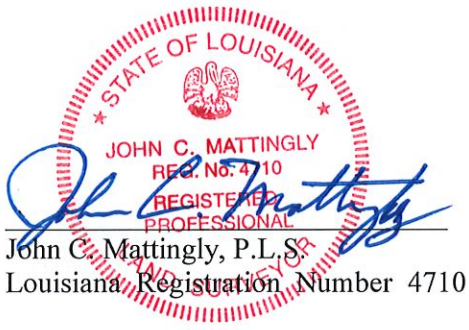

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