

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

Horizontal and Vertical Control Report

Type of Survey: Navigable Area
Project Number: OPR-Y395-KR-20
Time Frame: May 2020 - December 2020

LOCALITY

State(s): Illinois
Indiana
Michigan
General Locality: Chicago, IL

2020

CHIEF OF PARTY
David J. Bernstein, CH, PLS, GISP

LIBRARY & ARCHIVES

Date:

HYDROGRAPHIC TITLE SHEET

H13363
H13364
H13365
H13366
H13367
H13368
H13369

INSTRUCTIONS - The Hydrographic Sheet should be accompanied by this form, filled in as completely as possible, when the sheet is forwarded to the office.

FIELD No

Geodynamics LLC

State Illinois, Indiana, Michigan

General Locality Chicago, IL

Sub-Locality Vicinity of Chicago, IL

Scale 1:5,000 1:10,000 1:20,000 **Date of Survey** May - August 2020

Instructions Dated March 27, 2020 **Project No.** OPR-Y395-KR-20

Vessel R/V Benthos, R/V Chinook, R/V Substantial, R/V Endeavor

Chief of Party David J. Bernstein, CH, PLS, GISP

Surveyed by Geodynamics LLC

Soundings by echo sounder Kongsberg 2040C, R2 Sonic 2024

Graphic record scaled by N/A

Graphic record checked by N/A **Automated Plot** N/A

Verification by Atlantic Hydrographic Branch

Soundings in Meters at Low Water Datum (LWD), International Great Lakes Datum 1985 (IGLD85)

REMARKS: WGS84, UTM Zone 16 North
Times are in UTC
The purpose of this contract is to provide NOAA with modern, accurate hydrographic
survey data to update the nautical charts of the assigned area.

SUBCONSULTANTS: eTrac Inc., 637 Lindero, Suite 100, San Rafael, CA 94901
Ocean Operators LLC, 848 N. Rainbow Blvd. #4755, Las Vegas, NV, 89107



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A. Introduction

This Horizontal and Vertical Control Report (HVCR) is applicable to all surveys for OPR-Y395-KR-20 (Vicinity of Chicago, Illinois). Surveys H13363, H13364, H13365, H13366, H13367, H13368, and H13369 were acquired in the most southern region of Lake Michigan, which includes the Chicago Harbor and much of the Indiana and Michigan shoreline. As defined in the Project Instructions (PI), “Conducting a modern bathymetric survey in this area will provide critical data for the updating of National Ocean Service (NOS) nautical charting products and services to increase maritime safety near the Michigan, Indiana, and Illinois shoreline. Survey data from this project is intended to supersede all prior survey data in the common area.” These surveys meet the requirements defined in the Statement of Work (SOW), Hydrographic Survey PI, Hydrographic Surveys Specifications and Deliverables 2020 (HSSD), and correspondence with the National Oceanographic and Atmospheric Administration (NOAA) Hydrographic Survey Division (HSD) Operations (OPS) branch throughout the project.

While the HSSD 2020 requires surveys delivered in North American Datum of 1983 (NAD83-2011) reference system, consideration to deliver OPR-Y395-KR-20 in the World Geodetic System 1984 (WGS84) reference system was approved on July 20, 2020. This approval was granted due to limitations in the sonar processing software and denoted the close relationship of the WGS84 reference system to the International Terrestrial Reference System 2014 (ITRF14) realization. Consequently, WGS84 and ITRF14 are considered synonymous for OPR-Y395-KR-20 (refer to project correspondence “TO1 Chicago – Datum Transformation”).

B. Horizontal Control

B.1 Horizontal Datum

The horizontal datum for this project is WGS84. Surveys were projected to Universal Transverse Mercator (UTM) Zone 16 North (N), Meters (m).

B.2 Real-time Kinematic Corrections

Horizontal control during pre-survey vessel calibrations utilized Real-Time Kinematic (RTK) network-based corrections from the Kara ReIL-NET RTK Network. Single station corrections from “Alsip”, relative to NAD83-2011, were received via Wireless Wide Area Network (WWAN) connection.

B.3 SBAS Corrections

Horizontal control for surveys H13363-H13369 utilized G2+ Global Navigation Satellite System (GNSS) satellite corrections provided by the Fugro Marinestar Satellite-Based Augmentation System (SBAS). Each vessel’s POS MV 320 received the G2+ corrections, providing decimeter-level real-time horizontal control. Real-time corrections received by the POS MV were referenced to the ITRF14 realization.



B.4 Post-Processed Horizontal Control

All positioning data were post-processed using the Applanix POSpac Mobile Mapping Solution (MMS) software. Post-processed corrections were implemented with Trimble’s CenterPoint RTX service. Horizontal accuracy (RMS) was improved with sub-decimeter positioning in the Smoothed Best Estimate of Trajectory (SBET) file, that was applied to the survey data in CARIS HIPS.

C. Vertical Control

C.1 Vertical Datum

The vertical datum for this project is the Low Water Datum (LWD), International Great Lakes Datum 1985 (IGLD85).

C.2 VDatum Separation Model (SEP)

NOAA’s HSD OPS provided a VDatum SEP model package with the initial project files. A revision to the SEP model package was provided on 04/16/2020, which addressed a lack of coverage within H13363 and included two models, NAD83-LWD_IGLD85 and ITRF14-LWD_IGLD85. As described in the Project Instructions and the SEP model package, the following metadata accompanies the SEP models.

VDatum Separation Model				
VDatum Version	Geoid	Area	Area Version	Separation Uncertainty
3.9	2012	IGLD	1	0.045 m

C.3 Real-time Kinematic Corrections

Vertical control during pre-survey vessel calibrations also utilized RTK network-based corrections from the Kara ReIL-NET RTK Network. Single station corrections from “Alsip”, relative to NAD83-2011, were received via WWAN connection. Ellipsoid heights of the water surface and soundings were reduced to LWD IGLD85 in real-time on each vessel by incorporating the NAD83-LWD_IGLD85 SEP model in Qinsy.

C.4 SBAS Corrections

Vertical control for surveys H13363-H13369 utilized G2+ GNSS satellite corrections provided by the Fugro Marinestar SBAS. Each vessel’s POS MV 320 received the G2+ corrections, providing decimeter-level real-time vertical control. Real-time corrections received by the POS MV were referenced to the ITRF14 realization. Ellipsoid heights of the water surface and soundings were reduced to LWD IGLD85 in real-time on each vessel by incorporating the ITRF14-LWD_IGLD85 SEP model in Qinsy.

C.5 Post-Processed Vertical Control

All ellipsoid data were post-processed using the Applanix POSpac MMS software. Post-processed corrections were implemented with Trimble’s CenterPoint RTX service. Vertical accuracy (RMS)



was improved to sub-decimeter in the SBET file that was applied to the survey data in CARIS HIPS. The ITRF14-LWD_IGLD85 SEP model was also utilized in CARIS HIPS to reduce the sonar data to LWD_IGLD85.

C.6 Vertical Control Confidence Check

Following pre-survey calibrations and still utilizing RTK network-based corrections, a “float test” was performed with the R/V Chinook to ensure the quality of the GNSS corrections, SEP model, and survey systems integrations. The vessel remained stationary while nearby NOS Water Level Station 9087044 - Calumet Harbor and recorded the LWD_IGLD85 elevation of the water surface. This information was compared to the near real-time water level data collected at CALU for the same time period and showed excellent agreement (Figure 1).


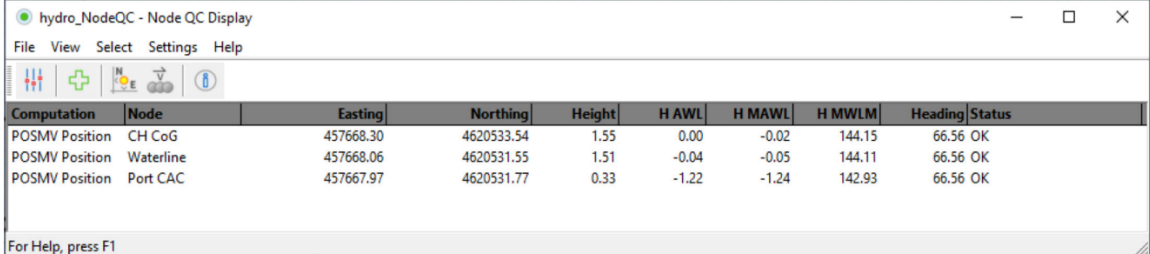

OPR-Y395-KR-20 Vicinity of Chicago Float Test - R/V Chinook		<h2 style="margin: 0;">FLOAT TEST</h2> <h2 style="margin: 0;">R/V Chinook</h2>		 Geodynamics 310 A Greenfield Dr. Newport, NC 28570 252-247-5785 www.GeodynamicsGroup.com																																									
General Calibration Information																																													
Vessel	R/V Chinook	Personnel:	Dave Bernstein	Brandon Barnette																																									
Date (s):	5/29/2020		Anna Atencio	Davis Batten																																									
Julian Day:	150																																												
Water Level Station Information																																													
Station ID:	9087044	NOAA Chart:	14929																																										
Station Name:	Calumet Harbor, IL	Established:	02/01/1995																																										
Latitude	41° 43.8' N																																												
Longitude:	87° 32.3' W																																												
Time (UTC)	Tide Gauge (LWD, m)	Vessel Waterline Reading (LWD, m)	Difference (m)																																										
21:36	1.496	1.51	-0.014																																										
Mean Difference:	-0.014	Summary: The vessel was held as close to the water level gauge as possible for this comparison. The vessel utilized a provided SEP Model. Using RTK, POS MV vertical RMS was 0.026 m.																																											
Std Dev:	N/A																																												
Photos																																													
Image of Water Level Reading from Vessel (Qinsy Node Screen):																																													
 <table border="1" style="width: 100%; border-collapse: collapse; font-size: small;"> <thead> <tr> <th>Computation</th> <th>Node</th> <th>Easting</th> <th>Northing</th> <th>Height</th> <th>H AWL</th> <th>H MAWL</th> <th>H MWLM</th> <th>Heading</th> <th>Status</th> </tr> </thead> <tbody> <tr> <td>POSMV Position</td> <td>CH CoG</td> <td>457668.30</td> <td>4620533.54</td> <td>1.55</td> <td>0.00</td> <td>-0.02</td> <td>144.15</td> <td>66.56</td> <td>OK</td> </tr> <tr> <td>POSMV Position</td> <td>Waterline</td> <td>457668.06</td> <td>4620531.55</td> <td>1.51</td> <td>-0.04</td> <td>-0.05</td> <td>144.11</td> <td>66.56</td> <td>OK</td> </tr> <tr> <td>POSMV Position</td> <td>Port CAC</td> <td>457667.97</td> <td>4620531.77</td> <td>0.33</td> <td>-1.22</td> <td>-1.24</td> <td>142.93</td> <td>66.56</td> <td>OK</td> </tr> </tbody> </table>						Computation	Node	Easting	Northing	Height	H AWL	H MAWL	H MWLM	Heading	Status	POSMV Position	CH CoG	457668.30	4620533.54	1.55	0.00	-0.02	144.15	66.56	OK	POSMV Position	Waterline	457668.06	4620531.55	1.51	-0.04	-0.05	144.11	66.56	OK	POSMV Position	Port CAC	457667.97	4620531.77	0.33	-1.22	-1.24	142.93	66.56	OK
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Image of Water Level from Tide Gauge:																																													
 <p style="font-size: x-small; text-align: center;">NOAA NOS/CO-OPS Observed Water Levels at 9087044, Calumet Harbor, IL From 2020/05/29 00:00 GMT to 2020/05/29 23:59 GMT</p> <p style="font-size: x-small; text-align: right;">Friday, May 29 2020, 21:36 GMT Preliminary: 1.496 m</p> <p style="font-size: x-small; text-align: center;">Legend: — Verified — Preliminary</p> <p style="font-size: x-small;">Options for: 9087044 Calumet Harbor, IL From: May 29 2020 To: May 29 2020 Units: Metric Timezone: GMT Datum: LWD Shift dates: Back 1 Day Forward 1 Day Interval: 6 min 1 hr H L Day Month Update: P D</p>																																													

Figure 1. Graphic documenting the vertical control confidence check performed at NOS water level station 9087044 – Calumet Harbor, IL.

D. Approval Sheet



LETTER OF APPROVAL

**Registry Nos.
H13363, H13364, H13365, H13366, H13367, H13368, and H13369**

OPR-Y395-KR-20 - Vicinity of Chicago, IL
HORIZONTAL AND VERTICAL CONTROL REPORT

This report and the accompanying data are respectfully submitted.

As Chief of Party, field operations contributing to the accomplishment of Surveys H13363, H13364, H13365, H13366, H13367, H13368, and H13369 were conducted under my direct supervision, with frequent personal checks of progress and adequacy. This report and accompanying data deliverable have been closely reviewed and are considered complete and adequate as per the Statement of Work (April 2, 2020).



David J. Bernstein, CH, PLS, GISP | Geodynamics LLC | Chief of Party | November 12, 2020

Geodynamics LLC
November 2020

E. List of Acronyms

GNSS	Global Navigation Satellite System
HSD	Hydrographic Survey Division
HSSD	Hydrographic Surveys Specifications and Deliverables
HVCR	Horizontal and Vertical Control Report
IGLD85	International Great Lakes Datum 1985
ITRF14	International Terrestrial Reference System 2014
LWD	Low Water Datum
m	Meter
MMS	Mobile Mapping Solution
N	North
NAD83	North American Datum of 1983
NOAA	National Oceanographic and Atmospheric Administration
NOS	National Ocean Service
OPS	Operations
PI	Project Instructions
RMS	Root Mean Square
RTK	Real-Time Kinematic
SBAS	Satellite-Based Augmentation System
SBET	Smoothed Best Estimate of Trajectory
SEP	Separation
SOW	Statement of Work
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984
WWAN	Wireless Wide Area Network