U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

HORIZONTAL AND VERTICAL CONTROL REPORT

Type of Survey	**Hydrographic**
Project Number	**OPR-J347-KR-18**
Contract Number	**EA-133C-14-CQ-0037**
Task Order Number	**1305M218FNCNJ0138 and Modifications**
Time Frame	**August 2018 - September 2019**

LOCALITY

State	**Louisiana**
General Locality	**Mississippi River**

2019

CHIEF OF PARTY

Jonathan L. Dasler, David Evans and Associates, Inc.

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DATE _____

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

Horizontal and Vertical Control Report
Project OPR-J347-KR-18
Locality: Mississippi River
August 2018 – September 2019
S/V *Blake* and RHIB *Sigsbee*
David Evans and Associates, Inc.
Chief of Party: Jonathan L. Dasler, PE, PLS, CH

INTRODUCTION

This report applies to surveys H13188, H13189, H13190, H13191, H13192, H13193, H13194, H13195, H13196, H13212, and H13330, all located on the Mississippi River in Louisiana between Baton Rouge and the entrance to Southwest Pass. The project area encompassed approximately 98 square nautical miles (SNM) and over 510 miles of shoreline. The original project area included in the *Hydrographic Survey Project Instructions* issued on July 20, 2018 extended from Baton Rouge (Mile 232.5 Above Head of Passes (AHOP)) to Head of Passes (Mile 0 AHOP). A contract modification was issued on December 11, 2018, extending the project area upriver from Baton Rouge to Mile 236 AHOP and Baton Rouge Harbor, and downriver from Head of Passes to the entrance to Southwest Pass (Mile 21 Below Head of Passes (BHOP)). A second contract modification issued on August 15, 2019 split the area upriver of Baton Rouge that was added to survey H13188 during the first contract modification into a new survey area, H13330. All surveys follow requirements defined in the *Statement of Work* (November 19, 2018), *Hydrographic Survey Project Instructions* (August 8, 2019), and National Ocean Service (NOS) *Hydrographic Surveys Specifications and Deliverables* (HSSD) (March 2018).

Historic flooding of the Mississippi River during OPR-J347-KR-18 survey operations impacted the ability of David Evans and Associates, Inc. (DEA) to efficiently and safely complete all project objectives within the scheduled project timeline. Flood conditions, unsafe currents, and restrictions from the United States Coast Guard (USCG) Captain of the Port prevented survey operations from Baton Rouge to New Orleans after December 2018. While the initial survey of this stretch of the river was completed in the Fall of 2018 and significant effort was made to investigate features and fill holidays, DEA was unable to acquire all independent feature investigations and all holidays in proximity to terminal facilities and the 2-meter inshore depth limit. Many of these features were in locations that restricted a 90-degree pass due to strong currents and proximity to shoreline, fixed structures or barge fleeting. The remaining features warranting additional investigation identified during review were planned to take place while transiting to the extension of the H13188 survey area upriver of Baton Rouge, which was added to the contract on December 11, 2018. This area was broken out of H13188 and designated with registry number H13330 in the August 15, 2019 contract modification.

Flooding also impacted acquisition and processing downstream of New Orleans, specifically in the vicinity of Head of Passes and Southwest Pass. The United States Army Corps of Engineers (USACE) was actively dredging during survey operations to address significant shoaling caused by the flooding. Numerous dredges participated in the emergency dredging which at times impacted DEA planned operations and caused artifacts in the multibeam sonar data when there

was coverage overlap between pre- and post-dredge bottom conditions. Further, flooding and strong river currents resulted in significant sediment migration during and between survey operations, which is evident on all survey sheets.

The *Project Instructions* called for high resolution charting at 1:5,000 survey scale to support the National Oceanic and Atmospheric Administration's (NOAA) Precision Navigation initiative for the Mississippi River including: Object Detection Coverage for all waters in the survey area to the 2-meter depth contour; Ellipsoid Reference Survey (ERS) using a custom separation model for the Mississippi River; verification of Aids to Navigation (ATONs); assignment of shoreline and nearshore features (including bridges, overhead wires, revetments, assigned existing terminals, and all uncharted features) to be obtained by vessel based mobile laser scanning technology; and delivery of LAS data referenced using ERS methods. Operational challenges included, but were not limited to: conducting surveys in a heavily congested industrial waterway; high river current velocities and transiting debris from high water levels; over 465 miles of shoreline surveys in restricted waters with small launch operations in close proximity to terminals, large barge fleets, wrecks, ruins, submerged piling, and numerous snags; minimal river access for provisioning and refueling; dynamic sediment migration exceeding 0.25 meters per hour in some areas; resolution of chart datum and revisions to the separation model; coordinating mapping efforts with ships at berth; dense fog; on-going dredging operations; and various navigational trials associated with a heavily trafficked industrial waterway. Due to these contingencies and the volume of shoreline operations required, survey operations were conducted during daylight hours only.

The project's survey purpose for all surveys, which was defined in the *Project Instructions*, is "The Ports of Southern Mississippi River represent the largest port complex in the world and one of the most heavily trafficked waterways in the United States. Annually, over 500 million tons of cargo is moved on the Lower Mississippi. This project area includes the Port of South Louisiana, the Port of New Orleans, the Port of Greater Baton Rouge, and Plaquemines Port, all ranking in the top 12 ports for annual tonnage in the United States. The Port of South Louisiana, river mile 114.9 to 168.5, is the largest tonnage port in the western hemisphere, handling approximately 262 million tons. The Port of New Orleans, river mile 81.2 to 114.9, handles approximately 90 million tons annually. The Port of Greater Baton Rouge, river mile 168.5 to 253, and Plaquemines Port, river mile 0 to 81.2, handle approximately 73 and 57 million tons annually, respectively. [1]

Critical charting updates are needed for the Mississippi River especially for areas outside of the USACE federally maintained channel areas. These areas outside of the federally maintained channel account for the majority of the navigable river and include ports and terminals essential for commerce and trade. The new bathymetric data in this project area encompassing 89 SNM will support high resolution charting products for maritime commerce and update National Ocean Service (NOS) nautical charting products."

[1] U.S Army Corps of Engineers, Navigation Data Center, Waterborne Commerce Statistics Center, Principal Ports of the United States, www.navigationdatacenter.us/data/datappor.htm

A. VERTICAL CONTROL

The OPR-J347-KR-18 *Project Instructions* specified that all data collected in support of the project to be vertically referenced to the ellipsoid and corrected to chart datum using a separation model generated by NOAA. The separation model defined the NAD83(2011) to chart datum relationship for the project area. The Mississippi River Low Water Reference Plane (LWRP) (2007), as defined by the USACE, is chart datum upriver of mile 13.4 AHOP and Mean Lower Low Water, Epoch 2012-2016, (MLLW), defined by NOAA, is chart datum below mile 13.4 AHOP. The transition between LWRP (2007) and MLLW is a step of 13 centimeters in the separation model at mile 13.4 AHOP, which can be seen in the separation model shown in Figure 1. All sounding and mobile lidar data were referenced to these chart datums using ERS methods. All time tagged data used Coordinated Universal Time (UTC).

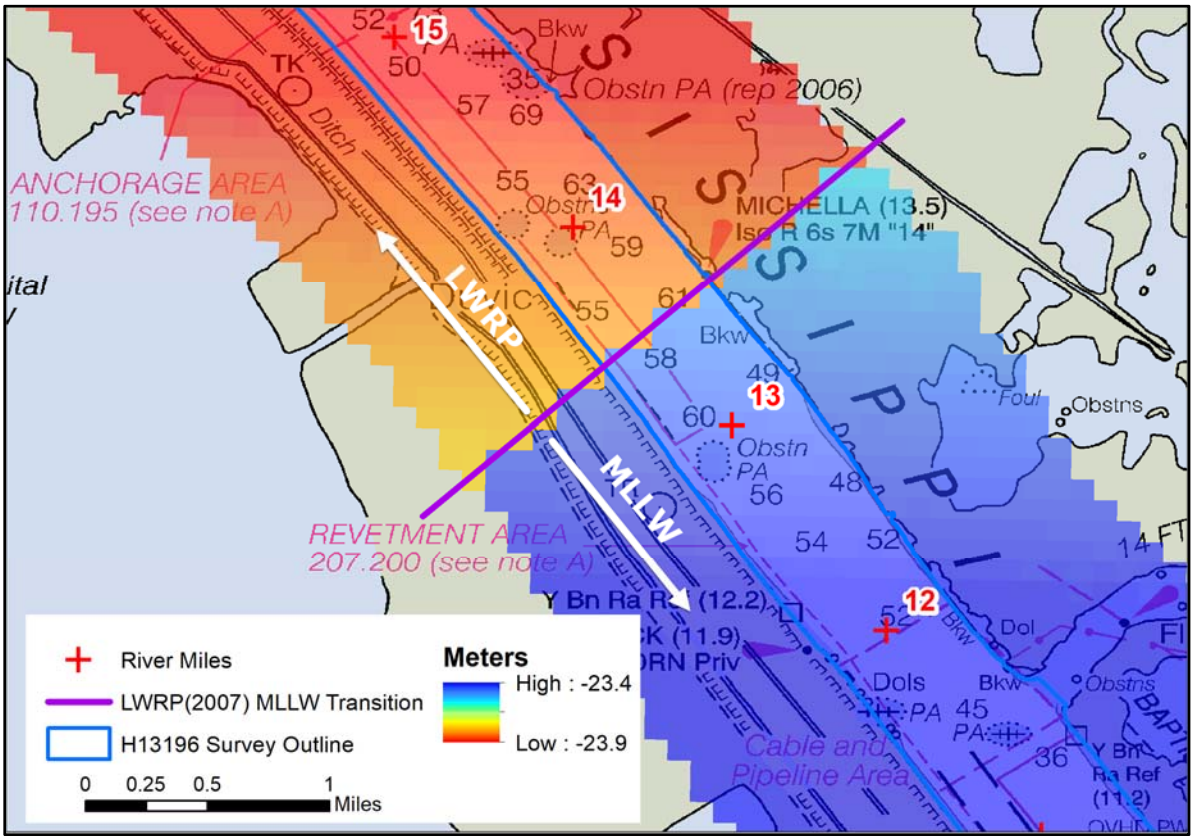


Figure 1. MLLW LWRP (2007) Transition at Mile 13.4 AHOP

A1. Separation Model

All data were corrected to chart datum using the separation model NAD83-LWRP2007_RM13.4_MLLW2012-2016_Geoid12B provided by NOAA on June 21, 2019. This was not the model originally provided with the *Project Instructions* prior to starting survey operations in August of 2018. Discussion of the analysis performed DEA that led to the model revision is discussed in Section A4 Quality Control of this report.

The separation model extended well beyond the limits of the project area; including South Pass and Pass A Loutre down river from Head of Passes and from the upriver limit of the survey area at mile 236 AHOP to Mile 336 AHOP south of Natchez, Mississippi. The model NAD83 (2011) to chart datum values are shown in Figure 2, highlighting the portions of the model falling within the project area.

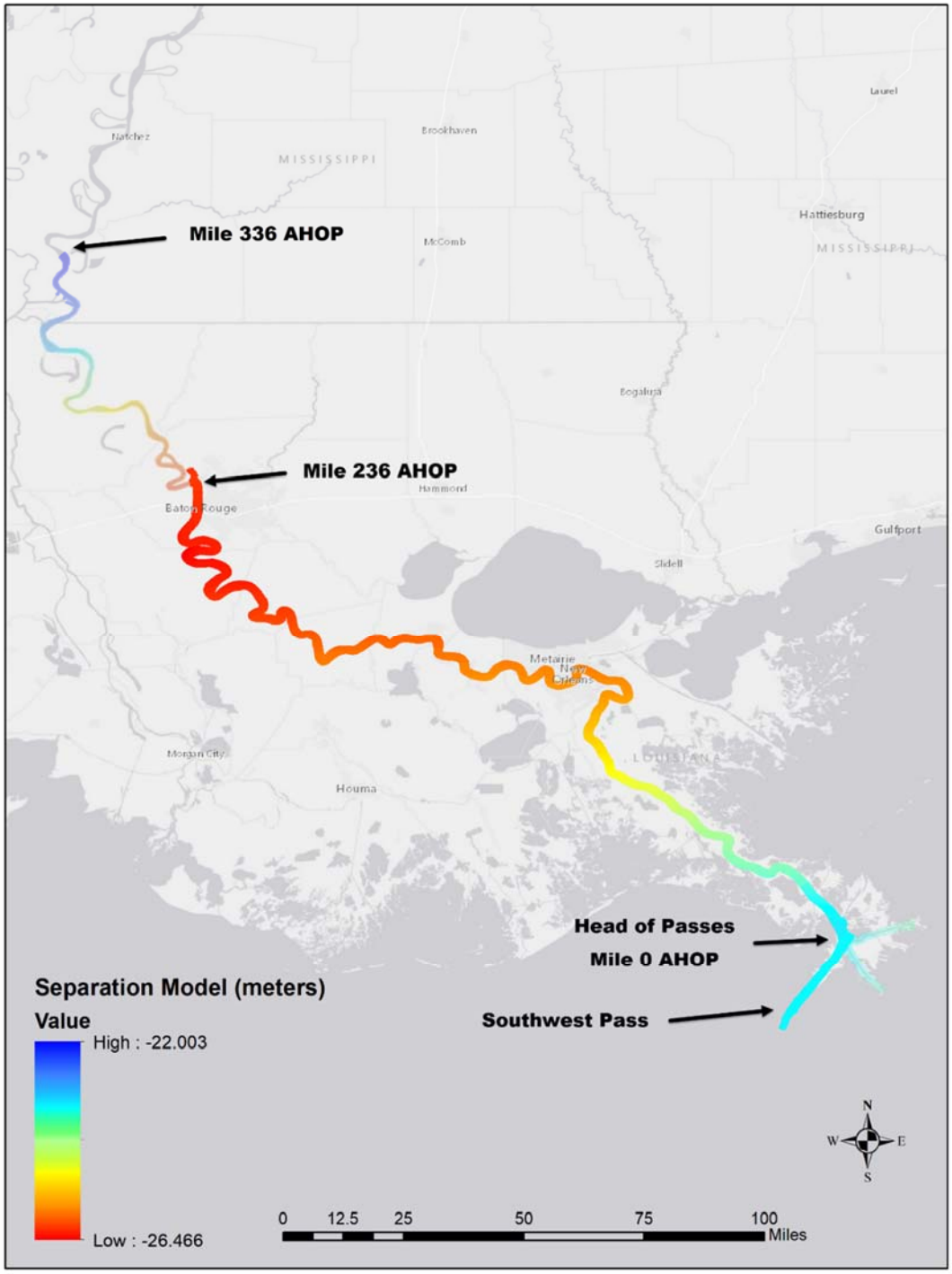


Figure 2. OPR-J347-KR-18 Separation Model Extents

A2. ERS Methods

All survey data were referenced to the NAD83 (2011) ellipsoid at time of acquisition using Real Time Kinematic (RTK) methods. During acquisition, RTK correctors were obtained by the survey vessels via either cellular or radio modem. Most corrections were obtained using Networked Transport of RTCM via Internet Protocol (NTRIP) from Louisiana State University's (LSU) Center for Geoinformatics (C4G) service over a dedicated cellular modem. The southern end of survey H13212, which was in Southwest Pass, was outside of cellular coverage and required an alternate method of RTK correction. In this area, an RTK Global Navigation Satellite System (GNSS) base station was installed at the Associated Branch Pilots' Southwest Pass Station in proximity to the NOAA Center for Operational Products and Services (CO-OPS) water level station Pilots Station East, S.W. Pass, LA (8760922). RTK correctors were broadcast from the base station to the survey vessels via radio modem.

If a loss of service was experienced during acquisition it was noted by the field watch stander, and those data were further analyzed to be resurveyed. No prolonged outages were experienced while surveying.

A3. DEA Operated Reference Station

Due to the distance of this survey from the reference stations used in LSU's C4G network, DEA installed a base station (BASE) at the Associated Branch Pilots' Southwest Pass Station to provide an additional source of RTK corrections. This station was utilized for all H13212 survey data collected downriver of mile 8.5 BHOP, which was well within the 40-kilometer maximum baseline length distance set in the HSSD. Figure 3 depicts the H13212 survey area segmented by RTK source used during operations with a smaller 20-kilometer radius shown around the location of the BASE.

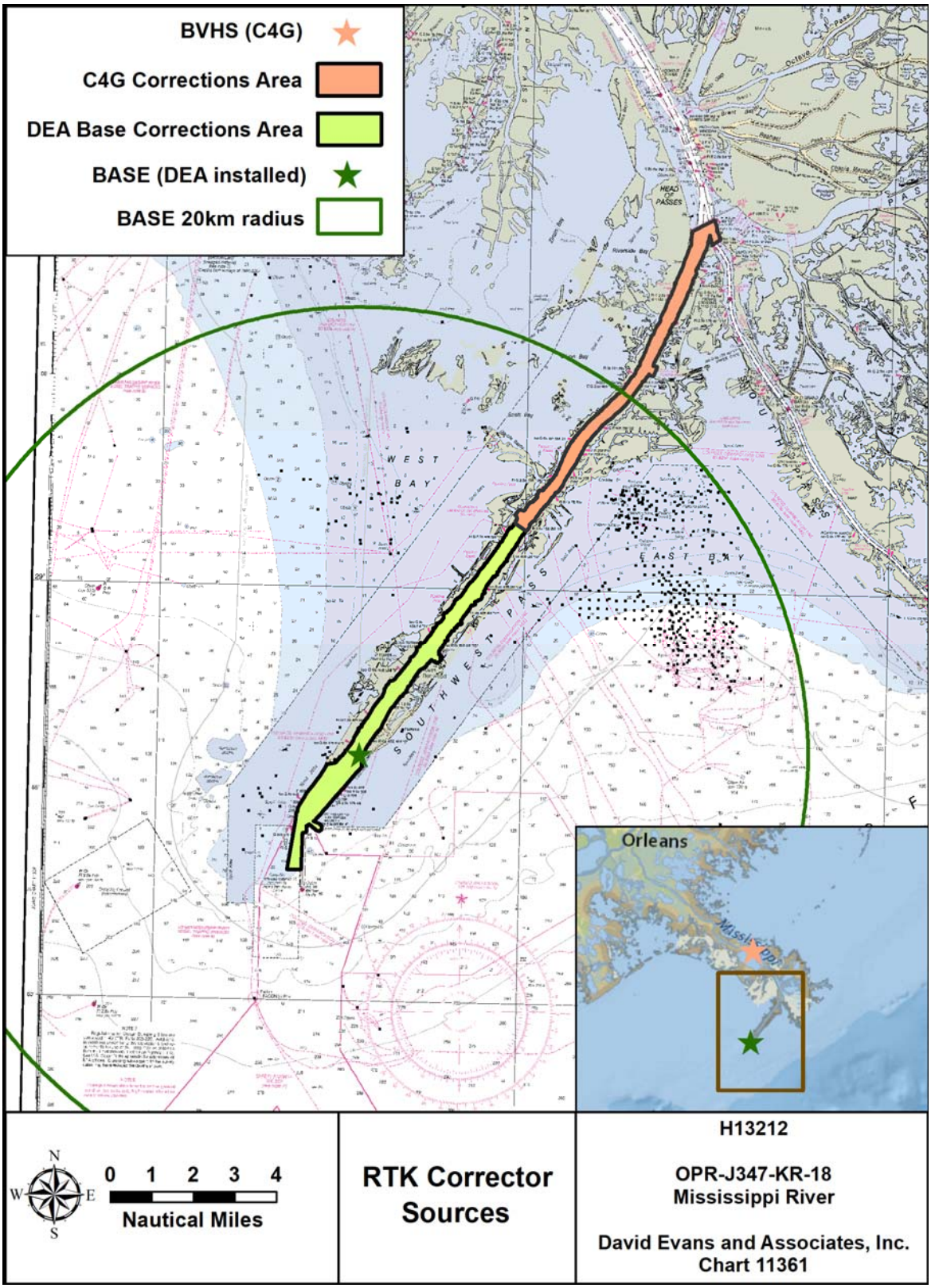


Figure 3**. H13212 RTK Corrector Sources**

The installation and use of BASE followed practices specified in the HSSD and was routinely verified by the field unit by conducting weekly position checks. This was a temporary setup and no permanent survey marker was occupied or established. The station was installed on February 28, 2019 and removed on April 29, 2019.

Coordinates of BASE were obtained by submitting a 24-hour RINEX file logged on March 1, 2019 to NOAA's Online Positioning User Service (OPUS). The solution derived by OPUS was processed using a rapid GNSS ephemeris and later checked against a precise orbit. The OPUS solution met passing criteria for solution statistics established in the NOAA publication *User's Guide for GPS Observations (December 2009)*. The site coordinates, which are included in Table 1, were derived at the Antenna Reference Point (ARP). A listing of equipment used at the GNSS base station is included in Table 2.

Table 1. BASE Antenna Reference Point (ARP) Coordinates

Coordinates NAD83 (2011) (Epoch 2010.00) ARP (24 Hour OPUS Solution)				
Latitude	**Longitude**	**Ellipsoid Height (m)**	**Installation Date**	**Removal Date**
28° 55' 56.69548" (N)	89° 24' 25.69327" (W)	-16.181	02/28/2019	04/29/2019

Table 2. BASE Equipment

Instrument	Manufacturer	Model	Serial No.
Base Station Receiver	Trimble	Net R5	4750K11589
Base Station Antenna	Trimble	Zephyr Geodetic Model II	1441003378
Base Station Radio	Trimble	TrimMark III	050065010480

The OPUS reports for the original coordinates and those used for weekly site verification checks are included in the Base Station Data folder found in Digital B-Horizontal Control Data supplementing this report. The GNSS base station documentation, including the OPUS reports and weekly verification checks, is also included in Appendix II of this report. Figures 4 and 5 depict the location of the base station at the pilot's station.

Figure 4. Location of DEA BASE at the Associated Branch Pilots' Southwest Pass Station

Figure 5. DEA Installed GNSS Station "BASE"

A4. Quality Control Checks

A4a. Position Checks

Verification of the C4G network correctors were conducted by the field unit at two National Geodetic Survey (NGS) monuments in the vicinity of USACE water level gauges. The two monuments included AU2196, near the USACE Carrollton water level gauge (1445), and AT0760, near the USACE Algiers Lock gauge (1729). NGS data sheets for these control monuments are included in Appendix IV of this report. An RTK GNSS position and elevation was observed using a Trimble R8 rover GNSS with correctors from the C4G network and application of GEOID12B for a comparison of NAVD88 orthometric heights. Table 3 lists the horizontal and vertical difference between the position and elevation of the NGS published data versus observed. The primary purpose of this exercise was to validate and document position and elevation data obtained from the Louisiana C4G real-time network were within survey specifications. All differences from these checks were within acceptable levels. However, it should be noted that these monuments are

in an area of known land subsidence as noted in Table 3 and on the NGS data sheets in Appendix IV.

Table 3. Validation of Louisiana C4G Real-Time Network

NGS Monument	AU2196 (NAD83 (2011) UTM 15 meters)			AT0760 (NAD83 (2011) UTM 15 meters)		
	North	East	NAVD88	North	East	NAVD88
NGS Data Sheet	3,314,648.972	776,668.420	3.24	3,313,455.168	792,385.972	0.68
C4G RTK Observed	3,314,649.006	776,668.421	3.209	3,313,455.16	792,385.97	0.606
Difference (meters)	-0.034	-0.001	0.031	0.011	0.006	0.074
These stations are in an area of known vertical motion. Due to the variability of land subsidence, uplift, and crustal motion, NGS has, determined the orthometric heights for marks in these suspect subsidence areas should be considered valid only at the epoch date associated with the orthometric height. These heights must always be validated when used as control.						
AU2196	This is a Height Modernization Survey Station. The horizontal coordinates were established by GPS observations and adjusted by the National Geodetic Survey in March 2019. NAVD 88 orthometric height was determined with geoid model GEOID12A. The orthometric height was determined by GPS observations and a high-resolution geoid model using precise GPS observation and processing techniques. NAVD88 Epoch 2009.55					
AT0760	This is a Height Modernization Survey Station. The horizontal coordinates were established by GPS observations and adjusted by the National Geodetic Survey in June 2012. NAVD 88 orthometric height was determined with geoid model GEOID12A. The orthometric height was determined by GPS observations and a high-resolution geoid model using precise GPS observation and processing techniques. NAVD88 Epoch 2009.55					

The NGS OPUS solution for base station BASE was compared to an RTK position obtained from the C4G network to verify agreement from the two sources of corrections used for the survey. The observation was made on February 28, 2019 by using the base station receiver as a rover and provide C4G correctors to obtain a position of the ARP relative to the Louisiana C4G real-time network. The Universal Transverse Mercator (UTM) 16N position difference between the OPUS derived position and C4G derived position was -1.8 centimeters in northing and -1.0 centimeters in easting. The ellipsoid elevation difference was -5.9 centimeters. All are within acceptable limits for the project.

A4b. Tide Floats

Though not required by the *Project Instructions,* DEA performed numerous vessel floats at USACE and NOAA CO-OPS water level gauges within the project area. The gauges are used by pilots and the maritime community for determination of under keel clearance when navigating the Mississippi River. DEA believes it is prudent to conduct these float observations to check the output of the gauges relative to chart datum and to compare ellipsoidal referenced water levels using the NOAA provided separation model to conventional water levels measured at the gauges, which are used by the USACE for hydrographic surveys. Results of this exercise identified both problems in the original separation model provided and issues with USACE published corrections

to the gauges on the USACE site rivergages.com, which lead to corrections to the NOAA separation model and revisions to published corrections on the USACE website.

To document that both vessels were getting consistent results, the *Blake* and *Sigsbee* did a side by side float comparison on September 16, 2018 (DN 259) in the vicinity of Baton Rouge. The result was an average difference in water level between the two vessels of 0.02 feet (0.6 centimeters) with a standard deviation of 0.03 feet (0.9 centimeters).

Results of floats using NAVD88 orthometric heights and revised USACE corrections from stage datum to NAVD88 was used to compare the water level data obtained from vessel floats to gauge data. Appendix III of this report shows the results of these observations for the Survey Vessel *Blake* and RHIB *Sigsbee.* The table also shows all correctors applied from USACE stage datum to NAVD88 and LWRP (2007). It should be noted that water levels derived from float observations from the *Blake* are more reliable due to the size, stability, and draft sight tubes for accurate water level determination. The *Sigsee* is a small, more dynamic, vessel with the GNSS antenna mounted directly over the sonar on the bow of the RHIB. While this configuration provides accurate sounding data due to the fixed distance from the GNSS antenna phase center to the acoustic center of the sonar, water level varies with minor waves and any movement aboard the vessel.

The comparison of float observations from the *Blake* to corrected gauge data relative to NAVD88 at the 13 water level gauges showed six of the gauges agreeing within 0.1 feet (3 centimeters), including the CO-OPS gauges at Pilottown (8760721) and Pilot Station East SW Pass (8760922), which agreed within 0.02 feet (0.6 centimeters). The following was noted at other gauge locations:

- USACE gauge at Baton Rouge (01160) read consistently high by approximately 0.4 feet (12 centimeters) on all five observations;
- USACE gauges at Bonne Carre (01280), Alliance (01390), Pt a la Hache (01400), Venice ((01480), Head of Passes (01545), and SW Pass East Jetty (01670) read consistently high by approximately 0.3 feet (9 centimeters).

The USACE website rivergages.com lists the NAVD88 correction as Epoch 2009.55, which is an NGS leveling adjustment unrelated to geoid models. This was discussed with NGS and the differences observed are likely due to a combination of geoid models, leveling adjustments and the subsidence.

A4c. Separation Model Analysis

After NOAA issued a revised model that extended the coverage to include all of the H13212 survey area in Southwest Pass, DEA performed an independent check of the model. The analysis involved a detailed inspection of the gridded separation model and comparisons of the input NAVD88 to chart datum values, used by NOAA staff in model development, to published values.

Much of the surface analysis involved an inspection of the NAVD88 to LWRP relationship that was incorporated into the overall model. In order to accomplish this task, the geoidal component was removed from the model by using raster math in ArcGIS. GEOID09, which was used in the original model, was subtracted from the separation model. The resulting grid should have been equivalent to the LWRP profile published by USACE. However, that was not the case and multiple

issues were discovered in the LWRP component of the model. Contours at 0.1-foot interval developed from the LWRP grid exhibited artifacts caused by the methodology used to develop the model. An example of these artifacts is shown in Figure 6, where LWRP to NAVD88 contours run parallel to the river rather than perpendicular which would be expected based on the LWRP gradient published by USACE. Figure 6 presents USACE river miles (dots) with mile and NAVD88 elevation in feet of LWRP (2007) and 0.1-foot contours of the separation between NAVD88 and LWRP (2007) after subtracting GEOID09.

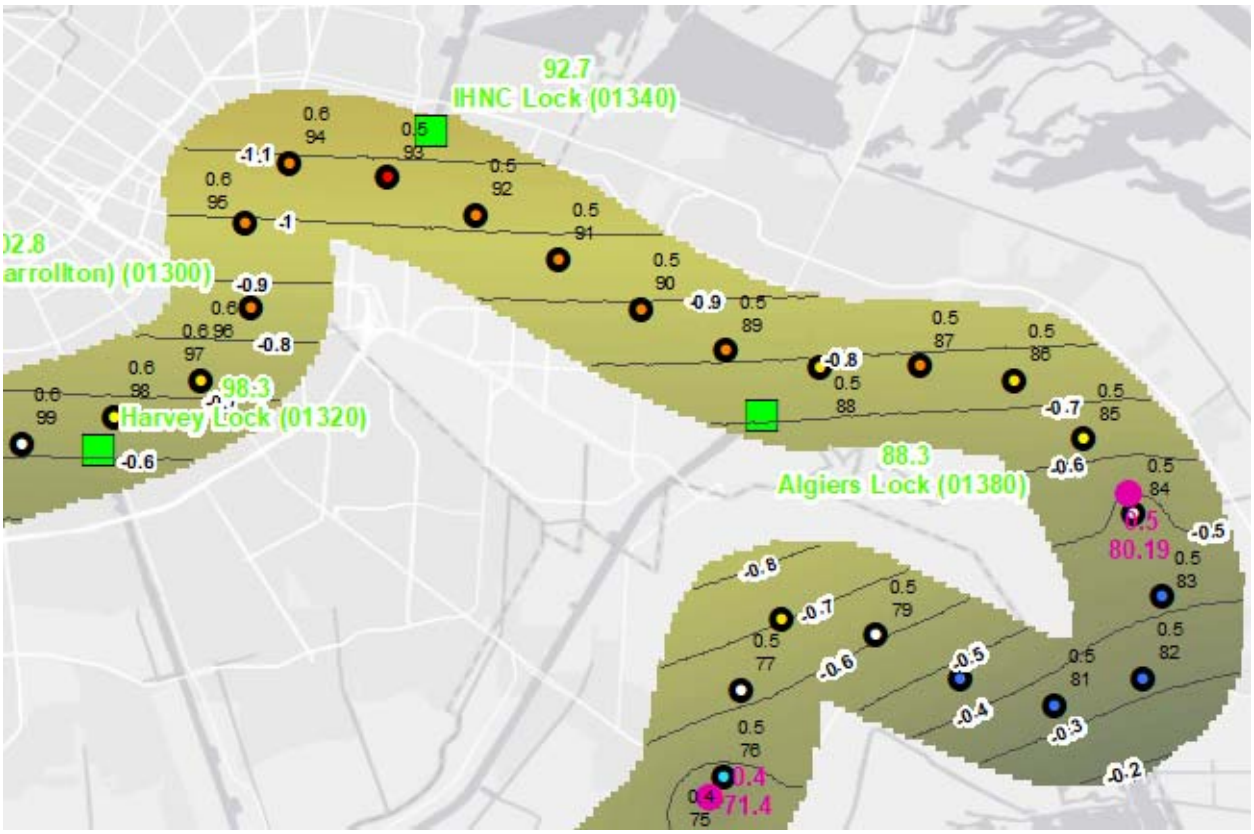


Figure 6. Example of Errors in the Original Separation Model in the Vicinity of New Orleans

The analysis found that while the model fit published values and USACE gauges where the published NAVD88 to LWRP relationship was incorporated into the model, there were extreme undulations in the model between these tie points. These undulations, which were artifacts from the modelling process, are shown in Figure 7 relative the published LWRP profile along the entire project area from Head of Passes (Mile 0 AHOP) to upriver of Baton Rouge (Mile 236 AHOP).

Figure 7. NAVD88 to LWRP Profile compared to SEP after backing out GEOID12B and GEOID09

A5. Separation Revisions

DEA informed NOAA Hydrographic Surveys Division (HSD) staff about the results of the model analysis in May 1, 2019. Over the following two months, DEA and NOAA collaborated on the development of a revised model which included a May 8, 2019 webinar meeting with USACE, HSD, NGS, and CO-OPS with DEA presenting results of vessel floats at USACE gauges at New Orleans District; meetings at NOAA headquarters with HSD, NGS, and CO-OPS on July 27, 2019 to discuss Mississippi River Datum Discrepancies; and numerous other calls to resolve model issues and resolution of the transition between MLLW and LWRP (2009).

The final model was issued by NOAA on June 21, 2019 after most of the survey had been completed. The application of the new model required reprocessing previously acquired data, including LAS data collected during mobile mapping operations. Reprocessing methods are discussed in detail in the *OPR-J347-KR-18 Data Acquisition and Processing Report*.

Multiple separation models were issued by HSD Operations Branch over the course of the project. Revisions were provided to expand model coverage and to rectify issues discovered during the quality control checks performed by David Evans and Associates, Inc discussed in Section A.4. Table 4 summarizes the models and rationale for revision. All submitted survey data were corrected to chart datum using the model NAD83-*LWRP2007_RM13.4_MLLW2012-*

2016_Geoid12B issued on June 21, 2019. A profile of this model relative to NAVD88 (GEOID12B) is depicted in Figure 8.

Table 4. OPR-J347-KR-18 Separation Models and Revisions

Date Issued	Model Name	Comment
5/24/2018	NAD83-LWRP2007_MLLW12B	SEP included with draft *Project Instructions*
7/31/2018	NAD83-LWRP2007_MLLW12B	SEP included with award. Model used during MMS survey.
8/27/2018	NAD83-LWRP2007_MLLW12B_Buffered	Model buffered to include onshore LAS coverage. Model used during hydrographic acquisition from 9/2/2018 (DN 245) to 4/13/2019 (DN 103) for S/V *Blake* and 4/14/2019 (DN 104) RHIB *Sigsbee*.
4/5/2019	NAD83-LWRP2007_MLLW12B_Buffered_Ext	Model extended to the bottom of Sheet 10 and top of Sheet 1 MOD. Used by S/V *Blake* from 4/14/2019 (DN 104) to 4/30/2019 (DN 120) and RHIB *Sigsbee* from 4/15/2019 (DN 105) to 4/30/2019 (DN 120).
5/3/2019	NAD83-LWRP2007_MLLW_Geoid12B	Revised model. SWP still unresolved. Only used for analysis, not applied to data.
6/21/2019	NAD83-LWRP2007_RM13.4_MLLW2012-2016_Geoid12B	Final Model applied to all delivered data. SWP issues addressed. Model used during hydrographic acquisition from 9/5/2019 (DN 248) to 9/9/2019 (DN 252).

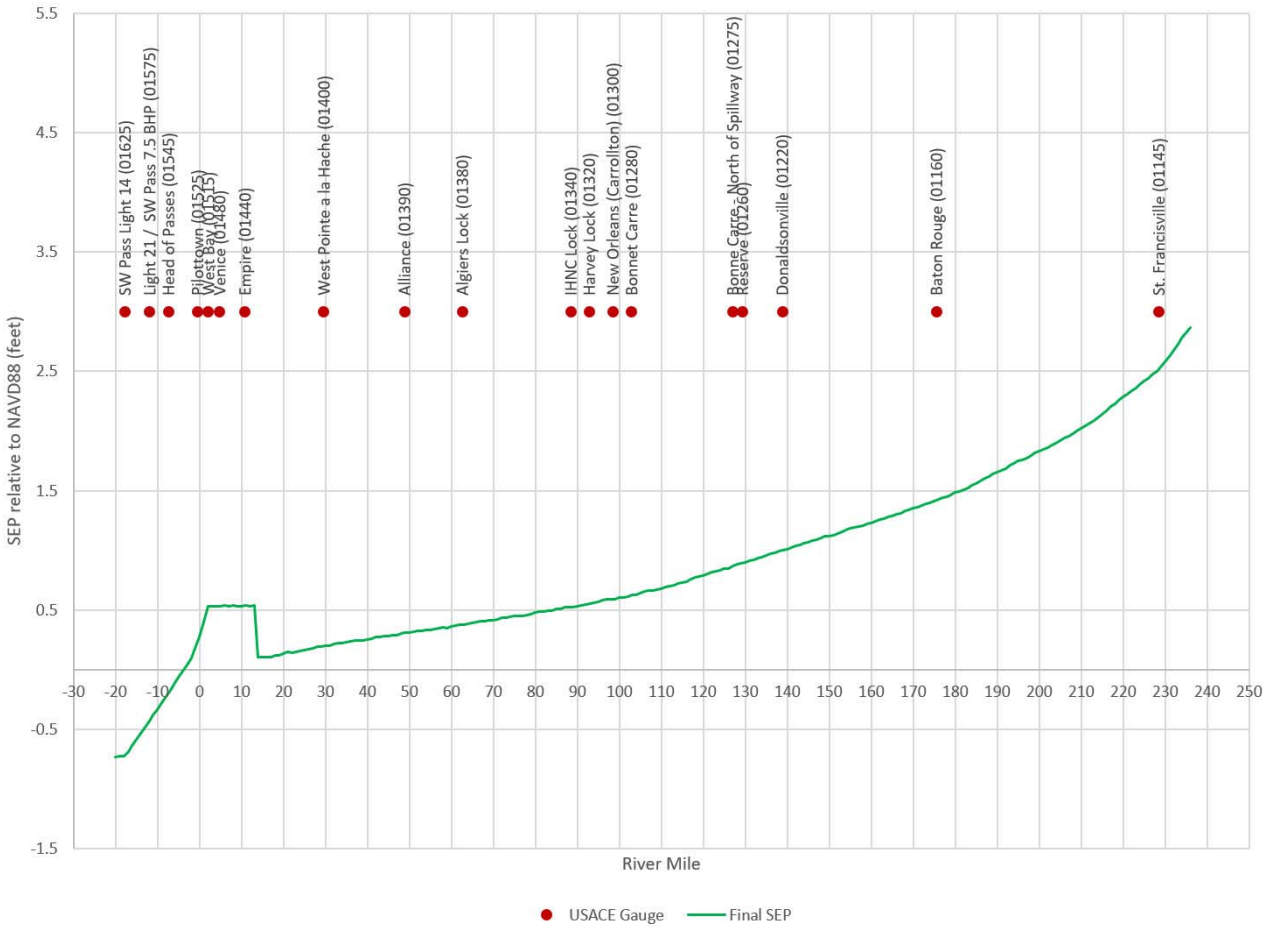


Figure 8. OPR-J347-KR-18 Final Separation Model Profile Relative to NAVD88

A detail of the discontinuity near Head of Passes and the transition from MLLW to LWRP (2007) is depicted in Figure 9.

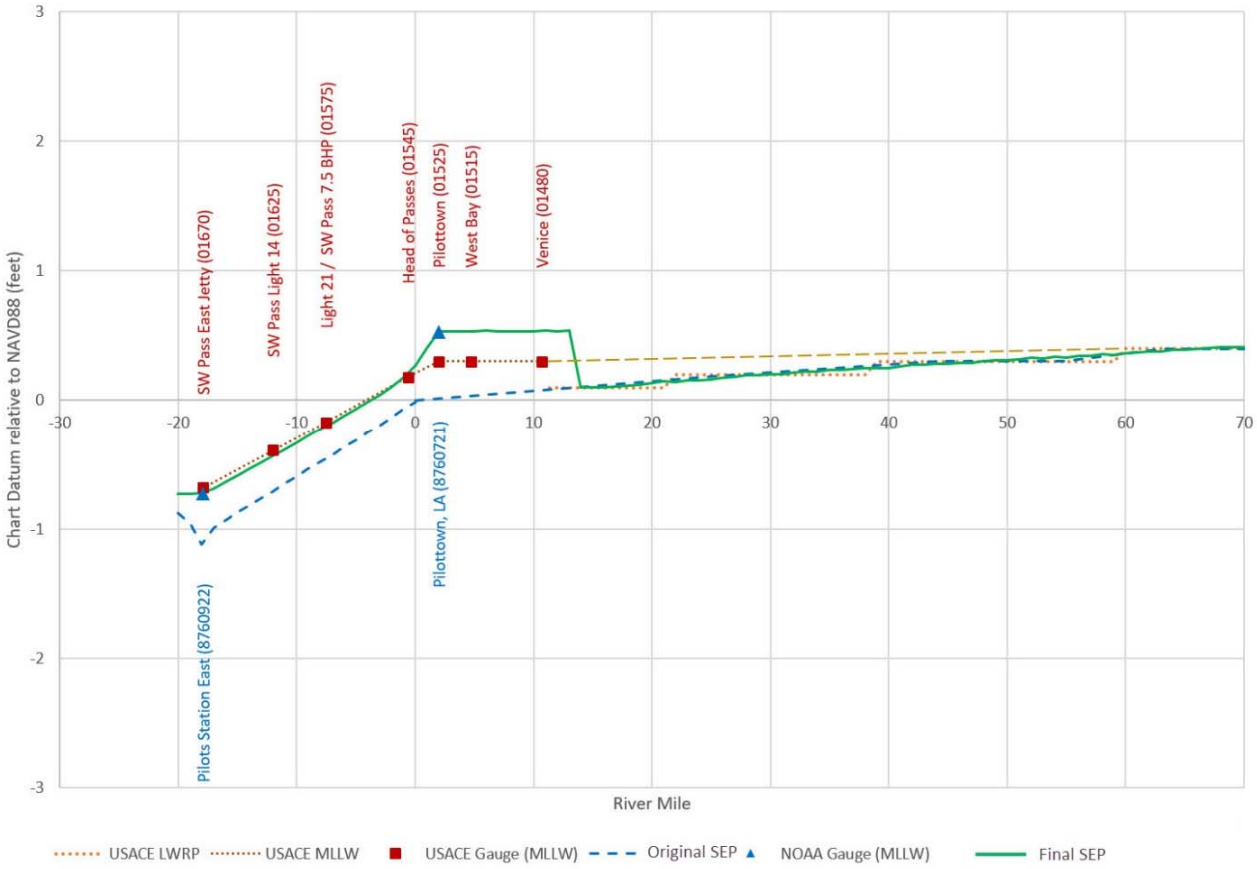


Figure 9. OPR-J347-KR-18 Separation Model Comparison at Southwest Pass

B. HORIZONTAL CONTROL

The horizontal datum for this project is the North American Datum of 1983 (NAD83). Position data consists of both geographic coordinates and projected coordinates. Projected coordinates are in meters using UTM Zones 15 North and 16 North. The boundary between Zones 15 and 16 passes through surveys H13193 and H13194 (Figure 10). When UTM coordinates were recorded, surveys H1330, H13188, H13189, H13190, H13191, H13192, and H13193 used UTM Zone 15N. Surveys H13194, H13195, H13196, and H13212 used UTM Zone 16N coordinates.

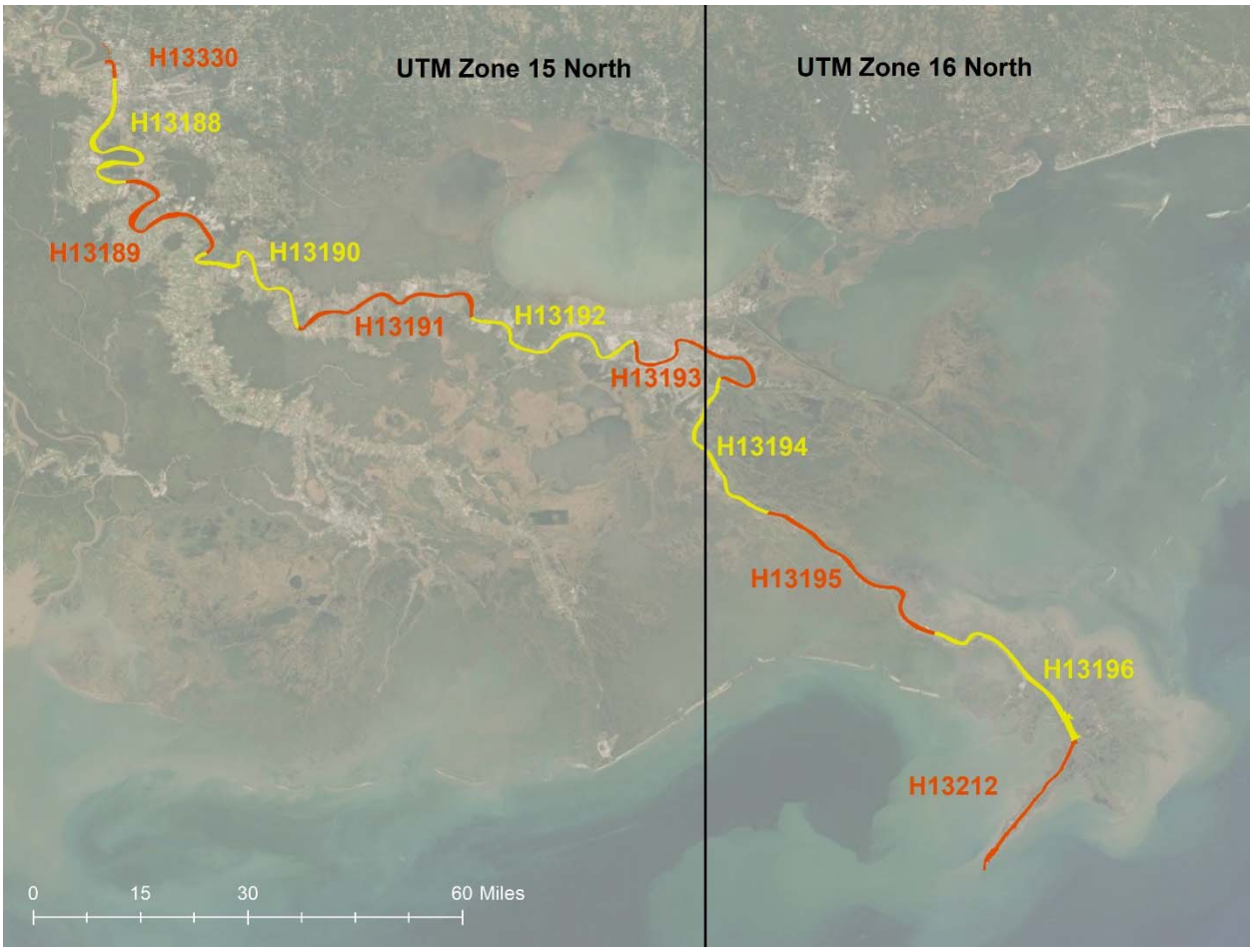


Figure 10. UTM Zone junction within the OPR-J347-KR-18 Project Area

Horizontal control methods followed the same ERS methodology discussed in Section A of this document. All horizontal positioning for soundings followed requirements set forth in the OPR-J347-KR-18 *Project Instructions* and the HSSD.

B1. Positioning Systems Confidence Checks

Weekly checks of the positions systems were performed by comparing positions output from the primary and secondary RTK systems on each vessel. The mean computed difference for both vessels was less than 10 centimeters. Individual results from these checks are included in Separate I *Acquisition of Processing Logs* for each survey and in Appendix I of this report.

C. LETTER OF APPROVAL

The letter of approval for this report and accompanying data follows on the next page.

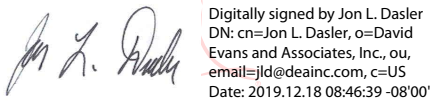
DAVID EVANS AND ASSOCIATES INC.

LETTER OF APPROVAL

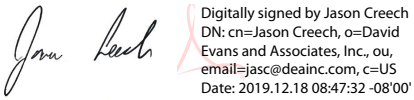
OPR-J347-KR-18
HORIZONTAL AND VERTICAL CONTROL REPORT

This report and the accompanying data are respectfully submitted.

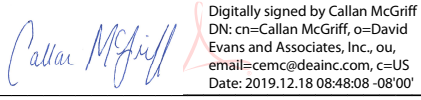
Field operations contributing to the accomplishment of OPR-J347-KR-18 were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and associated data have been closely reviewed and are considered complete and adequate as per the OPR-J347-KR-18 *Statement of Work* (November 19, 2018) and *Hydrographic Survey Project Instructions* (August 8, 2019).



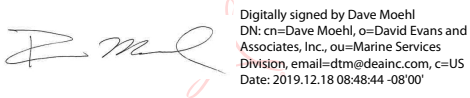
Jonathan L. Dasler, PE, PLS, CH
NSPS/THSOA Certified Hydrographer
Chief of Party



Jason Creech, CH
NSPS/THSOA Certified Hydrographer
Charting Manager/Project Manager



Callan McGriff, EIT
IHO Cat-A Hydrographer
Lead Hydrographer



David T. Moehl, PLS, CH
NSPS/THSOA Certified Hydrographer
Lead Hydrographer

David Evans and Associates, Inc.
September 2019

D. TABLE OF ACRONYMS

AHOP	Above Head of Pass
ARP	Antenna Reference Point
ATON	Aid to Navigation
BHOP	Below Head of Pass
C4G	Center for GeoInformatics
CH	Certified Hydrographer
CO-OPS	Center for Operational Oceanographic Products and Services
DEA	David Evans and Associates, Inc.
ERS	Ellipsoid Reference System
GNSS	Global Navigation Satellite System
HSD	Hydrographic Surveys Division
HSSD	Hydrographic Surveys Specifications and Deliverables
LSU	Louisiana State University
LWRP	Low Water Reference Plane
MLLW	Mean Lower Low Water
NAD83	North American Datum of 1983
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NSPS	National Society of Professional Surveyors
NTRIP	Networked Transport of RTCM via Internet Protocol
OPUS	Online Positioning User Service
PE	Professional Engineer
PLS	Professional Land Surveyor
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-time Kinematic
SNM	Square Nautical Miles
S/V	Survey Vessel
THSOA	The Hydrographic Society of America
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator