



Cover Sheet



Title Sheet



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**A-Vertical Control**

All sounding data were reduced to MLLW initially using unverified tidal data from the NOAA tide station (ID #: 8423898), located in Fort Point, Newcastle Island, NH.

Table 1 - Tide Gauges

Gauge	Model	Gauge Type	Location	Latitude	Longitude	Operational
8423898	NOAA Gauge	Acoustic	Fort Point, NH	43°04'18"N	70°42'42" W	N/A

Table 2 - Final Tide Zones

Zone	Primary			
	Site	Number	Time	Range Ratio
NA169	Fort Point	8423898	-6 min	1.00

Preliminary tidal data was downloaded from the NOAA CO-OPS website (http://www.co-ops.nos.noaa.gov/data_res.html) approximately 5 hours after each flight. The data was downloaded in UTC time (Eastern Standard Time to UTC was +4 hours) and appended to a cumulative file which was then applied to the data.

On November 3, 2005, the verified tidal data was downloaded from the NOAA CO-OPS website for OPR-A321-KRL-05. On November 20, 2005, using the GCS software, the tide zone file and verified tides were imported into GCS and all LiDAR sounding data were tide corrected. Verified tidal data was used for the Preliminary Smooth Sheet.

During the OPR-A321-KRL-05, Approaches to Portsmouth Survey, there were no unusual conditions regarding tidal information to note. Refer to Appendix A for a more detailed description and Tidal Data.

Tidal Range

The established tidal range for OPR-A321-KRL-05 as per the NOAA CO-OPS website is 2.743 meters (9.000 feet). This value was used in determining height above MHW.

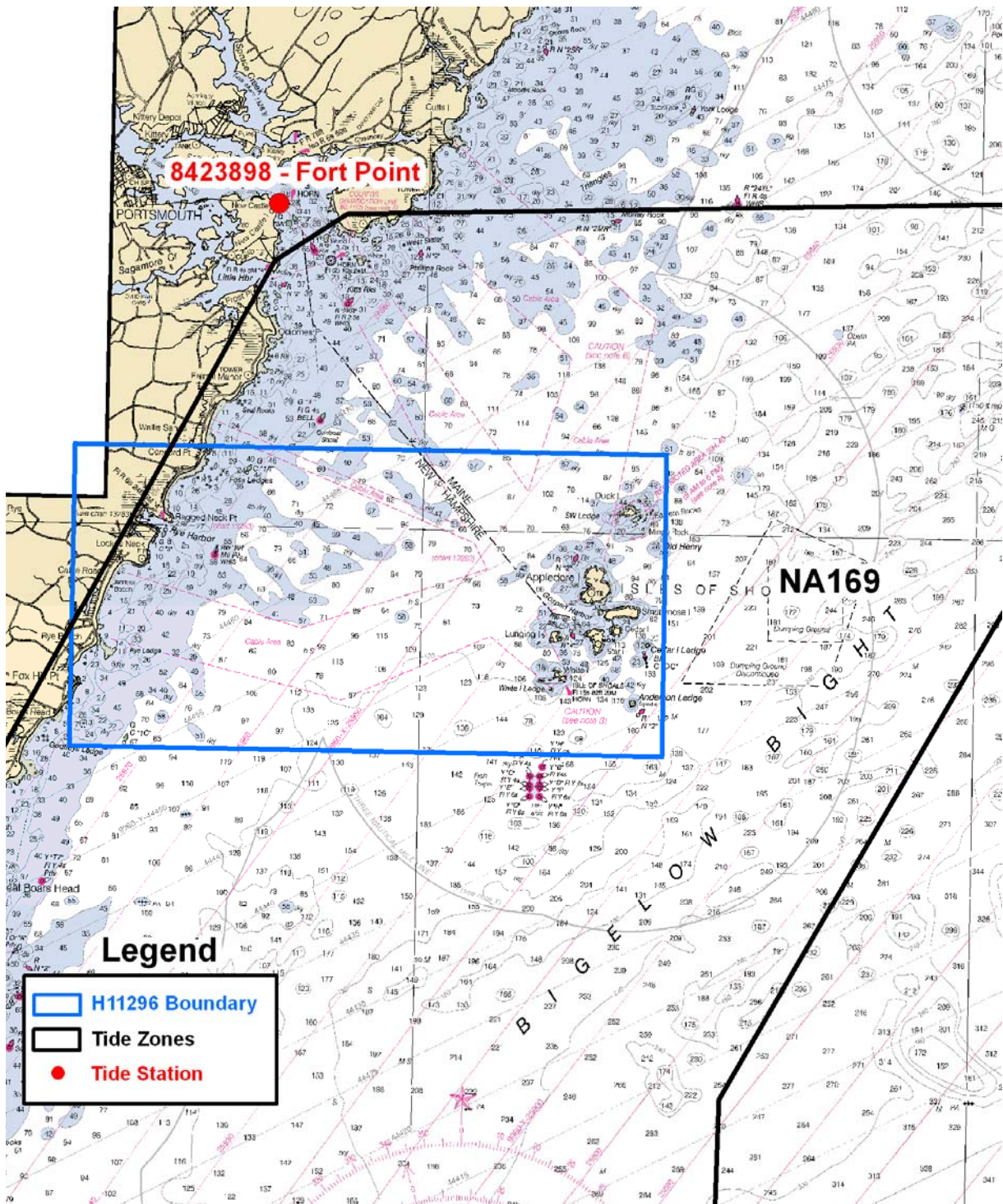


Figure 1 Tide Zoning



B-Horizontal Control

The horizontal control datum for this survey was the North American Datum of 1983 (NAD83). Raw positions were originally collected in WGS84 and transformed to NAD83 during the post-processed kinematic GPS (KGPS) routine.

It was necessary to acquire dual frequency GPS data at a known location on the ground so that a KGPS solution could be used for final positioning. The National Geodetic Survey (NGS) benchmark AB2631 was used as the ground control point for this survey. Refer to the Appendix B for Horizontal Control results and procedures.

Additionally, it was critical to know the elevations of the control points in both the processed ellipsoidal datum and the final charting datum, in this case NAD83 and MLLW respectively. The offset between these two datums was applied during post-processing to depict data in the final charting datum. It should be noted that at no time was the final data set corrected with KGPS altitude data (except for Topographic data); only horizontal position. Altitude data were evaluated for accuracy against traditional tide zone and tide gauge methodology. The evaluation of vertical data was for experimental purposes only.

Airborne Positioning was determined in real time using an OmniStar 3100LM DGPS receiver. An AeroAntenna AT-3065-9 antenna was used to acquire the differential corrections. Two differential receivers were available: the OmniStar 3100LM and a CSI MBX-3S Coast Guard beacon receiver. The OmniStar 3100LM was the primary source of differential corrections for this project. However, final positions were determined using post-processed KGPS.

Positioning system confidence checks were conducted on a daily basis using the SHOALS-1000T airborne acquisition software. The software has numerous real time displays that were monitored throughout the survey to ensure the positional accuracies specified in the NOS Hydrographic Surveys Specifications and Deliverables (version March 2003) were achieved. These include, but are not limited to the following: GPS Status, Position accuracy, Receiver Status (which included HDOP) and Satellite Status. During periods of high HDOP and/or low number of available satellites survey operations were suspended. Note: Flights were planned to avoid periods of high PDOP/HDOP and/or low number of available satellites



C-Approval Sheet

Approval Sheet

For

H11296

Standard field surveying and processing procedures were followed in producing this survey in accordance with the following documents:

OPR-A321-KRL-05 statement of work and hydrographic manual;
Fugro Pelagos, Inc. LiDAR Acquisition Procedures;
Fugro Pelagos, Inc. LiDAR Processing Procedures;

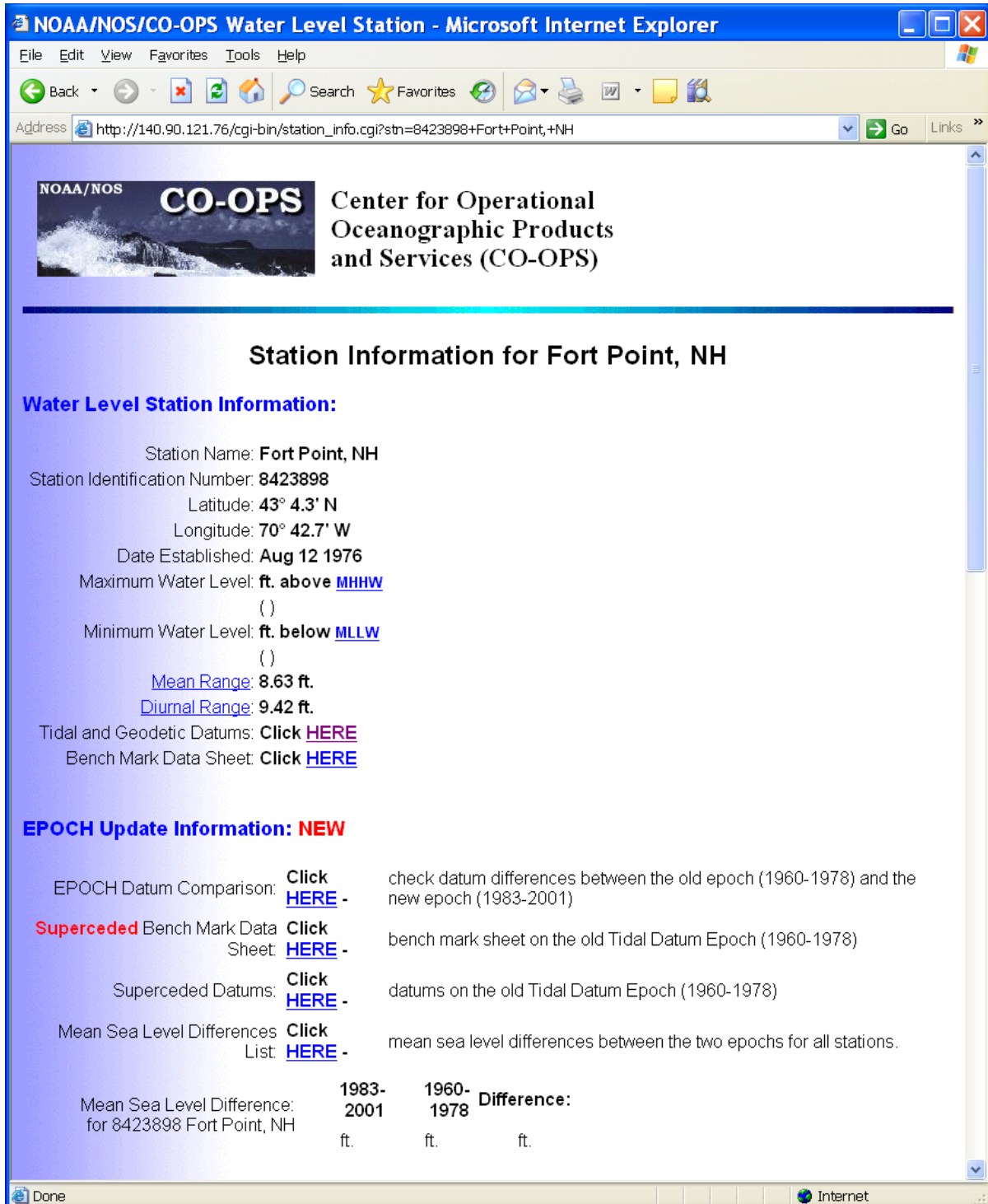
The data were reviewed daily during acquisition and processing.

This report has been reviewed and approved. All records are forwarded for final review and processing to the Chief, Atlantic Hydrographic Branch.

Approved and forwarded,

Dushan Arumugam, Fugro Pelagos, Inc.
Lead Hydrographer
Fugro Pelagos, Inc. Survey Party

Appendix A -Tides and Water Levels



NOAA/NOS/CO-OPS Water Level Station - Microsoft Internet Explorer

Address: http://140.90.121.76/cgi-bin/station_info.cgi?stn=8423898+Fort+Point,+NH

NOAA/NOS CO-OPS Center for Operational Oceanographic Products and Services (CO-OPS)

Station Information for Fort Point, NH

Water Level Station Information:

Station Name: **Fort Point, NH**
 Station Identification Number: **8423898**
 Latitude: **43° 4.3' N**
 Longitude: **70° 42.7' W**
 Date Established: **Aug 12 1976**
 Maximum Water Level: **ft. above MHHW**
 (
 Minimum Water Level: **ft. below MLLW**
 (
 Mean Range: **8.63 ft.**
 Diurnal Range: **9.42 ft.**

Tidal and Geodetic Datums: [Click HERE](#)
 Bench Mark Data Sheet: [Click HERE](#)

EPOCH Update Information: NEW

EPOCH Datum Comparison: [Click HERE](#) - check datum differences between the old epoch (1960-1978) and the new epoch (1983-2001)

Superceded Bench Mark Data Sheet: [Click HERE](#) - bench mark sheet on the old Tidal Datum Epoch (1960-1978)

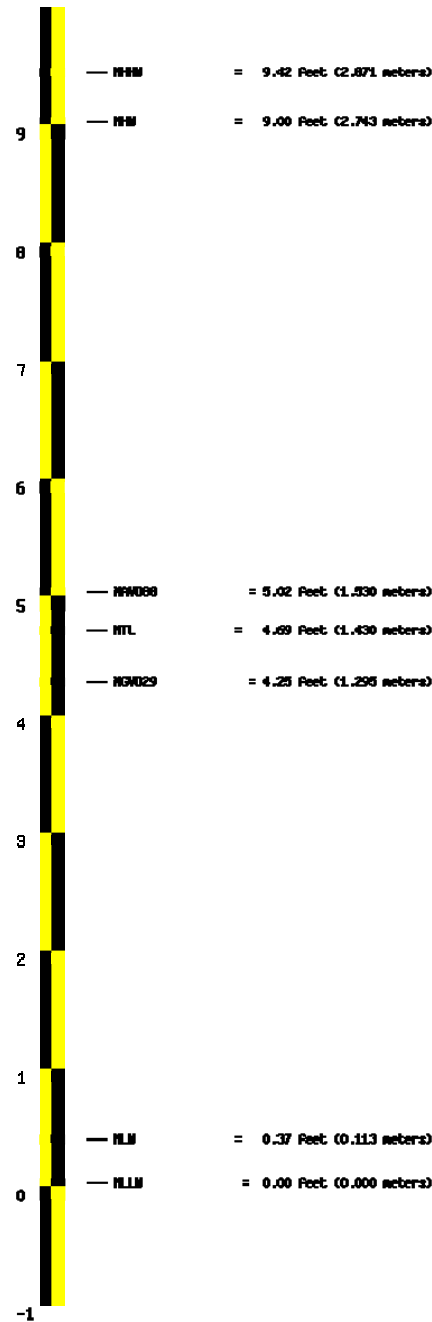
Superceded Datums: [Click HERE](#) - datums on the old Tidal Datum Epoch (1960-1978)

Mean Sea Level Differences List: [Click HERE](#) - mean sea level differences between the two epochs for all stations.

Mean Sea Level Difference: for 8423898 Fort Point, NH	1983- 2001	1960- 1978	Difference:
	ft.	ft.	ft.



Elevation Information for PID = 000427, VM = 17345
Station_ID --- 8423898



The NAD 88 and the NAD 29 elevations related to MLLW were computed from Bench Mark, 842 3898 TIDAL 2, at the station.

Displayed tidal datums are Mean Higher High Water (MHHW), Mean High Water (MHW), Mean Tide Level (MTL), Mean Low Water (MLW), and Mean Lower Low Water (MLLW) referenced on 1983-2001 Epoch



Appendix B –Horizontal Control

Data Sheet RetrievalThe NGS Data Sheet						
DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.25						
1 National Geodetic Survey, Retrieval Date = SEPTEMBER 7, 2005						
AB2631	*****					
AB2631	FBN	-	This is a Federal Base Network Control Station.			
AB2631	TIDAL BM	-	This is a Tidal Bench Mark.			
AB2631	DESIGNATION	-	PORTSMOUTH USCG			
AB2631	PID	-	AB2631			
AB2631	STATE/COUNTY	-	NH/ROCKINGHAM			
AB2631	USGS QUAD	-	KITTELY (1989)			
AB2631						
AB2631	*CURRENT SURVEY CONTROL					
AB2631						
AB2631*	NAD 83(1996)-	43 04 15.17437(N)	070 42 48.58831(W)	ADJUSTED		
AB2631*	NAVD 88	-	7.346 (meters)	24.10 (feet)	ADJUSTED	
AB2631						
AB2631	X	-	1,541,329.464 (meters)	COMP		
AB2631	Y	-	-4,404,671.979 (meters)	COMP		
AB2631	Z	-	4,333,244.347 (meters)	COMP		
AB2631	LAPLACE CORR-		2.77 (seconds)	DEFLEC99		
AB2631	ELLIP HEIGHT-		-19.23 (meters)	(07/01/02)	GPS OBS	
AB2631	GEOID HEIGHT-		-26.58 (meters)	GEOID03		
AB2631	DYNAMIC HT	-	7.345 (meters)	24.10 (feet)	COMP	
AB2631	MODELED GRAV-		980,461.1 (mgal)	NAVD 88		
AB2631						
AB2631	HORZ ORDER	-	A			
AB2631	VERT ORDER	-	SECOND	CLASS I		
AB2631	ELLP ORDER	-	THIRD	CLASS I		
AB2631						
AB2631	.This is a reference station for the PORTSMOUTH 2					
AB2631	.National Continuously Operating Reference Station (POR2).					
AB2631						
AB2631	.The horizontal coordinates were established by GPS observations					
AB2631	.and adjusted by the National Geodetic Survey in July 1997.					
AB2631						
AB2631	.The orthometric height was determined by differential leveling					
AB2631	.and adjusted by the National Geodetic Survey in July 2002.					
AB2631						
AB2631	.This Tidal Bench Mark is designated as VM 17349					
AB2631	.by the Center for Operational Oceanographic Products and Services.					
AB2631						
AB2631	.The X, Y, and Z were computed from the position and the ellipsoidal ht.					
AB2631						
AB2631	.The Laplace correction was computed from DEFLEC99 derived deflections.					
AB2631						
AB2631	.The ellipsoidal height was determined by GPS observations					
AB2631	.and is referenced to NAD 83.					
AB2631						
AB2631	.The geoid height was determined by GEOID03.					
AB2631						
AB2631	.The dynamic height is computed by dividing the NAVD 88					
AB2631	.geopotential number by the normal gravity value computed on the					
AB2631	.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45					
AB2631	.degrees latitude (g = 980.6199 gals.).					
AB2631						
AB2631	.The modeled gravity was interpolated from observed gravity values.					
AB2631						
AB2631			North	East	Units	Scale Factor
AB2631	!SPC NH	-	63,857.310	377,630.656	MT	1.00004078
AB2631	!UTM 19	-	4,770,110.922	360,494.918	MT	0.99983942
AB2631						
AB2631	!	-	Elev Factor	x	Scale Factor	=
AB2631	!SPC NH	-	1.00000302	x	1.00004078	=
AB2631	!UTM 19	-	1.00000302	x	0.99983942	=
AB2631						
AB2631						
AB2631	PID	Reference Object	Distance		Geod. Az	
AB2631						
AB2631	OC0429	CONSTITUTION 147 RM 1	222.800 METERS		10608	
AB2631						
AB2631						
AB2631	SUPERSEDED SURVEY CONTROL					
AB2631						
AB2631	ELLIP H (07/24/97)	-	-19.25 (m)	GP()		2 1
AB2631	NAD 83(1992)-	43 04 15.17442(N)	070 42 48.58787(W)	AD(1995.00)		A
AB2631	ELLIP H (04/02/96)	-	-19.25 (m)	GP(1995.00)		4 2
AB2631						

Dated: 8th January, 2006

AB2631
AB2631.Superseded values are not recommended for survey control.
AB2631.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AB2631.See file dsdata.txt to determine how the superseded data were derived.
AB2631
AB2631_U.S. NATIONAL GRID SPATIAL ADDRESS: 19TCH6049570111(NAD 83)
AB2631_MARKER: DH = HORIZONTAL CONTROL DISK
AB2631_SETTING: 66 = SET IN ROCK OUTCROP
AB2631_STAMPING: PORTSMOUTH USCG 1994
AB2631_MARK LOGO: NGS
AB2631_MAGNETIC: N = NO MAGNETIC MATERIAL
AB2631_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD
AB2631+STABILITY: POSITION/ELEVATION WELL
AB2631_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AB2631+SATELLITE: SATELLITE OBSERVATIONS - October 21, 1995
AB2631
AB2631 HISTORY - Date Condition Report By
AB2631 HISTORY - 1994 MONUMENTED NGS
AB2631 HISTORY - 19951021 GOOD NGS

STATION DESCRIPTION

AB2631'DESCRIBED BY NATIONAL GEODETIC SURVEY 1994 (RAH)
AB2631'THE STATION IS LOCATED JUST EAST OF PORTSMOUTH, NH AT THE USCG STATION
AB2631'FOR PORTSMOUTH HARBOUR IN NEW CASTLE, NH.\$TO REACH THE STATION FROM
AB2631'HIGHWAY 95/1 ROTARY IN PORTSMOUTH, PROCEED SOUTHEAST ON BY-PASS 1 FOR
AB2631'1.6 MI (2.6 KM) TO HIGHWAY 1. CONTINUE SOUTH ON HIGHWAY 1 FOR 0.5 MI
AB2631'(0.8 KM) TO INTERSECTION OF HIGHWAY 1 AND ELWIN ROAD. TURN LEFT (EAST)
AB2631'ON ELWIN ROAD AND CONTINUE FOR 1.45 MI (2.33 KM) TO INTERSECTION OF
AB2631'ELWIN ROAD AND ROUTE 1A. TURN LEFT (NORTHWEST) ON ROUTE 1A AND
AB2631'PROCEED 0.45 MI (0.72 KM) TO INTERSECTION OF ROUTE 1A AND 1B. TURN
AB2631'RIGHT (NORTHEAST) ON ROUTE 1B FOR 2.6 MI (4.2 KM) TO ENTRANCE ROAD TO
AB2631'FORT CONSTITUTION AND USCG STATION PORTSMOUTH HARBOR (WHERE ROUTE 1B
AB2631'CHANGES FROM MAIN STREET TO WENTWORTH ROAD). TURN RIGHT (EAST) ON TO
AB2631'ACCESS ROAD AND PROCEED EAST FOR 0.03 MI (0.05 KM) TO FORT
AB2631'CONSTITUTION TURN OFF. TURN RIGHT (EAST) CONTINUING 162 FT (49.4 M)
AB2631'TO ROCK OUTCROP ON THE RIGHT AND THE STATION.\$THE STATION IS LOCATED
AB2631'195.5 FT (59.6 M) NORTH NORTHWEST OF A POWER POLE, 189.3 FT (57.7 M)
AB2631'EAST OF A BLACK FIRE HYDRANT, 73.5 FT (22.4 M) SOUTHEAST OF A FIRE
AB2631'HYDRANT, 73.5 FT (22.4 M) SOUTH OF THE SOUTHEAST CORNER OF A CONCRETE
AB2631'BUILDING FOUNDATION, AND 16.8 FT (5.1 M) NORTH OF THE ROAD CURB.\$FOR
AB2631'ACCESS CONTACT CWO-4 MICHAEL E. PENDLETON, COMMANDING OFFICER, USCG
AB2631'STATION PORTSMOUTH HARBOR, NEW CASTLE, NH 03854-0600, PHONE
AB2631'(603)436-4415.

STATION RECOVERY (1995)

AB2631
AB2631
AB2631'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1995 (ALG)
AB2631'RECOVERED AS DESCRIBED.

*** retrieval complete.
Elapsed Time = 00:00:02



Appendix C –KGPS Processing Summary

The following tables outline the estimated positional accuracies of the post-processed dual-frequency GPS data for the LiDAR survey on every Julian Day that dual-frequency KGPS data was available. Note KGPS data was always available for the LIDAR system.

The data were obtained from the report file generated by the Applanix POSPac POSGPS software after post-processing the GPS data.

Forward / Reverse Separation RMS values are the average differences between the forward and reverse solutions, and serve as a check on the repeatability of the solution. Note that for this project, the KGPS data output from POSGPS and applied to the survey lines in CARIS or GCS are a combined forward and reverse solution.

The position standard deviation percentages are the percent of the number of positions for that day that fall within the specified standard deviation range.

Average baseline refers to the average distance from the base station in Fort Point, NH to the LiDAR airborne system. This can have an effect on positioning accuracy as the further the vessel is from the base station, the less ionospheric-induced positioning error can be corrected for.

Quality Percentages refers to the percent of positions that are given the corresponding quality tag by POSGPS. The values are as follows:

Table 3 Quality Tags

Quality	Meaning	Estimated Accuracy
1	Fixed Integer	0.00 – 0.15m
2	Converged Float or Noisy Fixed Integer	0.05 – 0.40m
3	Converging Float	0.20 – 1.00 m
4	Converging Float	0.50 – 2.00 m
5	DGPS	1.00 – 5.00 m
6	DGPS	2.00 – 10.00 m

Table 4 Results from the LiDAR

Julian Day	Fwd/Rev Separation RMS Values (meters)			Position Standard Deviation Percentages (%)					Quality Percentages (%)						Average Baseline (km)
	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	Q1	Q2	Q3	Q4	Q5	Q6	
252A	0.021	0.012	0.032	82.9	17.1				100						10.977
252B	0.015	0.018	0.028	98.4	1.6				100						13.532
253A	0.024	0.016	0.038	77.4	22.6				100						13.955
253B	0.016	0.012	0.019	98.8	1.2				100						11.138
254A	0.016	0.020	0.027	92.5	7.6				100						12.162
254B	0.005	0.012	0.009	100.0					100						12.560
254C	0.003	0.001	0.011	96.0	4.0				100						11.089
255A	0.005	0.013	0.018	100.0					100						9.940