

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

Horizontal and Vertical Control Report

Type of Survey _____ **Hydrographic Survey** _____

Field No. _____ **H12004, H12065, H12066, H12067** _____

Registry No. _____ **OPR-P188-TE-09** _____

LOCALITY

State _____ **Alaska** _____

General Locality _____ **Unimak Pass** _____

2009

CHIEF OF PARTY
Marta Krynytzky

LIBRARY & ARCHIVES

DATE _____ **January 2010** _____

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HYDROGRAPHIC TITLE SHEET

**Horizontal & Vertical
Control Report
OPR-P188-TE-09**

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. H12004, H12065, H12066, H12067

State Alaska

General Locality Unimak Pass

Sub-Locality Various

Scale N/A Date of Survey May 16th-August 26th, 2009

Instructions dated N/A Project No. OPR-P188-TE-09

Vessel M/V Bluefin, R/V Mt. Mitchell, R/V Mt. Augustine & Skiff Spare Rhib

Chief of party Marta Krynytzky

Surveyed by TerraSond Ltd.

Soundings by echo sounder, lead line, pole Multibeam Echosounder

Graphic record scaled by N/A

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

Verification by N/A

Soundings in fathoms feet at MLW MLLW Meters at MLLW

REMARKS: Contract No.: DG133C-05-CQ-1079

Contractor: TerraSond Ltd. All times recorded in UTC

1617 South Industrial Way, Suite 3

Palmer, AK 99645

VERTICAL AND HORIZONTAL CONTROL REPORT

OPR-P188-TE-09

2009

Unimak Pass



H12004

H12065

H12066

H12067

Vessels: *M/V Bluefin, R/V Mt. Mitchell, R/V Mt. Augustine, and skiff Spare Rhib*

State: **Alaska**

Locality: **Unimak Pass**

Year: **2009**

Lead Hydrographer: **Marta Krynytzky**

TERRASOND

A. Vertical Control

The time meridian for this project was 000° longitude. All measurements were made in Universal Time, Coordinated (UTC). No measurements were made using local time. The local time meridian for the project was 165° west longitude and local time Alaska was offset from UTC by eight hours (Alaska Daylight Time = UTC - 8 hours).

Tide Correctors and Zoning

Sounding data was adjusted for tidal influence using zoning modified by John Oswald and Associates (JOA) and verified tides from tidal gauges at Scotch Cap, AK (946-2808), Akun, AK (946-2719) and King Cove (945-9881) (Figure 1). Digital zone data is provided in the Digital Data folder provided with this report. A detailed discussion of tidal zoning methodology, *Tidal Zoning for Unimak Pass 2009*, provided by JOA, can be found in *Appendix I* of this report. Figures 1 and 2 show the time and range correctors and tide zone distribution.

Two subordinate gauges were installed to provide initial and final processing for the project areas. TerraSond, Ltd. contracted with JOA to install bubbler-style and Sea-Bird SBE 26plus tide gauges at Scotch Cap (946-2808) and Akun, AK (946-2719). JOA was also contracted to process the tide data and to deliver final verified tides and zones. The Scotch Cap bubbler orifice was often exposed to the air at extreme low tides. These occurrences could be readily recognized and have been excluded from data computations of that gauge.

Additionally one Sea-Bird was installed at historic tide gauge site Sanak Harbor, Sanak Island (945-9968) and three roving Sea-Bird tide gauges were deployed throughout the project area for various amounts of time. Data from these four Sea-Bird instruments were used to assist in tidal zoning.

Unimak Pass is a major mixing and water exchange location between the Northern Pacific Ocean, Gulf of Alaska and the Bering Sea. Strong tidal currents and unusual tidal patterns are often observed. Unusual tidal patterns include several strong flood currents separated by weak or non-existent ebb currents, often resulting in a ‘double flood’ current that will flood continuously with currents peaking and diminishing approximately twice a day. See *Appendix I* for more details.

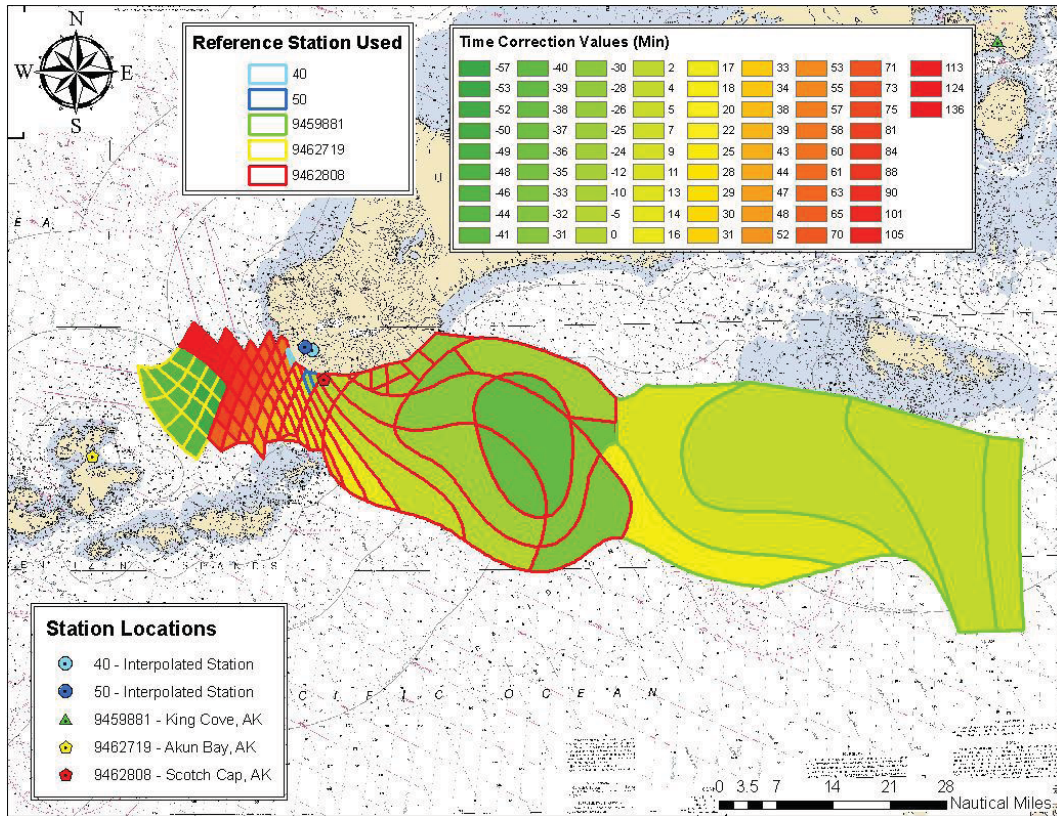


Figure 1 - Final tidal zones, showing time correction values

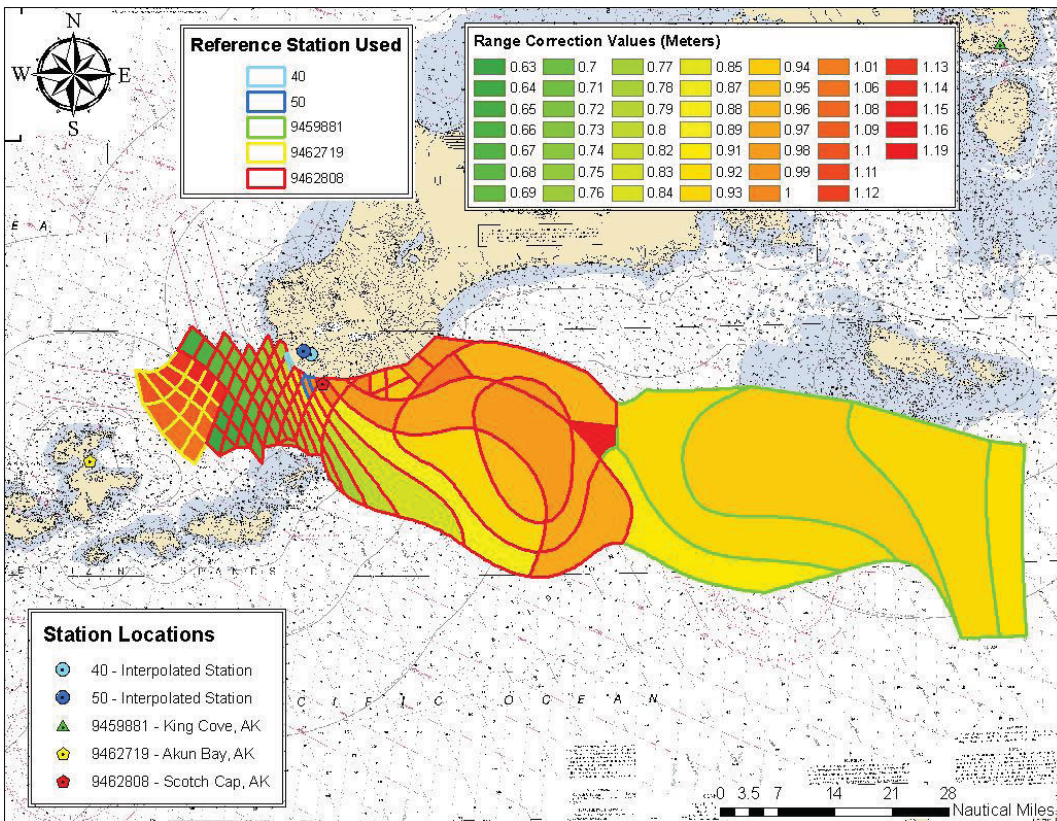


Figure 2 - Final tidal zones, showing range correction values

Ellipsoid Height Survey

Ellipsoid Height survey at Scotch Cap, Station 946-2808, was completed on benchmark TIDAL 4. The ellipsoid height survey at Akun, Station 946-2719, was completed on benchmark A. Observations were made using a Novatel DL4+ GPS receiver at each station. At both stations a level loop was run through 5 benchmarks to carry the elevation down to the water for staff shots. See *Appendix I* for more details.

B. HORIZONTAL CONTROL

The horizontal control datum used for this survey was the North American Datum of 1983 (NAD 83). The projection used was Universal Transverse Mercator (UTM) Zone 3 North.

For field processing, sounding position control was determined using a Global Positioning System (GPS). The primary source of navigation correctors was the United States Coast Guard differential GPS (DGPS) station at Cold Bay, AK, CORS ID BAY5. The NGS data sheet information, acquired from the NGS website, is also included in this report in *Appendix II*.

DGPS Confidence checks were performed in the field for the *M/V Bluefin* and *R/V Mt. Augustine* by comparing the positions calculated by the POS M/V to a common node calculated by the DSM. Two methods were employed for confidence checks. In many cases, the acquisition software QPS QINSy was used to plot both, in real time, the Primary POS M/V position and the DSM position. Screen grabs of these plots with error ellipses were taken. For the second method, positions from the POS M/V and the DSM were used. The differences in the northing and easting values were calculated and graphed in excel. A circle based on the allowable error was placed on the graph. The circle verifies the 95 percent confidence level which does not exceed 5 meters + 5 percent of the depth for the given line, according to section 3.1 of NOAA Hydrographic Survey Specifications and Deliverables, April 2009. A summary of weekly DGPS confidence checks is provided in *Separates I* of each survey's Descriptive Report.

For final processing, sounding position control was determined using POS PAC Post Processed Kinematic (PPK) positioning. Three independent PPK base stations were installed for this survey at tide stations: Scotch Cap, Akun and Sanak.

Final coordinates for each PPK base station were computed using NGS's OPUS service. Converted RINEX files randomly selected for each base station were sent to OPUS and averaged for the final base station coordinate used in post processing. Refer to *Appendix II* for the OPUS solution results. The base station data was then used to post-process the rover POS data logged from each vessel's Applanix POS MV V4. Post-processing was done using Applanix POSPAC MMS v5.1. See *Appendix III* for a summary of processing results. Refer to the Data Acquisition and Processing Report (DAPR) for further details on the production of the Smoothed Best Estimate Trajectory (SBET) files.

Station Location	Latitude	Longitude
Scotch Cap, Unimak Island	54° 23' 42.45" N	164° 44' 41.89" W

Station Location	Latitude	Longitude
Akun Bay, Akun Island	54° 14' 20.13" N	165° 32' 27.78" W
Sanak Harbor, Sanak Island	54° 28' 47.17" N	162° 48' 49.16" W

Table 1 -- Base Station used for PPK processing.

Refer to the DAPR for OPR-P188-TE-09 for further details on PPK navigation processing and application to survey lines in CARIS.

LETTER OF APPROVAL

Project Wide Vertical and Horizontal Control Report

OPR-P188-TE-00

H12004, H12065, H12066, H12067

All information contained in this Vertical and Horizontal Control Report for OPR-P188-TE-09 has been reviewed and approved by me and is hereby respectfully submitted.

Marta Krynytzky

Digitally signed by Marta Krynytzky
DN: CN = Marta Krynytzky, C = US,
O = TerraSond Ltd., OU = Charting
Date: 2010.01.14 09:08:41 -09'00'

**Marta Krynytzky, Lead Hydrographer
TerraSond Ltd.**

Date January 14, 2009

APPENDIX I
Tides

Attachments:

Tide Station Report for 946-2719 Akun Island consisting of:

- Closeout Site Report (1 page)
- To Reach Statement (1 page)
- Chartlets (2 pages)
- Benchmark Sketch (1 page)
- Abstract of Conventional Leveling on Historic Datum (1 page)
- Datum Offset Computation Worksheets (1 pages)
- Water Density Observations and Slope Constant (1 page)
- Summary of Staff Observations on Historic Datum (1 page)
- Staff Shot Observations (6 pages)
- Sensor Elevation Diagram (1 page)
- Photos (6 pages)
- Calibration Reports (17 pages)
- NGS GPS Station Observation Forms (6 pages)
- Benchmark Datasheets (2 pages)
- Installation Level Notes (8 pages)

Tide Station Report for 946-2808 Scotch Cap

- Closeout Site Report (1 pages)
- To Reach Statement (1 page)
- Chartlets (2 pages)
- Benchmark Sketch (1 page)
- Abstract of Conventional Leveling on Historic Datum (1 page)
- Datum Offset Computation Worksheets (1 page)
- Water Density Observations and Slope Constant (1 page)
- Summary of Staff Observations on Historic Datum (1 pages)
- Staff Shot Observations on Historic Station Datum (2 pages)
- Sensor Elevation Diagram (1 page)
- Photos (9 pages)
- Calibration Reports (25 pages)
- NGS GPS Station Observation Forms (6 pages)
- Benchmark Datasheets (2 pages)
- Benchmark History (1 page)
- Installation Level Notes (10 pages)

Tidal Zoning for Unimak Pass 2009, Combined Approach Using Conventional and PPK
Water Levels by JOA Surveys, LLC

Site Report
946-2719 Akun Island, Akun Bay, AK

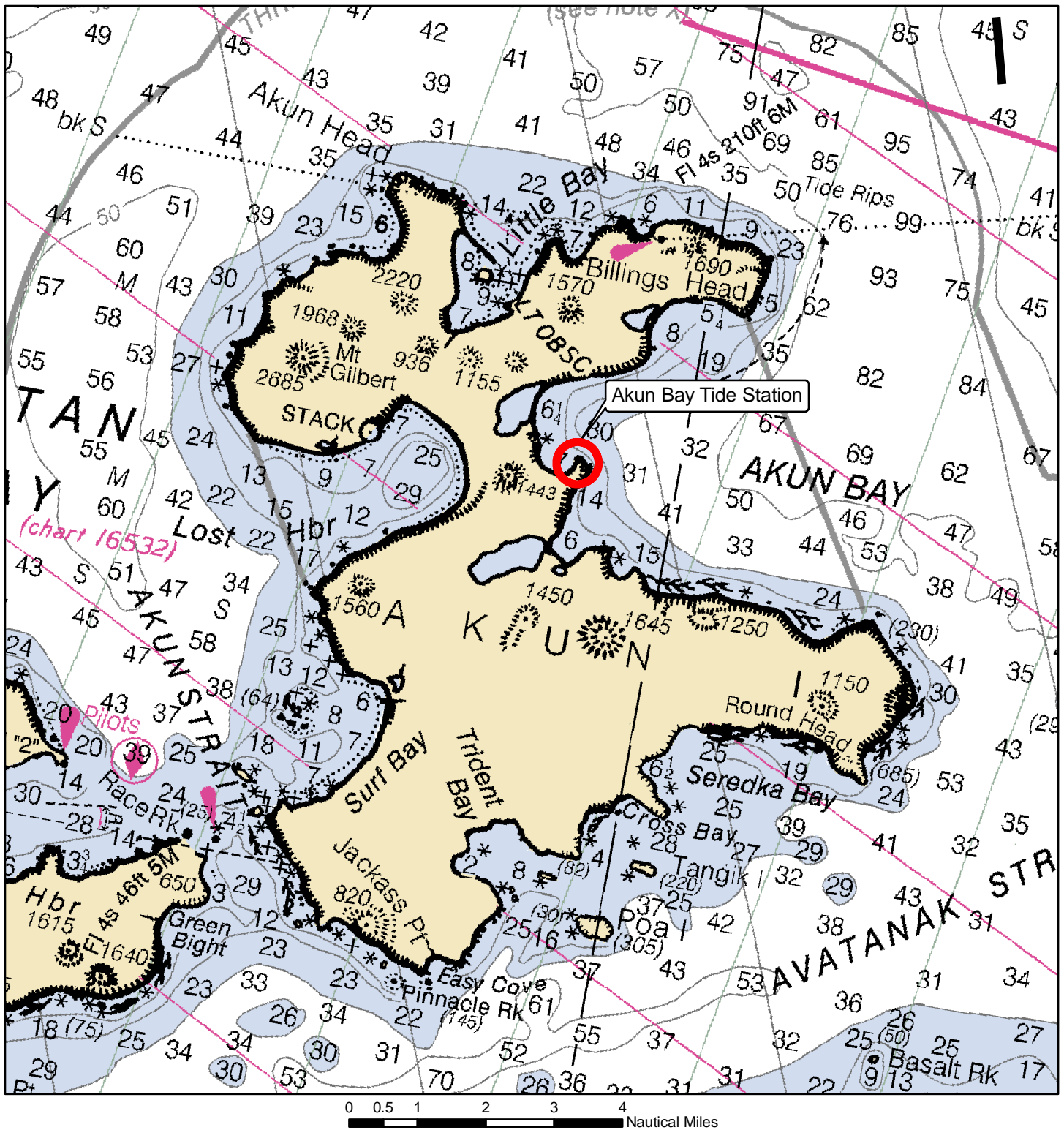
Site Visit	Purpose of Visit	Removal	Team Leader	N. Wardwell, JOA	Date of Visit	9/5/09 - 9/7/09	
Tertiary Station	Installation	April 10, 2009	Removal	September 7, 2009	Number of Days	151	
Project	OCS	OPR-P188-TE-09			JOA	141	
Position (NAD83)	Latitude (N)	54° 14' 20"	Longitude (W)	165° 32' 28"	Time Meridian	0° (UTC)	
Local Values	Gravity (milligals)	981539	GOES Angles	Elev 22°/ Az 144°	Magnetic Declination	11° E, +0° 8' W/year	
Contractor	Prime TerraSond Ltd. 1617 South Industrial Way, Suite 3 Palmer, AK 99645 (907) 745-7215 ATTN: Kathleen Mildon			Tide Consultant JOA Surveys, LLC 2000 E. Dowling Rd, Suite 10 Anchorage, AK 99507 (907) 561-0136 phone ATTN: Nathan Wardwell			
Owner	Akutan Corporation PO Box 8 Akutan, AK 99553 (907) 698-2206						
Location	To reach the tidal bench marks from the Unalaska (Dutch Harbor) City Dock, proceed by boat NNE 26km (14nm) to the north side of Akutan Island, then proceed NE for 37km (20nm) to the entrance to Akutan Pass between Akutan and Akun islands, then proceed East 26km (14nm) to Billings Head at the NE point of Akun Island, then proceed 5km (3nm) South to Akun Bay, then proceed SW 6km (3nm) to Helianthus Cove. The bench marks are located on a rock ledge/bluff facing north.						
Tide House	The tide gauge electronics are housed in individual Pelican cases mounted inside a 4' (wide) by 3' (high) by 3' (deep) wooden shed anchored down with guide wires. There is barbed-wire fence surrounding the tide house and solar cells. A gate to the fence is located in the SW corner. The orifice line for the two bubbler gauges run outside to the grass edge then across the boulders on the beach. The orifice tubing is attached to 3/8" cable. There is a Duckbill anchor at the grass ledge and just outside the tide house that are used to anchor the orifice lines and cable. From the tide house to the barbed-wire fence the orifice tubing is covered with grass, then from outside the fence to the surf zone the tubing is covered with rocks to protect from fox and cattle. GPS and GOES antennas are mounted to the shed itself.						
Gauge 1	Installed	4/10/2009	Removed	9/7/2009			
	Pressure Sensor	DAA H350XL	Serial No.	1354	Vent Value (m)	NA	
			Averaging Interval	180 seconds	Slope Constant in Gauge	0.68398	
	Data Logger	combined in H350XL	Firmware	2.120			
	Pump	DAA H355	Serial No.	TID 1899			
	GOES Radio	DAA H222	Serial No.	1002	GPS timing	Yes	
	GOES Address	9070464A	Channel	170	Format	NGWLMS	
	Interval	1 hour	Offset	0:01:00	Transmit Window	10 seconds	
	Power	Two 12v deep cycle Optima batteries with a 70watt solar panel and solar controller.					
	Orifice	The bubbler orifice is attached to a 3/4" diameter galvanized pipe that is mounted vertically to a 1100 lbs anchor. The bubbler orifice is hose clamped to a 4"x3/4" pipe that is welded to the anchor. Between the orifice pipe and the pipe that is welded onto the anchor are plastic spacers. The length of the orifice tubing is approximately 550'.					
Anchors	The anchor is 1.2m in diameter. They have three legs equally spaced. Each leg is 50cm (wide) by 50cm (long) by 20cm (tall). Inside each leg are four 60 lbs lengths of railroad rail. At the end of each leg is a handle. The buoy line is 3/4" blue polyline that is approximately 45' long. There are two buoys used as surface expressions: one large white inflatable drag buoy and another small foam trailing buoy. The trailing buoy is attached to the main buoy line with a separate piece of floating line.						
Gauge 2	Installed	4/10/2009	Removed	9/7/2009			
	Pressure Sensor	DAA H350XL	Serial No.	3541	Vent Value (m)	NA	
			Averaging Interval	180 seconds	Slope Constant in Gauge	0.68398	
	Data Logger	combined in H350XL	Firmware	2.12			
	Pump	DAA H355	Serial No.	1803			
	GOES Radio	DAA H222	Serial No.	1003	GPS timing	Yes	
	GOES Address	907060A6	Channel	170	Format	NGWLMS	
	Interval	1 hour	Offset	0:01:20	Transmit Window	10 seconds	
	Power	Two 12v deep cycle Optima batteries with a 70watt solar panel and solar controller.					
	Orifice	The bubbler orifice is attached to a 3/4" diameter galvanized pipe that is mounted vertically to the metal yoke for the 1100 lbs anchor. Hose are used to clamp the orifice to the yoke. Between the orifice pipe and the pipe that is welded					
Anchors	The anchor is 1.2m in diameter. They have three legs equally spaced. Each leg is 50cm (wide) by 50cm (long) by 20cm (tall). Inside each leg are four 60 lbs lengths of railroad rail. At the end of each leg is a handle. The buoy line is 3/4" blue polyline that is approximately 45' long. There are two buoys used as surface expressions: one large white inflatable drag buoy and another small foam trailing buoy. The trailing buoy is attached to the main buoy line with a separate piece of floating line.						
Gauge 3	Installed	4/10/2009	Removed	9/7/2009			
	Pressure Sensor	SBE 26+ (100 psi)	Serial No.	1158	Vent Value (m)	NA	
			Averaging Interval	180 seconds			
	Data Logger	combined in SBE 26+	Firmware	NA			
	Acoustic Modem	LinkQuest UWM 1000	Serial No.	010216			
	Power for modem	Link quest	Serial No.	010220			
	Power	12 D-Cell (1.5v) batteries for the seabird and extra battery pack for the modem					
Anchors	The anchor is 1.2m in diameter. They have three legs equally spaced. Each leg is 50cm (wide) by 50cm (long) by 20cm (tall). Inside each leg are four 60 lbs lengths of railroad rail. At the end of each leg is a handle. The buoy line is 3/4" blue polyline that is approximately 60' long. There are two buoys used as surface expressions: one large Green inflatable drag buoy and another small foam trailing buoy. The trailing buoy is attached to the main buoy line with a separate piece of floating line.						
Tidal Bench Marks	Primary	Recovered	Established	Designations			
	946 2719 TIDAL 1	4	1	946 2719 TIDAL 1, 946 2719 TIDAL 2, 946 2719 TIDAL 3, 946 2719 TIDAL 4, 946 2719 A			
Leveling	Date	Order	Type	Bench Marks Connected			
	4/9/09 - 4/11/09	Third	Optical	946 2719 TIDAL 1, 946 2719 TIDAL 2, 946 2719 TIDAL 3, 946 2719 TIDAL 4, 946 2719 A			
	9/5/2009	Third	Optical	946 2719 TIDAL 1, 946 2719 TIDAL 2, 946 2719 TIDAL 3, 946 2719 TIDAL 4, 946 2719 A			
	NAVD88 Level Tie	No NAVD88 marks within 1.6km (1 mi).					
GPS & OPUS	Bench Mark	Date	Session Length	Latitude (N)	Longitude (W)	Ellipsoid Height (m)	
	9462719 A	4/9/2009	22.5 hrs	54° 14' 20.08925"	165° 32' 28.20926"	19.789	
	NAVD88 GPS Tie	link to OPUS-DB datasheet http://beta.ngs.noaa.gov/OPUS/getDatasheet.jsp?PID=BBB93&style=modern					
Station History	4/7/09 - 4/11/09: The tide station was re-occupied with two bubblers and one seabird. Four historic marks were found and one new (Stainless steel deep rod rod) was established.						
	9/5/09 -9/7/09: The tide station was removed by N. Wardwell and G. Gray. Leveling was completed on 9/5/09, the staff shots were performed the following day, and the removal was completed on 9/7/09.						

TO REACH STATEMENT

946 2719
Akun Island, Alaska

To reach the bench marks from the Dutch Harbor Spit Dock, proceed NNE 14.0 km (7.6 nm) to Priest Rock, then NE for 39.8 km (21.5 nm) to the entrance to Akutan Pass between Akutan and Akun islands, then ENE for 21.8 km (11.8 nm) to Akun Head, then east for 9.8 km (5.3 mi) to Billings Head, then south for 4.6 km (2.5 nm) to Akun Bay, then SSW for 5.4 km (2.9 nm) to Helianthus Cove. The bench marks are along a rock ledge/bluff facing north. The tide gauge and sensors were located at the base of the grass bluff near the rock point on the eastern shore of Helianthus cove.

AKUN BAY, ALASKA (946-2719)



Station Number: 946-2719

Station Name: AKUN BAY, AK

Latitude: 54-14-20 N

Longitude: 165-32-28 W

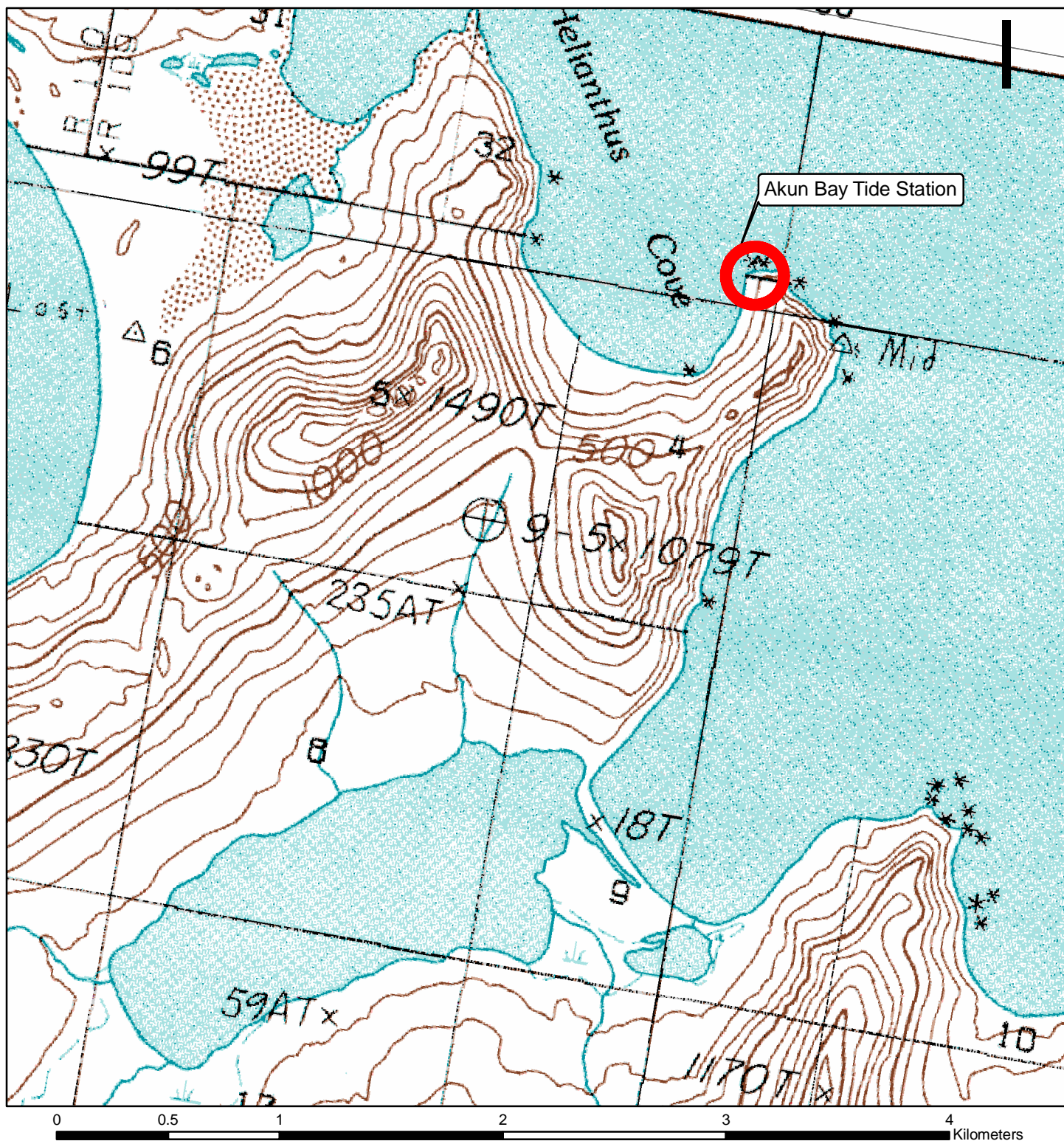
NOAA Chart: 16520, 22nd Ed., Mar/04

Display Scale: 1:150,000

Chart Scale = 1:300,000

USGS Quad: Unimak (A-5)

AKUN BAY, ALASKA (946-2719)



Station Number: 946-2719

USGS Quad: UNIMAK A-5

Station Name: AKUN BAY, AK

Map Scale = 1:25,000

Latitude: 54-14-20 N

Longitude: 165-32-28 W

BENCHMARK SKETCH

JOA

REVISED BY:

DATE:

STATION NAME

STATION NO.

REVISED BY:

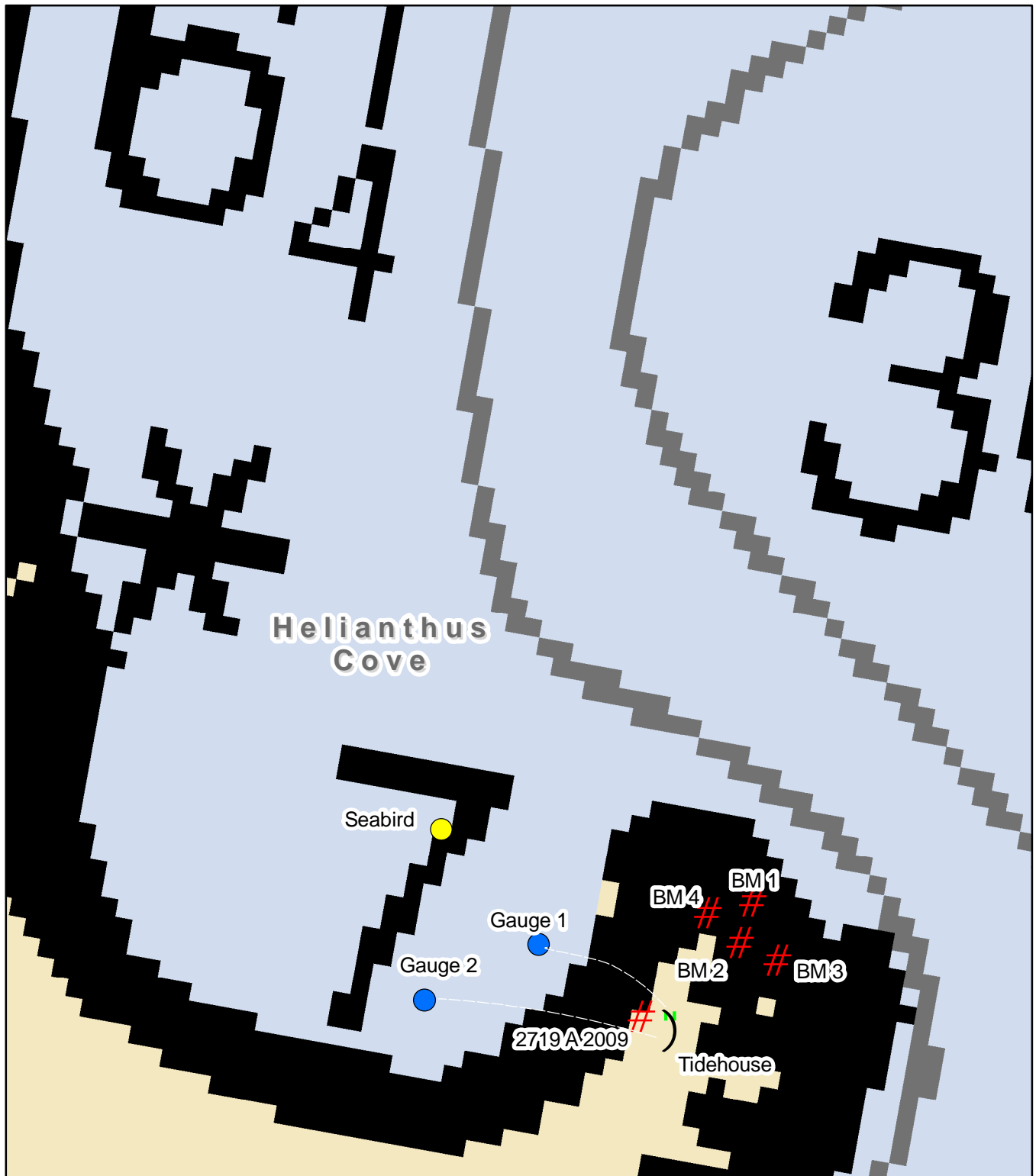
DATE:

AKUN BAY, ALASKA

946-2719

REVISED BY:

DATE:



Abstract of Conventional Leveling on Historic Station Datum

Akun Bay, Alaska

946-2719

Connected bench marks: 9462719 TIDAL 1, 9462719 TIDAL 2, 9462719 TIDAL 3, 9462719 TIDAL 4, 9462719 A
 Primary bench mark: 9462719 TIDAL 1

	<u>Initial leveling</u>	<u>Closeout leveling</u>
Date	4/9/09 & 4/10/09	9/4/2009
Level/SN	NA2/5191316	NA2/5191316
Observer	N. Wardwell	N. Wardwell
Rod person	M. Ewing	G. Gray
C Factor (mm/m)	0.04333	0.00001
Fieldbook Pages	NewWiz	NewWiz

Installation Leveling									
(all values in meters)									
Bench Mark		Distance	Diff. of Elevation (DE)			Closure	Mean DE	Station Datum	
From	To		Forward	Reverse	Elevation			Bench Mark	
9462719 TIDAL 1	9462719 TIDAL 2		0.6780	-0.6773	0.0007	0.6776	2.8920	3.5696	9462719 TIDAL 1
9462719 TIDAL 2	9462719 TIDAL 4		0.1450	-0.1457	-0.0007	0.1454	3.7150	3.7150	9462719 TIDAL 2
9462719 TIDAL 4	9462719 A		0.3617	-0.3617	0.0000	0.3617	4.0767	4.0767	9462719 TIDAL 4
Spur									
9462719 TIDAL 2	9462719 TIDAL 3		-0.0110	0.0113	0.0003	-0.0112	3.5584	3.5584	9462719 TIDAL 3

Closeout Leveling									
(all values in meters)									
Bench Mark		Distance	Diff. of Elevation (DE)			Closure	Mean DE	Station Datum	
From	To		Forward	Reverse	Elevation			Bench Mark	
9462719 TIDAL 1	9462719 TIDAL 2		0.6773	-0.6773	0.0000	0.6773	2.8920	3.5693	9462719 TIDAL 1
9462719 TIDAL 2	9462719 TIDAL 4		0.1457	-0.1470	-0.0013	0.1464	3.7157	3.7157	9462719 TIDAL 2
9462719 TIDAL 4	9462719 A		0.3613	-0.3613	0.0000	0.3613	4.0770	4.0770	9462719 TIDAL 4
Spur									
9462719 TIDAL 2	9462719 TIDAL 3		-0.0107	0.0110	0.0003	-0.0108	3.5585	3.5585	9462719 TIDAL 3

Comparison									
(all values in meters)									
Bench Mark		Distance	Diff. of Elevation (DE)			Closure	Mean DE	Station Datum	
From	To		Install	Closeout	Elevation			Bench Mark	
9462719 TIDAL 1	9462719 TIDAL 2		0.6776	0.6773	0.0003	0.6774	2.8920	3.5694	9462719 TIDAL 1
9462719 TIDAL 2	9462719 TIDAL 4		0.1454	0.1464	-0.0010	0.1459	3.7153	3.7153	9462719 TIDAL 2
9462719 TIDAL 4	9462719 A		0.3617	0.3613	0.0004	0.3615	4.0768	4.0768	9462719 TIDAL 4
Spur									
9462719 TIDAL 2	9462719 TIDAL 3		-0.0112	-0.0108	-0.0004	-0.0110	3.5584	3.5584	9462719 TIDAL 3

Notes :

1 - As per email from Manoj Samant on 4/14/09 BM is designated as the primary bench mark with an elevation of 2.892m above historic station datum.

Leveling		
Compiled by:	N. Wardwell	9/8/09
Verified by:	E. Opegard	10/2/09
		<i>dates</i>

Datum Offset Computation Worksheet

Abstract of Conventional Leveling on Historic Station Datum Akun Bay, Alaska

all values in meters

Current as of: Sep 05, 2009

Type of Visit: Removal of Tide Station

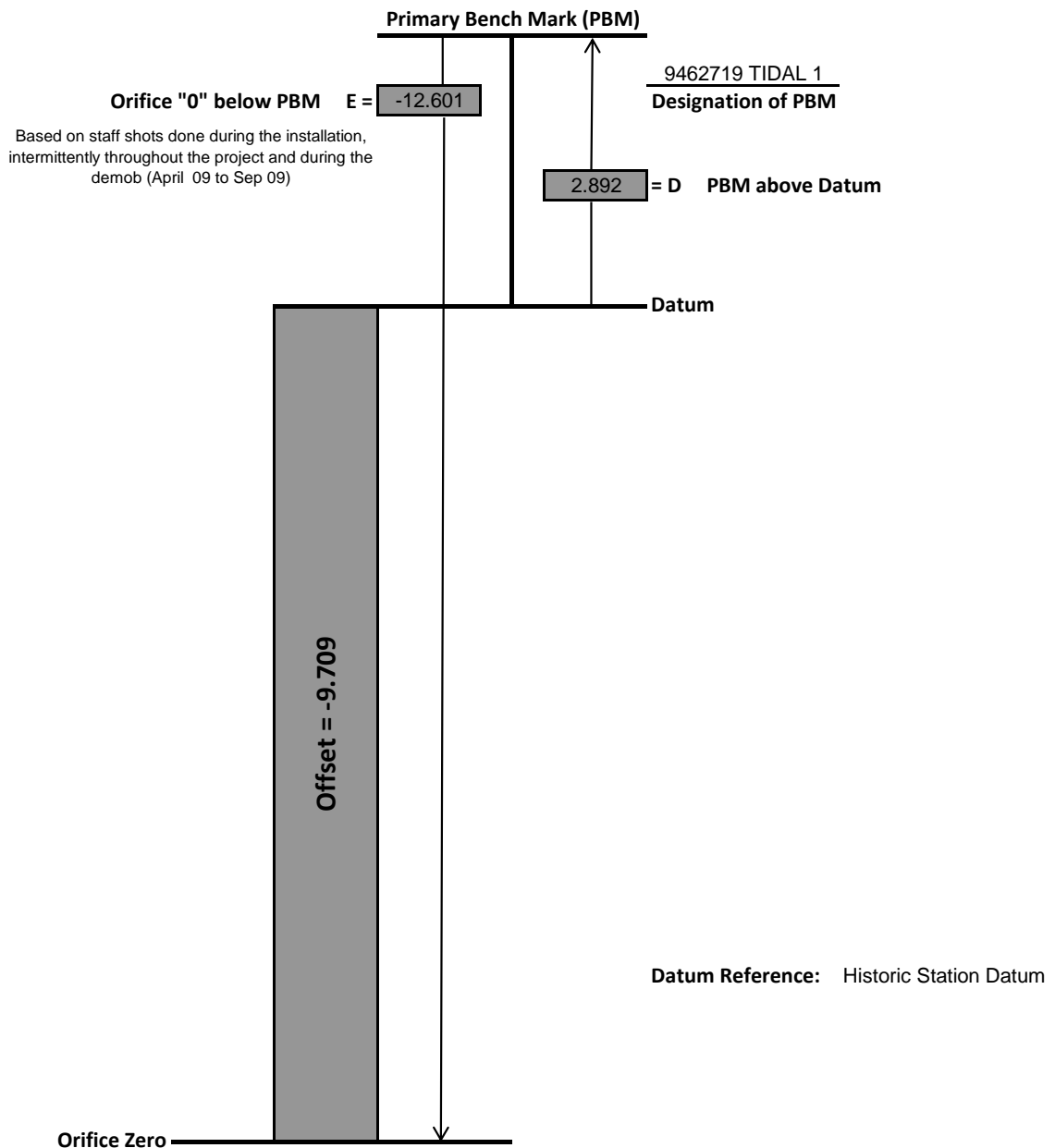
Sensor: The primary water level sensor is also referred to as Gauge # 1, and is a digital "bubbler" gauge.

Offset = D (PBM above Datum) + E (Orifice "0" below PBM)

Offset = 2.892 + -12.601

Offset = -9.709

The offset is the elevation of the Primary Water Level sensor zero or orifice zero above the datum of choice.



Water Density Observations and Slope Constant

Akun Bay, Alaska

946-2719

Date	Time	Density
04/09/09	22:31	1.027
04/10/09	03:23	1.027
05/21/09	00:03	1.026
05/21/09	00:07	1.026
05/21/09	00:28	1.026
05/28/09	21:01	1.026
05/28/09	21:58	1.027
05/28/09	22:41	1.027
06/14/09	06:36	1.025
06/14/09	07:14	1.025
06/22/09	02:54	1.025
06/22/09	03:11	1.026
06/22/09	03:40	1.026
06/22/09	04:07	1.026
07/07/09	18:42	1.027
07/07/09	19:12	1.027
07/07/09	20:01	1.027
07/07/09	20:30	1.027
07/07/09	21:35	1.027
07/07/09	22:04	1.026
07/07/09	22:30	1.027
07/19/09	19:00	1.027
07/19/09	19:30	1.026
07/19/09	20:00	1.027
07/19/09	20:36	1.026
07/19/09	21:00	1.027
07/19/09	21:30	1.027
07/19/09	22:00	1.026
07/19/09	22:30	1.026
07/19/09	23:00	1.026
08/02/09	22:36	1.026
08/02/09	23:14	1.027
08/02/09	23:38	1.026
08/03/09	00:01	1.027
08/03/09	00:30	1.027
08/03/09	01:00	1.026
08/03/09	01:30	1.026
09/06/09	18:51	1.022
09/06/09	19:49	1.022

Average Density = 1.0261

Final slope constant = 0.684599

.....
 Density of surface water measured by calibrated hydrometer. Samples obtained during staff (water leveling)
 The tide gauge pressure readings (PSI) are multiplied by the final slope constant to determine the corrected

$$\frac{\text{PSI to Pa Conversion Factor}}{\text{Gravity * Water Density * 1000}}$$

For N 54 14 20 and W 165 32 28 this equation is equivalent to:

$$\frac{6894.757}{9.8154 * 1.026 * 1000}$$

Gravity is calculated using the online NGS predicted gravity model for location and height:

http://www.ngs.noaa.gov/cgi-bin/grav_pdx.prl

Staff Shot Observations on Historic Station Datum Akun Bay, Alaska 946-2719

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
05/21 23:00	2719 A	0.297	3.440	0.330	1.264	10.952	9.489	14.982	-9.688	-8.225	-13.718	0.021	0.023	0.024	
05/21 23:06		0.297	3.440	0.320	1.254	10.965	9.504	14.997	-9.711	-8.250	-13.743	-0.002	-0.002	-0.001	
05/21 23:12		0.297	3.440	0.340	1.274	10.974	9.513	15.006	-9.700	-8.239	-13.732	0.009	0.009	0.010	
05/21 23:18		0.297	3.440	0.340	1.274	10.978	9.516	15.008	-9.704	-8.242	-13.734	0.005	0.006	0.008	
05/21 23:24		0.297	3.440	0.330	1.264	10.977	9.514	15.010	-9.713	-8.250	-13.746	-0.004	-0.002	-0.004	
05/21 23:30		0.297	3.440	0.350	1.284	10.998	9.536	15.029	-9.714	-8.252	-13.745	-0.005	-0.004	-0.003	
05/21 23:36		0.297	3.440	0.370	1.304	11.013	9.551	15.045	-9.709	-8.247	-13.741	0.000	0.001	0.001	
05/21 23:42		0.297	3.440	0.380	1.314	11.018	9.557	15.050	-9.704	-8.243	-13.736	0.005	0.005	0.006	
05/21 23:48		0.297	3.440	0.370	1.304	11.015	9.553	15.046	-9.711	-8.249	-13.742	-0.002	-0.001	0.000	
05/21 23:54		0.297	3.440	0.370	1.304	11.011	9.550	15.042	-9.707	-8.246	-13.738	0.002	0.002	0.004	
05/22 00:00		0.297	3.440	0.380	1.314	11.035	9.575	15.067	-9.721	-8.261	-13.753	-0.012	-0.013	-0.011	
05/22 00:06															
05/22 00:12		0.297	3.440	0.360	1.294	11.018	9.556	15.053	-9.724	-8.262	-13.759	-0.015	-0.014	-0.017	
05/22 00:18		0.297	3.440	0.400	1.334	11.045	9.583	15.078	-9.711	-8.249	-13.744	-0.002	-0.001	-0.002	
05/22 00:24		0.297	3.440	0.400	1.334	11.036	9.575	15.070	-9.702	-8.241	-13.736	0.007	0.007	0.006	
05/22 00:30		0.297	3.440	0.390	1.324	11.047	9.587	15.081	-9.723	-8.263	-13.757	-0.014	-0.015	-0.015	

Observed by: B. Macdonald, Pamela Pack average: -9.710 -8.248 -13.742
 Computed by: N. Wardwell stdev: 0.009 0.010 0.010
 Notes: Wave height 0 meters count: 15 15 15

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
05/28 21:12	2719 A	0.319	3.777	0.238	0.856	10.575	9.110	14.608	-9.719	-8.254	-13.752	0.006	0.008	0.006	
05/28 21:18		0.319	3.777	0.220	0.839	10.558	9.094	14.593	-9.719	-8.255	-13.754	0.005	0.006	0.004	
05/28 21:24		0.319	3.777	0.205	0.824	10.547	9.083	14.579	-9.723	-8.259	-13.755	0.001	0.002	0.003	
05/28 21:30		0.319	3.777	0.183	0.801	10.527	9.065	14.561	-9.726	-8.264	-13.760	-0.001	-0.002	-0.002	
05/28 21:36		0.319	3.777	0.170	0.789	10.513	9.050	14.546	-9.724	-8.261	-13.757	0.000	0.000	0.001	
05/28 21:42		0.319	3.777	0.150	0.769	10.492	9.029	14.527	-9.723	-8.260	-13.758	0.001	0.001	0.000	
						10.477									
						10.452									
						10.446									
						10.420									
05/28 22:18		0.121	4.016	0.495	0.677	10.390	8.927	14.422	-9.713	-8.250	-13.745	0.011	0.011	0.013	
05/28 22:24		0.121	4.016	0.460	0.642	10.370	8.909	14.405	-9.728	-8.267	-13.763	-0.004	-0.006	-0.005	
05/28 22:30		0.121	4.016	0.455	0.637	10.363	8.901	14.396	-9.726	-8.264	-13.759	-0.002	-0.003	-0.001	
05/28 22:36	2719 A	0.121	4.016	0.425	0.607	10.348	8.886	14.384	-9.741	-8.279	-13.777	-0.017	-0.018	-0.019	

Observed by: B. Macdonald, P. Pack, K. Nildon, B. Poulson average: -9.724 -8.261 -13.758
 Computed by: N. Wardwell stdev: 0.007 0.008 0.008
 Notes: Wave height 0.0-0.5 (calm, low swell) meters count: 10 10 10

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
06/14 06:30	2719 A	0.244	3.094	0.240	1.467	11.187	9.726	15.210	-9.720	-8.259	-13.743	0.020	0.019	0.022	
06/14 06:36		0.244	3.094	0.250	1.477	11.196	9.734	15.221	-9.719	-8.257	-13.744	0.021	0.021	0.021	
06/14 06:42		0.244	3.094	0.250	1.477	11.214	9.752	15.238	-9.737	-8.275	-13.761	0.003	0.003	0.004	
06/14 06:48		0.244	3.094	0.250	1.477	11.210	9.748	15.234	-9.733	-8.271	-13.757	0.007	0.007	0.008	
06/14 06:54		0.244	3.094	0.260	1.487	11.222	9.761	15.247	-9.735	-8.274	-13.760	0.005	0.004	0.005	
06/14 07:00		0.244	3.094	0.260	1.487	11.230	9.767	15.254	-9.743	-8.280	-13.767	-0.003	-0.002	-0.002	
06/14 07:06		0.244	3.094	0.270	1.497	11.247	9.784	15.270	-9.750	-8.287	-13.773	-0.010	-0.009	-0.008	
06/14 07:12		0.244	3.094	0.270	1.497	11.255	9.793	15.279	-9.758	-8.296	-13.782	-0.018	-0.018	-0.017	
06/14 07:18		0.244	3.094	0.290	1.517	11.268	9.805	15.291	-9.751	-8.288	-13.774	-0.011	-0.010	-0.009	
06/14 07:24		0.244	3.094	0.300	1.527	11.285	9.821	15.307	-9.758	-8.294	-13.780	-0.018	-0.016	-0.015	
06/14 07:30		0.244	3.094	0.320	1.547	11.292	9.831	15.317	-9.745	-8.284	-13.770	-0.005	-0.006	-0.005	
06/14 07:36		0.244	3.094	0.340	1.567	11.301	9.838	15.326	-9.734	-8.271	-13.759	0.006	0.007	0.006	
06/14 07:42		0.244	3.094	0.350	1.577	11.310	9.845	15.333	-9.733	-8.268	-13.756	0.007	0.010	0.009	
06/14 07:48		0.244	3.094	0.350	1.577	11.321	9.859	15.348	-9.744	-8.282	-13.771	-0.004	-0.004	-0.006	
06/14 07:54		2719 A	0.244	3.094	0.360	1.587	11.332	9.871	15.359	-9.745	-8.284	-13.772	-0.005	-0.006	-0.007

Observed by: B. Macdonald, P. Pack, K. Nildon, B. Poulson average: -9.741 -8.278 -13.765
 Computed by: N. Wardwell stdev: 0.012 0.012 0.012
 Notes: Wave height 0.0-0.5 (calm, low swell) meters count: 15 15 15

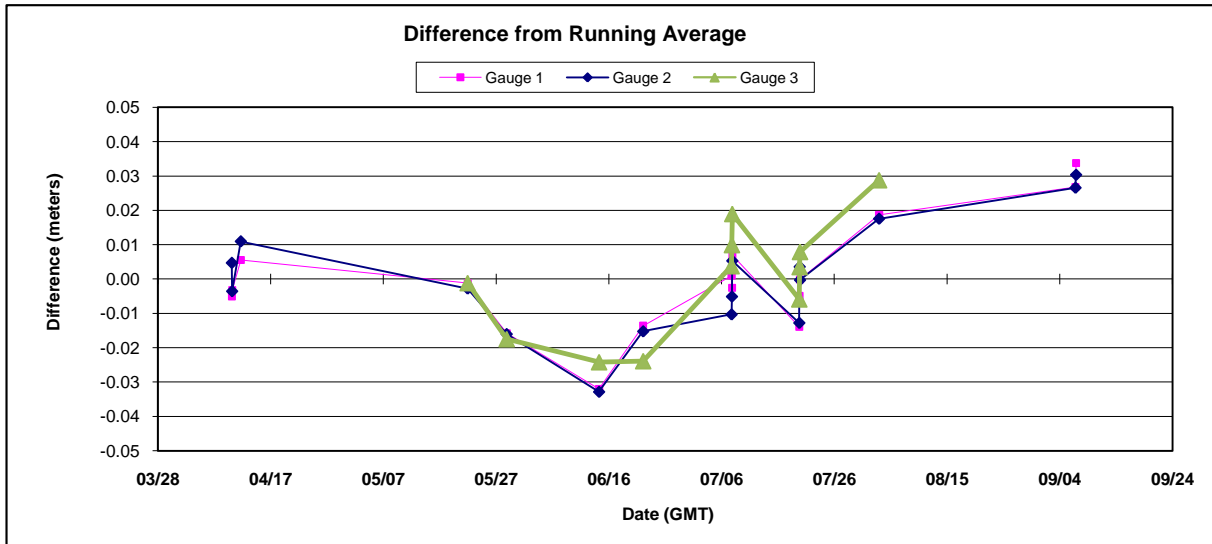
Summary of Staff Observations on Historic Station Datum

Akun Bay, Alaska

946-2719

	Gauge 1	Gauge 2	Gauge 3
Average	-9.709	-8.245	-13.741
St Dev	0.016	0.016	0.017
Count	16	16	11

Date (2009)	Gauge 1	Gauge 2	Gauge 3	Gauge 1 N	Gauge 2 N	Gauge 3 N
04/10	-9.714	-8.241	-13.384	11	11	11
04/10	-9.712	-8.249	-13.405	7	7	7
04/11	-9.703	-8.234	-13.397	10	10	10
05/21	-9.710	-8.248	-13.742	15	15	15
05/28	-9.724	-8.261	-13.758	10	10	10
06/14	-9.741	-8.278	-13.765	15	15	15
06/22	-9.722	-8.261	-13.765	20	20	20
07/07	-9.708	-8.256	-13.737	15	15	15
07/07	-9.711	-8.250	-13.731	15	15	15
07/07	-9.702	-8.240	-13.722	14	14	14
07/19	-9.722	-8.258	-13.747	15	15	15
07/19	-9.713	-8.242	-13.737	15	15	15
07/19	-9.709	-8.246	-13.733	11	11	11
08/02	-9.690	-8.228	-13.712	31	31	31
09/06	-9.682	-8.219	-13.644	20	20	20
09/06	-9.675	-8.215	-13.634	7	6	7



Note 1: All staff constants on this sheet were computed using raw water level readings from the tide gauges but staff readings relative to historic station datum. The average staff constants represent the value that must be added to each of the tide gauges' raw water level readings to produce station datum tide readings.

Note 2: Bold values are not used in the determination of the final staff constant.

Note 3: Gauge 3 is a Seabird SBE 26+ submersible with Paros Scientific sensor. The raw pressure readings measured during the installation and demobilization staff shots are corrected using barometric pressure measured at the King Cove NWLON. The raw pressure readings from 4/27/09 23:00 to 9/4/09 23:00 are corrected using barometric pressure measured at Scotch Cap. King Cove and Scotch Cap are 227 and 55 kilometers from the Akun tide station, respectively. Based on the staff shots and gauge to gauge comparisons barometric pressure measured at King Cove and Scotch Cap is significantly different. Thus, the install and demob staff shots for Gauge 3 are omitted from the determination of the final staff constant for Gauge 3.

Staff Shot Observations on Historic Station Datum Akun Bay, Alaska 946-2719

2719 A Elev: 4.0768

Bold = Rejected
all values in meters
residuals greater than 3cm are rejected

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual					
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3			
04/10 03:18	2719 A	0.342															
04/10 03:24		0.342	2.850	0.15	1.719	11.457	9.983	15.122	-9.738	-8.264	-13.403	-0.025	-0.024	-0.019			
04/10 03:30		0.342	2.875	0.19	1.734	11.468	9.994	15.134	-9.734	-8.260	-13.400	-0.021	-0.020	-0.016			
04/10 03:36		0.342	2.875	0.20	1.744	11.470	9.997	15.138	-9.726	-8.253	-13.394	-0.013	-0.013	-0.010			
04/10 03:42		0.342	2.875	0.23	1.774	11.469	9.996	15.138	-9.695	-8.222	-13.364	0.018	0.018	0.020			
04/10 03:48		0.342	3.050	0.39	1.759	11.467	9.993	15.137	-9.708	-8.234	-13.378	0.005	0.006	0.006			
04/10 03:54		0.342	2.905	0.27	1.784	11.478	10.005	15.146	-9.694	-8.221	-13.362	0.019	0.019	0.022			
04/10 04:00		0.342	3.145	0.50	1.774	11.480	10.009	15.152	-9.706	-8.235	-13.378	0.007	0.005	0.006			
04/10 04:06		0.342	3.145	0.50	1.774	11.486	10.014	15.160	-9.712	-8.240	-13.386	0.001	0.000	-0.002			
04/10 04:12		0.342	3.045	0.39	1.764	11.479	10.007	15.154	-9.715	-8.243	-13.390	-0.002	-0.003	-0.006			
04/10 04:18		0.342	3.155	0.50	1.764	11.478	10.006	15.153	-9.714	-8.242	-13.389	-0.001	-0.002	-0.005			
04/10 04:24		2719 A	0.342	3.145	0.50	1.774	11.479	10.005	15.156	-9.705	-8.231	-13.382	0.008	0.009	0.002		

Observed by: M. Ewing

average:

-9.714 -8.241 -13.384

Computed by: N. Wardwell

stdev:

0.014 0.014 0.013

Notes: Install staff shots. 1m offset removed from Gauge 1 readings

count:

11 11 11

Date in Gauge 1 was off by one day i.e it read 4/10/09 instead of 4/11/09

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
04/10 04:30	2719 A	0.342	3.120	0.42	1.719	11.477	10.005	15.154	-9.758	-8.286	-13.435	-0.046	-0.037	-0.030	
04/10 04:36		0.342	3.127	0.47	1.762	11.466	9.996	15.149	-9.704	-8.234	-13.387	0.008	0.015	0.018	
04/10 04:42		0.342	3.140	0.47	1.749	11.464	9.993	15.147	-9.715	-8.244	-13.398	-0.003	0.005	0.007	
04/10 04:48															
04/10 04:54		0.342	3.120	0.42	1.719	11.465	9.989	15.147	-9.746	-8.270	-13.428	-0.034	-0.021	-0.023	
04/10 05:00		0.342	3.150	0.53	1.799	11.465	9.994	15.148	-9.666	-8.195	-13.349	0.046	0.054	0.056	
04/10 05:06		0.342	3.090	0.40	1.729	11.447	9.974	15.131	-9.718	-8.245	-13.402	-0.006	0.004	0.003	
04/10 05:12		0.342	3.130	0.43	1.719	11.446	9.974	15.131	-9.727	-8.255	-13.412	-0.015	-0.006	-0.007	
04/10 05:18		0.342	3.050	0.37	1.739	11.452	9.981	15.138	-9.713	-8.242	-13.399	-0.001	0.007	0.006	
04/10 05:24		0.342	3.050	0.35	1.719	11.441	9.970	15.129	-9.722	-8.251	-13.410	-0.010	-0.002	-0.005	
04/10 05:30		2719 A	0.342	3.125	0.47	1.764	11.446	9.975	15.133	-9.682	-8.211	-13.369	0.030	0.038	0.036

Observed by: M. Ewing

average:

-9.712 -8.249 -13.405

Computed by: N. Wardwell

stdev:

0.015 0.012 0.013

Notes: Install staff shots. 1m offset removed from Gauge 1 readings

count:

7 7 7

Date in Gauge 1 was off by one day i.e it read 4/10/09 instead of 4/11/09

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
04/11 17:18	2719 A	0.353	3.427	0.395	1.398	11.092	9.623	14.796	-9.694	-8.225	-13.398	0.009	0.009	-0.001	
04/11 17:24		0.353	3.386	0.33	1.374	11.078	9.610	14.788	-9.704	-8.236	-13.414	-0.001	-0.002	-0.017	
04/11 17:30		0.353	3.408	0.34	1.362	11.070	9.601	14.778	-9.708	-8.239	-13.416	-0.005	-0.005	-0.019	
04/11 17:36		0.353	3.408	0.36	1.382	11.063	9.593	14.759	-9.681	-8.211	-13.377	0.022	0.023	0.020	
04/11 17:42		0.353	3.409	0.32	1.341	11.046	9.578	14.741	-9.705	-8.237	-13.400	-0.002	-0.003	-0.003	
04/11 17:48		0.353	3.386	0.29	1.334	11.032	9.564	14.727	-9.698	-8.230	-13.393	0.005	0.004	0.004	
04/11 17:54		0.353	3.407	0.29	1.313	11.022	9.553	14.717	-9.709	-8.240	-13.404	-0.006	-0.006	-0.007	
04/11 18:00		0.353	3.408	0.28	1.302	11.004	9.535	14.698	-9.702	-8.233	-13.396	0.001	0.001	0.001	
04/11 18:06		0.353	3.407	0.27	1.293	11.001	9.533	14.674	-9.708	-8.240	-13.381	-0.005	-0.006	0.016	
04/11 18:12		2719 A	0.353	3.409	0.25	1.271	10.990	9.522	14.661	-9.719	-8.251	-13.390	-0.016	-0.017	0.007

Observed by: N. Wardwell

average:

-9.703 -8.234 -13.397

Computed by: N. Wardwell

stdev:

0.010 0.011 0.013

Notes: Last set of install staff shots

count:

10 10 10

**Staff Shot Observations on Historic Station Datum
Akun Bay, Alaska
946-2719**

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual		
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3
06/22 02:24	2719 A	0.175	3.072	0.480	1.660	11.370	9.908	15.416	-9.710	-8.248	-13.756	0.012	0.012	0.008
06/22 02:30		0.175	3.072	0.475	1.655	11.386	9.925	15.429	-9.731	-8.270	-13.774	-0.009	-0.010	-0.010
06/22 02:36		0.175	3.072	0.485	1.665	11.392	9.931	15.436	-9.727	-8.266	-13.771	-0.005	-0.006	-0.007
06/22 02:42		0.175	3.072	0.500	1.680	11.405	9.944	15.448	-9.725	-8.264	-13.768	-0.003	-0.004	-0.004
06/22 02:48		0.175	3.072	0.505	1.685	11.409	9.949	15.454	-9.724	-8.264	-13.769	-0.002	-0.004	-0.005
06/22 02:54		0.175	3.072	0.515	1.695	11.422	9.961	15.464	-9.727	-8.266	-13.769	-0.005	-0.006	-0.005
06/22 03:00		0.175	3.072	0.535	1.715	11.431	9.970	15.475	-9.716	-8.255	-13.760	0.006	0.005	0.004
06/22 03:06		0.175	3.072	0.555	1.735	11.455	9.995	15.497	-9.720	-8.260	-13.762	0.002	0.000	0.002
06/22 03:12		0.175	3.072	0.550	1.730	11.443	9.980	15.486	-9.713	-8.250	-13.756	0.009	0.010	0.008
06/22 03:18		0.175	3.072	0.560	1.740	11.462	10.000	15.505	-9.722	-8.260	-13.765	0.000	0.000	-0.001
06/22 03:24		0.175	3.072	0.570	1.750	11.476	10.014	15.519	-9.726	-8.264	-13.769	-0.004	-0.004	-0.005
06/22 03:30		0.175	3.072	0.580	1.760	11.482	10.019	15.525	-9.722	-8.259	-13.765	0.000	0.001	-0.001
06/22 03:36		0.175	3.072	0.570	1.750	11.485	10.023	15.528	-9.735	-8.273	-13.778	-0.013	-0.013	-0.014
06/22 03:42		0.175	3.072	0.590	1.770	11.490	10.028	15.532	-9.720	-8.258	-13.762	0.002	0.002	0.002
06/22 03:48		0.175	3.072	0.605	1.785	11.502	10.039	15.542	-9.717	-8.254	-13.757	0.005	0.006	0.007
06/22 03:54		0.175	3.072	0.610	1.790	11.506	10.045	15.547	-9.716	-8.255	-13.757	0.006	0.005	0.007
06/22 04:00		0.175	3.072	0.620	1.800	11.518	10.057	15.558	-9.718	-8.257	-13.758	0.004	0.003	0.006
06/22 04:06		0.175	3.072	0.620	1.800	11.521	10.059	15.561	-9.721	-8.259	-13.761	0.001	0.001	0.003
06/22 04:12		0.175	3.072	0.620	1.800	11.520	10.059	15.560	-9.720	-8.259	-13.760	0.002	0.001	0.004
06/22 04:18		2719 A	0.175	3.072	0.615	1.795	11.524	10.062	15.564	-9.729	-8.267	-13.769	-0.007	-0.007

Observed by: J. Hazen, L. Gates, J. Dorfman

average: -9.722 -8.261 -13.765

Computed by: N. Wardwell

stdev: 0.006 0.006 0.006

Notes: Wave height 0.1-0.4 meters, winds 5-10 kts, seas calm

count: 20 20 20

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
07/07 18:42	2719 A	0.237	3.873	0.405	0.846	10.542	9.090	14.569	-9.696	-8.244	-13.723	0.011	0.011	0.014	
07/07 18:48		0.237	3.873	0.385	0.826	10.516	9.066	14.546	-9.690	-8.240	-13.720	0.017	0.015	0.017	
07/07 18:54		0.237	3.873	0.350	0.791	10.497	9.044	14.527	-9.706	-8.253	-13.736	0.001	0.002	0.001	
07/07 19:00		0.237	3.873	0.345	0.786	10.491	9.039	14.521	-9.705	-8.253	-13.735	0.002	0.002	0.002	
07/07 19:06		0.237	3.873	0.340	0.781	10.487	9.034	14.516	-9.706	-8.253	-13.735	0.001	0.002	0.002	
07/07 19:12		0.237	3.873	0.338	0.779	10.482	9.030	14.510	-9.703	-8.251	-13.731	0.004	0.004	0.006	
07/07 19:18		0.237	3.873	0.305	0.746	10.452	9.000	14.482	-9.706	-8.254	-13.736	0.001	0.001	0.001	
07/07 19:24		0.237	3.873	0.305	0.746	10.449	8.997	14.480	-9.703	-8.251	-13.734	0.004	0.004	0.003	
07/07 19:30		0.237	3.873	0.280	0.721	10.427	8.974	14.458	-9.706	-8.253	-13.737	0.001	0.002	0.000	
07/07 19:36		0.237	3.873	0.280	0.721	10.440	8.988	14.469	-9.719	-8.267	-13.748	-0.012	-0.012	-0.011	
07/07 19:42		0.237	3.873	0.280	0.721	10.430	8.978	14.460	-9.709	-8.257	-13.739	-0.002	-0.002	-0.002	
07/07 19:48		0.237	3.873	0.250	0.691	10.413	8.962	14.442	-9.722	-8.271	-13.751	-0.015	-0.016	-0.014	
07/07 19:54		0.237	3.873	0.250	0.691	10.406	8.955	14.435	-9.715	-8.264	-13.744	-0.008	-0.009	-0.007	
07/07 20:00		0.237	3.873	0.250	0.691	10.397	8.945	14.426	-9.706	-8.254	-13.735	0.001	0.001	0.002	
07/07 20:06		2719 A	0.237	3.873	0.250	0.691	10.409	8.958	14.437	-9.718	-8.267	-13.746	-0.011	-0.012	-0.009

Observed by: P. Pack, M. Krynytzky, L. Bennett, J. Hazen, L. Gates

average: -9.708 -8.256 -13.737

Computed by: N. Wardwell

stdev: 0.008 0.009 0.008

Notes: Wave height 0.0-0.5 meters, wind 5-10 knots, seas calm

count: 15 15 15

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
07/07 20:12	2719 A	0.237	3.873	0.258	0.699	10.416	8.955	14.435	-9.717	-8.256	-13.736	-0.006	-0.006	-0.005	
07/07 20:18		0.237	3.873	0.265	0.706	10.420	8.961	14.439	-9.714	-8.255	-13.733	-0.003	-0.005	-0.002	
07/07 20:24		0.237	3.873	0.240	0.681	10.400	8.938	14.418	-9.719	-8.257	-13.737	-0.008	-0.007	-0.006	
07/07 20:30		0.237	3.873	0.250	0.691	10.401	8.940	14.422	-9.710	-8.249	-13.731	0.001	0.001	0.000	
07/07 20:36		0.237	3.873	0.260	0.701	10.411	8.950	14.429	-9.710	-8.249	-13.728	0.001	0.001	0.003	
07/07 20:42		0.237	3.873	0.250	0.691	10.403	8.943	14.423	-9.712	-8.252	-13.732	-0.001	-0.002	-0.001	
07/07 20:48		0.237	3.873	0.250	0.691	10.407	8.948	14.426	-9.716	-8.257	-13.735	-0.005	-0.007	-0.004	
07/07 20:54		0.237	3.873	0.245	0.686	10.409	8.949	14.428	-9.723	-8.263	-13.742	-0.012	-0.013	-0.011	
07/07 21:00		0.237	3.873	0.240	0.681	10.395	8.934	14.415	-9.714	-8.253	-13.734	-0.003	-0.003	-0.003	
07/07 21:06		0.237	3.873	0.260	0.701	10.414	8.953	14.431	-9.713	-8.252	-13.730	-0.002	-0.002	0.001	
07/07 21:12		0.237	3.873	0.250	0.691	10.400	8.940	14.422	-9.709	-8.249	-13.731	0.002	0.001	0.000	
07/07 21:18		0.237	3.873	0.265	0.706	10.411	8.950	14.432	-9.705	-8.244	-13.726	0.006	0.006	0.005	
07/07 21:24		0.237	3.873	0.300	0.741	10.430	8.970	14.450	-9.689	-8.229	-13.709	0.022	0.021	0.022	
07/07 21:30		0.237	3.873	0.285	0.726	10.437	8.976	14.458	-9.711	-8.250	-13.732	0.000	0.000	-0.001	
07/07 21:36		2719 A	0.237	3.873	0.285	0.726	10.428	8.965	14.448	-9.702	-8.239	-13.722	0.009	0.011	0.009

Observed by: P. Pack, M. Krynytzky, L. Bennett, J. Hazen, L. Gates

average: -9.711 -8.250 -13.731

Computed by: N. Wardwell

stdev: 0.008 0.008 0.008

Notes: Wave height 0.0-0.5 meters, wind 5-10 knots, seas calm

count: 15 15 15

**Staff Shot Observations on Historic Station Datum
Akun Bay, Alaska
946-2719**

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
07/07 21:42	2719 A	0.237	3.873	0.300	0.741	10.444	8.983	14.464	-9.703	-8.242	-13.723	-0.002	-0.002	-0.002	
07/07 21:48		0.237	3.873	0.320	0.761	10.467	9.004	14.484	-9.706	-8.243	-13.723	-0.005	-0.003	-0.002	
07/07 21:54		0.237	3.873	0.320	0.761	10.472	9.012	14.492	-9.711	-8.251	-13.731	-0.010	-0.011	-0.010	
07/07 22:00		0.237	3.873	0.328	0.769	10.474	9.013	14.491	-9.705	-8.244	-13.722	-0.004	-0.004	-0.001	
07/07 22:06		0.237	3.873	0.325	0.766	10.472	9.010	14.494	-9.706	-8.244	-13.728	-0.005	-0.004	-0.007	
07/07 22:12		0.237	3.873	0.343	0.784	10.484	9.022	14.503	-9.700	-8.238	-13.719	0.001	0.002	0.002	
07/07 22:18		0.237	3.873	0.375	0.816	10.512	9.049	14.530	-9.696	-8.233	-13.714	0.005	0.007	0.008	
07/07 22:24		0.237	3.873	0.373	0.814	10.519	9.058	14.539	-9.705	-8.244	-13.725	-0.004	-0.004	-0.004	
07/07 22:30		0.237	3.873	0.370	0.811	10.508	9.046	14.529	-9.697	-8.235	-13.718	0.004	0.005	0.003	
07/07 22:36		0.237	3.873	0.392	0.833	10.531	9.070	14.551	-9.698	-8.237	-13.718	0.003	0.003	0.003	
07/07 22:42		0.237	3.873	0.385	0.826	10.534	9.071	14.556	-9.708	-8.245	-13.730	-0.007	-0.005	-0.008	
07/07 22:48		0.237	3.873	0.410	0.851	10.556	9.095	14.578	-9.705	-8.244	-13.727	-0.004	-0.004	-0.006	
07/07 22:54		0.237	3.873	0.418	0.859	10.557	9.095	14.578	-9.698	-8.236	-13.719	0.003	0.004	0.002	
07/07 23:00		2719 A	0.237	3.873	0.450	0.891	10.573	9.113	14.595	-9.682	-8.222	-13.704	0.019	0.018	0.017

Observed by: P. Pack, M. Krynytzky, L. Bennett, J. Hazen, L. Gates
 Computed by: N. Wardwell
 Notes: Wave height 0.0-0.5 meters, wind 5-10 knots, seas calm

average:	-9.702	-8.240	-13.722
stdev:	0.007	0.007	0.007
count:	14	14	14

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
07/19 19:00	2719 A	0.137	3.880	0.200	0.534	10.258	8.794	14.283	-9.724	-8.260	-13.749	-0.002	-0.002	-0.003	
07/19 19:06		0.137	3.880	0.215	0.549	10.276	8.812	14.302	-9.727	-8.263	-13.753	-0.005	-0.005	-0.007	
07/19 19:12		0.137	3.880	0.240	0.574	10.293	8.829	14.317	-9.719	-8.255	-13.743	0.003	0.003	0.003	
07/19 19:18		0.137	3.880	0.255	0.589	10.311	8.848	14.336	-9.722	-8.259	-13.747	0.000	-0.001	-0.001	
07/19 19:24		0.137	3.880	0.260	0.594	10.327	8.863	14.351	-9.733	-8.269	-13.757	-0.011	-0.011	-0.011	
07/19 19:30		0.137	3.880	0.285	0.619	10.340	8.877	14.365	-9.721	-8.258	-13.746	0.001	0.000	0.000	
07/19 19:36		0.137	3.880	0.295	0.629	10.350	8.886	14.375	-9.721	-8.257	-13.746	0.001	0.001	0.000	
07/19 19:42		0.137	3.880	0.300	0.634	10.359	8.894	14.384	-9.725	-8.260	-13.750	-0.003	-0.002	-0.004	
07/19 19:48		0.137	3.880	0.335	0.669	10.386	8.923	14.409	-9.717	-8.254	-13.740	0.005	0.004	0.006	
07/19 19:54		0.137	3.880	0.345	0.679	10.404	8.939	14.428	-9.725	-8.260	-13.749	-0.003	-0.002	-0.003	
07/19 20:00		0.137	3.880	0.360	0.694	10.411	8.945	14.436	-9.717	-8.251	-13.742	0.005	0.007	0.004	
07/19 20:06		0.137	3.880	0.390	0.724	10.436	8.971	14.460	-9.712	-8.247	-13.736	0.010	0.011	0.010	
07/19 20:12		0.137	3.880	0.395	0.729	10.448	8.984	14.473	-9.719	-8.255	-13.744	0.003	0.003	0.002	
07/19 20:18		0.137	3.880	0.415	0.749	10.472	9.007	14.492	-9.723	-8.258	-13.743	-0.001	0.000	0.003	
07/19 20:24		2719 A	0.137	3.880	0.420	0.754	10.483	9.017	14.504	-9.729	-8.263	-13.750	-0.007	-0.005	-0.004

Observed by: B. Wodarek, M. Krynytzky, P. McCarthy, L. Gates, P. Pack,
 V. Pascal
 Computed by: N. Wardwell
 Notes: Wave height 0 meters

average:	-9.722	-8.258	-13.747
stdev:	0.005	0.005	0.005
count:	15	15	15

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
07/19 20:30	2719 A	0.144	3.886	0.460	0.795	10.504	9.032	14.526	-9.709	-8.237	-13.731	0.004	0.005	0.006	
07/19 20:36		0.144	3.886	0.500	0.835	10.541	9.068	14.560	-9.706	-8.233	-13.725	0.007	0.009	0.012	
07/19 20:42		0.144	3.886	0.505	0.840	10.553	9.079	14.573	-9.713	-8.239	-13.733	0.000	0.003	0.004	
07/19 20:48		0.144	3.886	0.520	0.855	10.569	9.098	14.590	-9.714	-8.243	-13.735	-0.001	-0.001	0.002	
07/19 20:54		0.144	3.886	0.520	0.855	10.583	9.113	14.605	-9.728	-8.258	-13.750	-0.015	-0.016	-0.013	
07/19 21:00		0.144	3.886	0.570	0.905	10.620	9.149	14.641	-9.715	-8.244	-13.736	-0.002	-0.002	0.001	
07/19 21:06		0.144	3.886	0.600	0.935	10.646	9.175	14.669	-9.711	-8.240	-13.734	0.002	0.002	0.003	
07/19 21:12		0.144	3.886	0.620	0.955	10.665	9.193	14.689	-9.710	-8.238	-13.734	0.003	0.004	0.003	
07/19 21:18		0.144	3.886	0.635	0.970	10.679	9.207	14.703	-9.709	-8.237	-13.733	0.004	0.005	0.004	
07/19 21:24		0.144	3.886	0.645	0.980	10.696	9.225	14.722	-9.716	-8.245	-13.742	-0.003	-0.003	-0.005	
07/19 21:30		0.144	3.886	0.665	1.000	10.714	9.244	14.741	-9.714	-8.244	-13.741	-0.001	-0.002	-0.004	
07/19 21:36		0.144	3.886	0.670	1.005	10.723	9.251	14.750	-9.718	-8.246	-13.745	-0.005	-0.004	-0.008	
07/19 21:42		0.144	3.886	0.700	1.035	10.755	9.283	14.780	-9.720	-8.248	-13.745	-0.007	-0.006	-0.008	
07/19 21:48		0.144	3.886	0.745	1.080	10.779	9.307	14.806	-9.699	-8.227	-13.726	0.014	0.015	0.011	
07/19 21:54		2719 A	0.144	3.886	0.745	1.080	10.797	9.325	14.824	-9.717	-8.245	-13.744	-0.004	-0.003	-0.007

Observed by: B. Wodarek, M. Krynytzky, P. McCarthy, L. Gates, P. Pack,
 V. Pascal
 Computed by: N. Wardwell
 Notes: Wave height 0 meters

average:	-9.713	-8.242	-13.737
stdev:	0.007	0.007	0.007
count:	15	15	15

Staff Shot Observations on Historic Station Datum Akun Bay, Alaska 946-2719

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual		
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3
07/19 22:00	2719 A	0.144	3.886	0.780	1.115	10.823	9.359	14.846	-9.708	-8.244	-13.731	0.000	0.001	0.002
07/19 22:06		0.144	3.886	0.790	1.125	10.838	9.375	14.862	-9.713	-8.250	-13.737	-0.005	-0.005	-0.004
07/19 22:12		0.144	3.886	0.815	1.150	10.854	9.392	14.880	-9.704	-8.242	-13.730	0.004	0.003	0.003
07/19 22:18		0.144	3.886	0.825	1.160	10.881	9.418	14.905	-9.721	-8.258	-13.745	-0.013	-0.013	-0.012
07/19 22:24		0.144	3.886	0.850	1.185	10.891	9.427	14.914	-9.706	-8.242	-13.729	0.002	0.003	0.004
07/19 22:30		0.144	3.886	0.890	1.225	10.920	9.457	14.945	-9.695	-8.232	-13.720	0.013	0.013	0.013
07/19 22:36		0.144	3.886	0.885	1.220	10.928	9.464	14.953	-9.708	-8.244	-13.733	0.000	0.001	0.000
07/19 22:42		0.144	3.886	0.905	1.240	10.951	9.487	14.974	-9.711	-8.247	-13.734	-0.003	-0.002	-0.001
07/19 22:48		0.144	3.886	0.930	1.265	10.970	9.507	14.993	-9.705	-8.242	-13.728	0.003	0.003	0.005
07/19 22:54		0.144	3.886	0.950	1.285	10.992	9.531	15.016	-9.707	-8.246	-13.731	0.001	-0.001	0.002
07/19 23:00	2719 A	0.144	3.886	0.955	1.290	11.005	9.543	15.030	-9.715	-8.253	-13.740	-0.007	-0.008	-0.007

Observed by: B. Wodarek, M. Krynytzky, P. McCarthy, L. Gates, P. Pack, V. Pascal

average: -9.709 -8.246 -13.733
stdev: 0.007 0.007 0.007
count: 11 11 11

Computed by: N. Wardwell

Notes: Wave height 0 meters

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
08/02 22:36	2719 A	0.585	3.508	0.160	1.314	10.981	9.518	14.999	-9.667	-8.204	-13.685	0.023	0.024	0.027	
08/02 22:42		0.585	3.508	0.170	1.324	11.009	9.547	15.025	-9.685	-8.223	-13.701	0.005	0.005	0.011	
08/02 22:48		0.585	3.508	0.170	1.324	11.009	9.546	15.029	-9.685	-8.222	-13.705	0.005	0.006	0.007	
08/02 22:54		0.585	3.508	0.180	1.334	11.034	9.573	15.054	-9.700	-8.239	-13.720	-0.010	-0.011	-0.008	
08/02 23:00		0.585	3.508	0.190	1.344	11.045	9.584	15.065	-9.701	-8.240	-13.721	-0.011	-0.012	-0.009	
08/02 23:06		0.585	3.508	0.200	1.354	11.061	9.599	15.080	-9.707	-8.245	-13.726	-0.017	-0.017	-0.014	
08/02 23:12		0.585	3.508	0.210	1.364	11.077	9.615	15.094	-9.713	-8.251	-13.730	-0.023	-0.023	-0.018	
08/02 23:18		0.585	3.508	0.230	1.384	11.092	9.632	15.111	-9.708	-8.248	-13.727	-0.018	-0.020	-0.015	
08/02 23:24		0.585	3.508	0.260	1.414	11.105	9.644	15.125	-9.691	-8.230	-13.711	-0.001	-0.002	0.001	
08/02 23:30		0.585	3.508	0.280	1.434	11.117	9.653	15.137	-9.683	-8.219	-13.703	0.007	0.009	0.009	
08/02 23:36		0.585	3.508	0.300	1.454	11.137	9.675	15.158	-9.683	-8.221	-13.704	0.007	0.007	0.008	
08/02 23:42		0.585	3.508	0.320	1.474	11.151	9.689	15.173	-9.677	-8.215	-13.699	0.013	0.013	0.013	
08/02 23:48		0.585	3.508	0.325	1.479	11.162	9.701	15.182	-9.683	-8.222	-13.703	0.007	0.006	0.009	
08/02 23:54		0.585	3.508	0.350	1.504	11.181	9.720	15.202	-9.677	-8.216	-13.698	0.013	0.012	0.014	
08/03 00:00		0.585	3.508	0.362	1.516	11.197	9.738	15.220	-9.681	-8.222	-13.704	0.009	0.006	0.008	
08/03 00:06		0.585	3.508	0.375	1.529	11.215	9.755	15.237	-9.686	-8.226	-13.708	0.004	0.002	0.004	
08/03 00:12		0.585	3.508	0.380	1.534	11.220	9.758	15.243	-9.686	-8.224	-13.709	0.004	0.004	0.003	
08/03 00:18		0.585	3.508	0.405	1.559	11.226	9.763	15.249	-9.667	-8.204	-13.690	0.023	0.024	0.022	
08/03 00:24		0.585	3.508	0.430	1.584	11.235	9.773	15.257	-9.651	-8.189	-13.673	0.039	0.039	0.039	
08/03 00:30		0.585	3.508	0.425	1.579	11.263	9.800	15.284	-9.684	-8.221	-13.705	0.006	0.007	0.007	
08/03 00:36		0.585	3.508	0.440	1.594	11.262	9.799	15.286	-9.668	-8.205	-13.692	0.022	0.023	0.020	
08/03 00:42		0.585	3.508	0.450	1.604	11.274	9.813	15.298	-9.670	-8.209	-13.694	0.020	0.019	0.018	
08/03 00:48		0.585	3.508	0.450	1.604	11.284	9.822	15.308	-9.680	-8.218	-13.704	0.010	0.010	0.008	
08/03 00:54		0.585	3.508	0.450	1.604	11.292	9.829	15.318	-9.688	-8.225	-13.714	0.002	0.003	-0.002	
08/03 01:00		0.585	3.508	0.455	1.609	11.302	9.841	15.330	-9.693	-8.232	-13.721	-0.003	-0.004	-0.009	
08/03 01:06		0.585	3.508	0.465	1.619	11.316	9.855	15.340	-9.697	-8.236	-13.721	-0.007	-0.008	-0.009	
08/03 01:12		0.585	3.508	0.470	1.624	11.330	9.868	15.354	-9.706	-8.244	-13.730	-0.016	-0.016	-0.018	
08/03 01:18		0.585	3.508	0.475	1.629	11.332	9.868	15.358	-9.703	-8.239	-13.729	-0.013	-0.011	-0.017	
08/03 01:24		0.585	3.508	0.450	1.604	11.350	9.887	15.373	-9.746	-8.283	-13.769	-0.056	-0.055	-0.057	
08/03 01:30		0.585	3.508	0.480	1.634	11.345	9.880	15.371	-9.711	-8.246	-13.737	-0.021	-0.018	-0.025	
08/03 01:36		2719 A	0.585	3.508	0.500	1.654	11.357	9.892	15.383	-9.703	-8.238	-13.729	-0.013	-0.010	-0.017

Observed by: P. McCarthy

average: -9.690 -8.228 -13.712
stdev: 0.018 0.018 0.018
count: 31 31 31

Computed by: N. Wardwell

Notes: Wave height 0.1 meters, swells 0.25-0.5 meters, calm winds

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual			
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	
09/06 18:42	2719 A	0.435	3.376	0.350	1.486	11.166	9.703	15.129	-9.680	-8.217	-13.643	0.002	0.002	0.001	
09/06 18:48		3.377	0.360	1.495	11.155	9.691	15.118	-9.660	-8.196	-13.623	0.022	0.023	0.021		
09/06 18:54		3.377	0.360	1.495	11.171	9.708	15.133	-9.676	-8.213	-13.638	0.006	0.006	0.006		
09/06 19:00		3.377	0.370	1.505	11.177	9.713	15.140	-9.672	-8.208	-13.635	0.010	0.011	0.009		
09/06 19:06		3.377	0.380	1.515	11.175	9.713	15.135	-9.660	-8.198	-13.620	0.022	0.021	0.024		
09/06 19:12		3.377	0.370	1.505	11.176	9.712	15.137	-9.671	-8.207	-13.632	0.011	0.012	0.012		
09/06 19:18		3.377	0.370	1.505	11.182	9.717	15.141	-9.677	-8.212	-13.636	0.005	0.007	0.008		
09/06 19:24		3.377	0.370	1.505	11.182	9.719	15.147	-9.677	-8.214	-13.642	0.005	0.005	0.002		
09/06 19:30		3.377	0.370	1.505	11.181	9.720	15.145	-9.676	-8.215	-13.640	0.006	0.004	0.004		
09/06 19:36		3.377	0.360	1.495	11.185	9.724	15.152	-9.690	-8.229	-13.657	-0.008	-0.010	-0.013		
09/06 19:42		3.377	0.370	1.505	11.197	9.732	15.157	-9.692	-8.227	-13.652	-0.010	-0.008	-0.008		
09/06 19:48		3.377	0.370	1.505	11.193	9.730	15.156	-9.688	-8.225	-13.651	-0.006	-0.006	-0.007		
09/06 19:54		3.377	0.350	1.485	11.195	9.734	15.158	-9.710	-8.249	-13.673	-0.028	-0.030	-0.029		
09/06 20:00		3.377	0.380	1.515	11.195	9.731	15.160	-9.680	-8.216	-13.645	0.002	0.003	-0.001		
09/06 20:06		3.377	0.380	1.515	11.223	9.761	15.184	-9.708	-8.246	-13.669	-0.026	-0.027	-0.025		
09/06 20:12		3.377	0.390	1.525	11.219	9.755	15.181	-9.694	-8.230	-13.656	-0.012	-0.011	-0.012		
09/06 20:18		3.377	0.410	1.545	11.229	9.768	15.190	-9.684	-8.223	-13.645	-0.002	-0.004	-0.001		
09/06 20:24		3.377	0.420	1.555	11.222	9.759	15.185	-9.667	-8.204	-13.630	0.015	0.015	0.014		
09/06 20:30		3.377	0.410	1.545	11.235	9.773	15.198	-9.690	-8.228	-13.653	-0.008	-0.009	-0.009		
09/06 20:36		2719 A	0.435	3.377	0.430	1.565	11.244	9.780	15.203	-9.679	-8.215	-13.638	0.003	0.004	0.006

Observed by: G. Gray

average: -9.682 -8.219 -13.644
stdev: 0.013 0.014 0.014
count: 20 20 20

Computed by: N. Wardwell

Notes: Rain and 30 kt winds, Staff shots taken in partially protected area rollers outside of area 1 to 1.5 meters, waves in area 0.1 to 0.2 meters

**Staff Shot Observations on Historic Station Datum
Akun Bay, Alaska
946-2719**

2719 A Elev: 4.0768

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading			Water Level minus Stage			Residual				
						Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3	Gauge 1	Gauge 2	Gauge 3		
09/06 21:12	2719 A	0.557	3.490	0.370	1.514	11.246	9.782	15.209	-9.732	-8.268	-13.695	-0.057	-0.053	-0.061		
09/06 21:18			3.490	0.440	1.584	11.249	9.785	15.208	-9.665	-8.201	-13.624	0.010	0.014	0.010		
09/06 21:24			3.575	0.360	1.419	11.252	9.789	15.207	-9.833	-8.370	-13.788	-0.158	-0.155	-0.154		
09/06 21:30			3.390	0.430	1.674	11.255	9.791	15.216	-9.581	-8.117	-13.542	0.094	0.098	0.092		
09/06 21:36			3.305	0.290	1.619	11.273	9.808	15.234	-9.654	-8.189	-13.615	0.021	0.026	0.019		
09/06 21:42			3.270	0.280	1.644	11.287	9.820	15.246	-9.643	-8.176	-13.602	0.032	0.039	0.032		
09/06 21:48			3.310	0.270	1.594	11.286	9.820	15.245	-9.692	-8.226	-13.651	-0.017	-0.011	-0.017		
09/06 21:54			3.335	0.340	1.639	11.279	9.814	15.242	-9.640	-8.175	-13.603	0.035	0.040	0.031		
09/06 22:00			2719 A	0.557	3.300	0.250	1.584	11.299	9.835	15.257	-9.715	-8.251	-13.673	-0.040	-0.036	-0.039
09/06 22:06					3.330	0.290	1.594	11.307	9.840	15.266	-9.713	-8.246	-13.672	-0.038	-0.031	-0.038

Observed by: G. Gray

Computed by: N. Wardwell

Notes: Rain and 30 kt winds, Staff shots taken in partially protected area

rollers outside of area 1 to 1.5 meters, waves in area 0.1 to 0.2 meters

average:

stdev:

count:

-9.675	-8.215	-13.634
0.032	0.031	0.031
7	6	7

Site Datum

Site Datum

2.892

PBM 9462719 TIDAL 1

PLANES

TBD

Highest Tide

TBD

MHW

TBD

MLLW

TBD

Lowest Tide

Orifice "0"

-9.856

Gauge 1¹

-8.389

Gauge 2¹

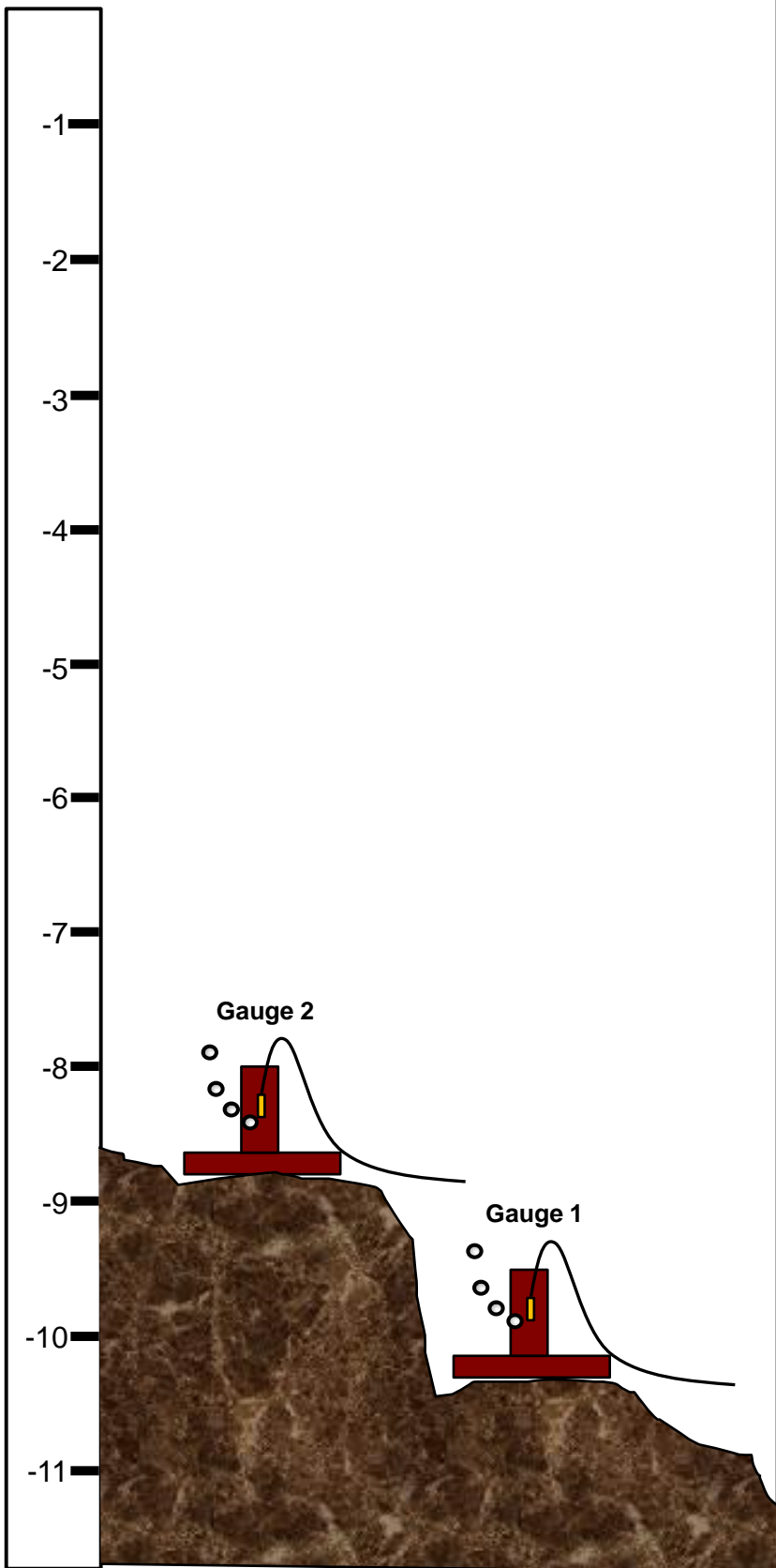
TBD

Gauge 3²

Notes: The elevations of the tide gauge orifices were determined through staff shots performed during the installation of the tide station.

1 – Gauges 1 and 2 are bubblers that are secured to separate anchors set approximately 130 meters offshore of the tide house.

2 – Gauge 3 is a SBE 26+ bottom mounted pressure sensor deployed as backup. The elevation of the SBE 26+ is yet TBD



JOA Surveys, LLC
 2000 E. Dowling Rd, #10
 Anchorage, AK 99507
 www.joasurveys.com

STATION:

Akun Bay, AK

REVISED

Drawn By:

N. Wardwell

Checked By:

Date:

4/10/09



9462719 A
Akun Island, AK
April 8, 2009

9462719 A 2009 face.jpg



9462719 A

9462719 A
Akun Island, AK
View north
April 8, 2009

9462719 A 2009 north.jpg



9462719 A
Akun Island, AK
View south
April 8, 2009

9462719 A

9462719 A south.JPG



9462719
Akun Island, AK
Bubbler Anchor
April 9, 2009

Orifice

9462719 bubbler anchor.jpg



9462719
Closeout levels
View NNE
September 5, 2009

9462719 Closeout Leveling NNE.jpg



9462719
Closeout Levels
View WNW
September 5, 2009

9462719 TIDAL 1

9462719 Closeout Leveling WNW.jpg



9462719
Gauge 3 (seabird)
September 7, 2009

9462719 Gauge 3 (seabird) acoustic modem.JPG



9462719
Gauge 3 (seabird)
September 7, 2009

9462719 Gauge 3 (seabird) anchor 2.JPG



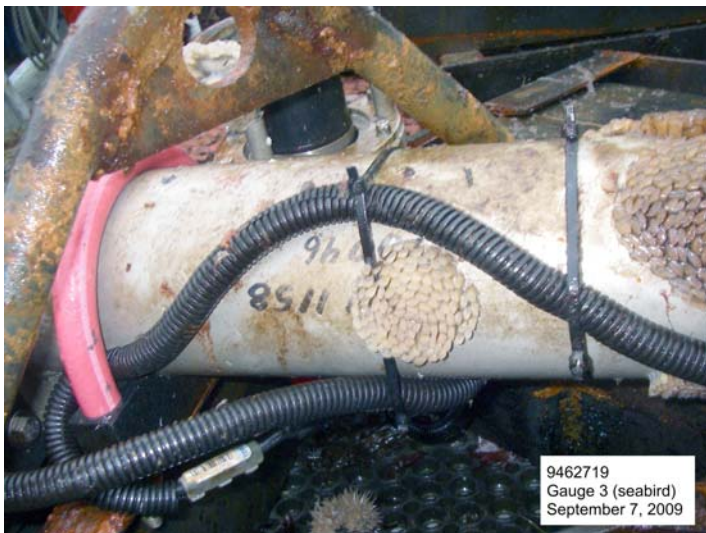
9462719
Gauge 3 (seabird)
September 7, 2009

9462719 Gauge 3 (seabird) anchor.JPG



9462719
Gauge 3 (seabird)
September 7, 2009

9462719 Gauge 3 (seabird) orifice.JPG



9462719
Gauge 3 (seabird)
September 7, 2009

9462719 Gauge 3 (seabird) serial number.JPG



9462719 Leveling NNE.JPG



9462719 Leveling WNW.JPG



9462719 seabird anchor and modem.jpg



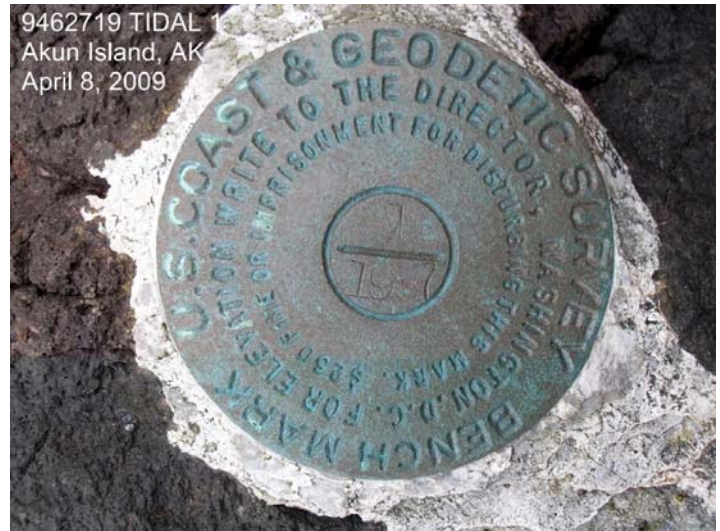
9462719 seabird anchor.jpg



9462719 Staff shots NNE 2.JPG



9462719 Staff Shots NNE.JPG



9462719 TIDAL 1 face.jpg

9462719 TIDAL 1
Akun Island, AK
View SW
April 8, 2009



9462719 TIDAL 2
Akun Island, AK
April 8, 2009



9462719 TIDAL 1 SW.jpg

9462719 TIDAL 2 face.jpg

9462719 TIDAL 2
Akun Island, AK
View NW
April 8, 2009



9462719 TIDAL 2 NW.jpg



9462719 TIDAL 2
Akun Island, AK
View west
April 8, 2009

9462719 TIDAL 2 west.jpg

9462719 TIDAL 3
Akun Island, AK
April 8, 2009



9462719 TIDAL 3 face.jpg

9462719 TIDAL 3
Akun Island, AK
View NE
April 8, 2009



9462719 TIDAL 3 NE.jpg



9462719 TIDAL 3
Akun Island, AK
View north
April 8, 2009

9462719 TIDAL 3 north.JPG



9462719 TIDAL 3
Akun Island, AK
View west
April 8, 2009

9462719 TIDAL 3 west.JPG



9462719 TIDAL 4
Akun Island, AK
View east
April 8, 2009

9462719 TIDAL 4 east.JPG



9462719 TIDAL 4
Akun Island, AK
April 8, 2009

9462719 TIDAL 4 face.jpg



9462719 TIDAL 4
Akun Island, AK
View south
April 8, 2009

9462719 TIDAL 4 south.JPG



9462719 TIDAL 4
Akun Island, AK
View west
April 8, 2009

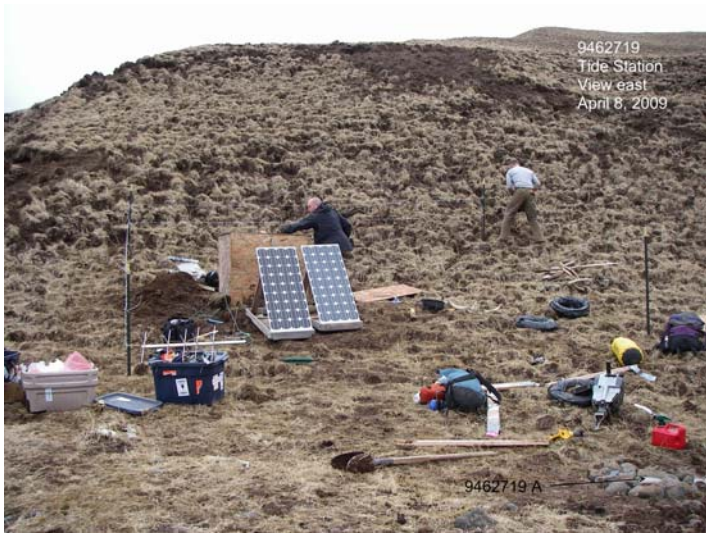
9462719 TIDAL 4 west.JPG



9462719 tide station.JPG



9462719 tidehouse 1.JPG



9462719 tidehouse 2.JPG



9462719 tidehouse closeup.jpg



9462719 Tidehouse NW.JPG



9462719 Tidehouse south.JPG

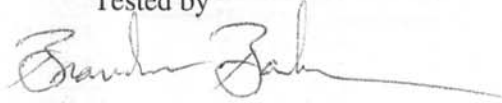
Certificate of Calibration

This certifies that your precision instrument met all of the specifications determined by tests performed on the date listed below. This instrument was subjected to extensive pre-qualifications. It was then calibrated using an automated test system over a period of approximately 20 hours followed by another 20 hour validation test.

WaterLOG calibration standards are traceable to the National Institute of Standards and Technology (NIST). The Model Number and Serial Number of the standard used are listed below.

The test data below is a sampling of the 150 actual data points taken during the pre-shipment validation test on this instrument.

Tested by



TEST REPORT

REPORT DATE: 02/10/2009
 DATE TESTED: 02/05/2009
 MODEL NUMBER: H350XL
 SERIAL NUMBER: S#003541
 NIST TRACEABLE REFERENCE: DH Instruments Model RPM1-G0030 SN40840

Reference Temp.	Measured Temp	Reference Press.	Measured Press.	Delta
-40.0	-40.0	0.001	0.001	0.000
-40.0	-39.9	4.470	4.470	0.000
-40.0	-39.9	8.946	8.945	0.001
-40.0	-39.9	17.947	17.947	0.000
-40.0	-39.9	26.946	26.946	0.000
-30.0	-30.0	1.445	1.447	-0.002
-30.0	-30.0	5.953	5.953	0.000
-30.0	-29.9	11.953	11.953	0.000
-30.0	-29.9	20.954	20.953	0.001
-30.0	-29.9	29.947	29.946	0.001
-20.0	-20.0	2.949	2.949	0.000
-20.0	-19.9	7.457	7.457	0.000
-20.0	-19.9	14.958	14.959	-0.001
-20.0	-19.9	23.964	23.965	-0.001
-9.9	-10.0	0.000	0.000	0.000
-10.1	-9.9	4.452	4.451	0.001

S#003541

12901 017

<i>Reference Temp.</i>	<i>Measured Temp</i>	<i>Reference Press.</i>	<i>Measured Press.</i>	<i>Delta</i>
-9.9	-9.9	8.961	8.960	0.001
-10.1	-9.9	17.964	17.964	0.000
-9.9	-9.9	26.965	26.966	-0.001
0.1	0.0	1.438	1.438	0.000
0.1	0.0	5.969	5.969	0.000
0.1	0.0	11.946	11.946	0.000
0.1	0.0	20.952	20.953	-0.001
-0.1	0.1	29.956	29.957	-0.001
10.1	10.0	2.962	2.962	0.000
9.9	10.0	7.468	7.469	-0.001
10.0	10.0	14.945	14.946	-0.001
10.1	10.0	23.963	23.963	0.000
20.1	19.9	0.000	0.000	0.000
19.9	20.0	4.465	4.465	0.000
20.1	20.0	8.969	8.970	-0.001
20.0	20.0	17.953	17.954	-0.001
20.0	20.0	26.951	26.953	-0.002
29.9	30.0	1.432	1.432	0.000
29.9	30.1	5.967	5.967	0.000
30.1	30.1	11.948	11.949	-0.001
30.1	30.1	20.945	20.946	-0.001
29.9	30.1	29.948	29.950	-0.002
39.9	40.0	2.962	2.962	0.000
39.9	40.0	7.468	7.469	-0.001
39.9	40.0	14.948	14.949	-0.001
39.9	40.0	23.949	23.950	-0.001
49.9	50.0	0.000	0.000	0.000
49.9	50.0	4.468	4.470	-0.002
50.1	50.1	8.948	8.949	-0.001
50.1	50.1	17.947	17.948	-0.001
50.0	50.1	26.947	26.948	-0.001
60.0	60.0	1.432	1.432	0.000
60.0	60.0	5.970	5.970	0.000
60.0	60.1	11.944	11.945	-0.001
60.0	60.0	20.951	20.952	-0.001
60.0	60.0	29.929	29.930	-0.001

Maximum Deviation From Standard: 0.001, -0.002

S#003541

Water Tube Test

Operator Name: _____ cm

Date: 3/17/2009

Slope Constant: 0.703082

From Top	Distance between Ports	Water Depth	S/N 3541	Delta
Port 1		0.353	0.355	-0.002
	0.503			
Port 2		0.856	0.855	0.001
	0.500			
Port 3		1.356	1.355	0.001
	0.501			
Port 4		1.857	1.856	0.001
	0.497			
Port 5		2.354	2.354	0.000
	0.503			
Port 6		2.857	2.856	0.001
	0.803			
Port 7		3.660	3.658	0.002

- 1) Set the averaging interval to 10 seconds
- 2) Set the slope to "Meters" (0.70308)
- 3) Measure one gauge through all 7 ports, then switch and do the next gauge
- 4) After you insert the tube into a new port, purge the gauge (20PSI, 30 seconds)
- 5) Measure the stage 3 times and write down the stage that appears at least 2 out of 3 times

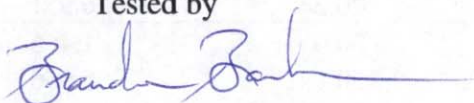
Certificate of Calibration

This certifies that your precision instrument met all of the specifications determined by tests performed on the date listed below. This instrument was subjected to extensive pre-qualifications. It was then calibrated using an automated test system over a period of approximately 20 hours followed by another 20 hour validation test.

WaterLOG calibration standards are traceable to the National Institute of Standards and Technology (NIST). The Model Number and Serial Number of the standard used are listed below.

The test data below is a sampling of the 150 actual data points taken during the pre-shipment validation test on this instrument.

Tested by



TEST REPORT

REPORT DATE: 03/24/2009
 DATE TESTED: 03/23/2009
 MODEL NUMBER: H350XL
 SERIAL NUMBER: S#001354
 NIST TRACEABLE REFERENCE: DH Instruments Model RPM1-G0030 SN40840

Reference Temp.	Measured Temp	Reference Press.	Measured Press.	Delta
-40.1	-39.9	0.000	-0.002	0.002
-39.9	-39.9	4.455	4.457	-0.002
-39.9	-39.8	8.968	8.971	-0.003
-39.9	-39.8	17.947	17.952	-0.005
-39.9	-39.9	26.950	26.956	-0.006
-30.0	-30.0	1.462	1.463	-0.001
-30.0	-30.0	5.961	5.961	0.000
-30.0	-30.0	11.967	11.969	-0.002
-30.0	-30.0	20.941	20.944	-0.003
-30.1	-30.0	29.957	29.960	-0.003
-20.0	-19.9	2.955	2.954	0.001
-20.0	-19.9	7.468	7.469	-0.001
-20.0	-19.9	14.946	14.947	-0.001
-20.0	-19.8	23.953	23.956	-0.003
-10.0	-10.0	-0.001	-0.002	0.001
-10.0	-9.9	4.459	4.459	0.000

S#001354

<i>Reference Temp.</i>	<i>Measured Temp</i>	<i>Reference Press.</i>	<i>Measured Press.</i>	<i>Delta</i>
-10.1	-9.9	8.947	8.946	0.001
-9.9	-9.8	17.946	17.949	-0.003
-10.0	-9.8	26.951	26.952	-0.001
0.0	0.0	1.463	1.461	0.002
0.0	0.1	5.961	5.961	0.000
-0.1	0.2	11.966	11.965	0.001
0.0	0.2	20.945	20.945	0.000
0.0	0.2	29.951	29.951	0.000
10.1	10.0	2.951	2.951	0.000
10.1	10.0	7.465	7.466	-0.001
9.9	10.1	14.943	14.942	0.001
10.1	10.1	23.950	23.949	0.001
20.0	19.9	-0.001	0.000	-0.001
20.0	20.0	4.459	4.458	0.001
20.0	20.1	8.948	8.948	0.000
20.0	20.1	17.949	17.949	0.000
20.0	20.2	26.951	26.952	-0.001
30.1	30.0	1.466	1.464	0.002
30.0	30.1	5.966	5.964	0.002
30.0	30.2	11.946	11.945	0.001
29.9	30.2	20.952	20.951	0.001
30.0	30.2	29.957	29.957	0.000
40.0	40.0	2.953	2.955	-0.002
40.0	40.1	7.468	7.469	-0.001
39.9	40.1	14.943	14.943	0.000
40.0	40.1	23.949	23.947	0.002
49.9	50.0	-0.001	0.000	-0.001
50.0	50.1	4.460	4.460	0.000
50.1	50.1	8.968	8.968	0.000
50.1	50.1	17.948	17.948	0.000
50.1	50.1	26.951	26.950	0.001
60.0	60.0	1.446	1.446	0.000
60.0	60.1	5.968	5.967	0.001
60.0	60.1	11.951	11.949	0.002
60.0	60.1	20.909	20.908	0.001
60.0	60.1	29.945	29.944	0.001

Maximum Deviation From Standard: 0.002, -0.006

Water Tube Test

Operator Name: _____ cm

Date: 4/3/2009

Slope Constant: 0.70308

From Top	Distance between Ports	Water Depth	S/N 1354	Delta
Port 1		0.338	0.338	0.000
	0.503			
Port 2		0.841	0.841	0.000
	0.500			
Port 3		1.341	1.34	0.001
	0.501			
Port 4		1.842	1.841	0.001
	0.497			
Port 5		2.339	2.337	0.002
	0.503			
Port 6		2.842	2.839	0.003
	0.803			
Port 7		3.645	3.642	0.003

- 1) Set the averaging interval to 10 seconds
- 2) Set the slope to "Meters" (0.70308)
- 3) Measure one gauge through all 7 ports, then switch and do the next gauge
- 4) After you insert the tube into a new port, purge the gauge (20PSI, 30 seconds)
- 5) Measure the stage 3 times and write down the stage that appears at least 2 out of 3 times

Tide Gauge System Acceptance Test

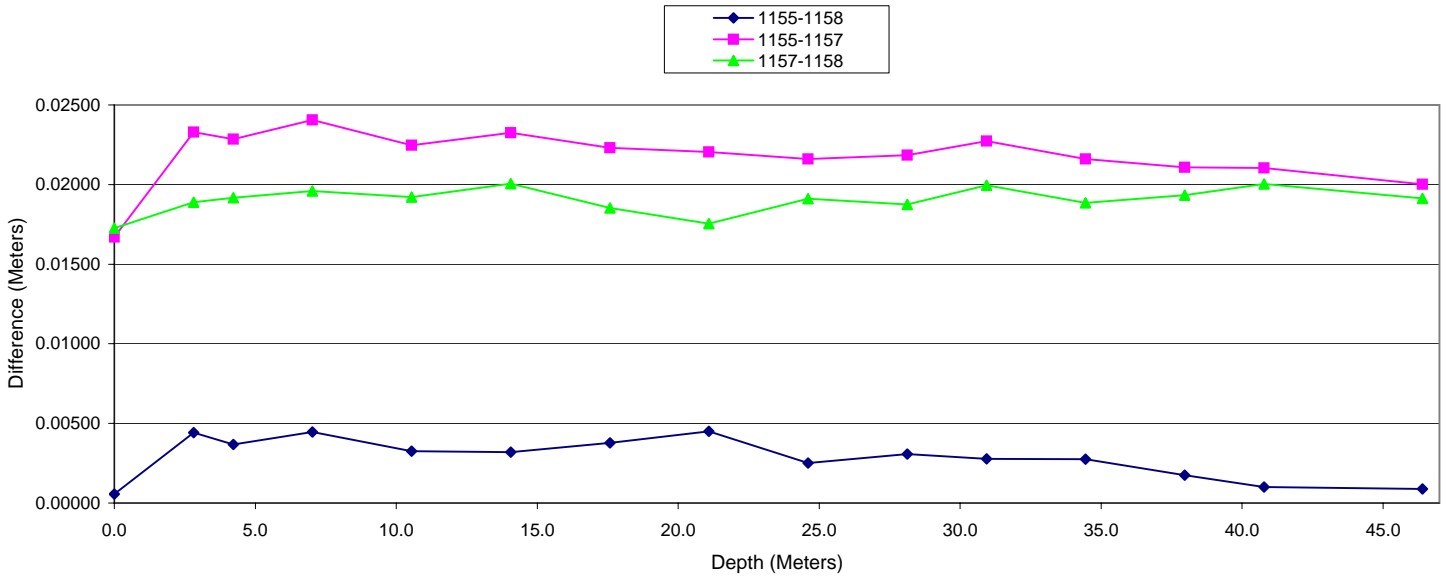
Serial No.: Seabird 1155
Date of test: 3/16/2009

Seabird 1157 Seabird 1158

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1155 PSI	1157 PSI	1158 PSI	1155-1157 Meters	1157-1158 Meters	1155-1158 Meters
0	0.0	5	-0.2522	-0.2285	-0.2530	0.0167	0.0173	0.0006
4	2.8	5	3.9522	3.9854	3.9585	0.0233	0.0189	0.0044
6	4.2	5	6.1814	6.2139	6.1866	0.0229	0.0192	0.0037
10	7.0	5	10.3738	10.4080	10.3802	0.0241	0.0196	0.0045
15	10.5	5	14.7704	14.8024	14.7750	0.0225	0.0192	0.0033
20	14.1	5	20.0147	20.0478	20.0193	0.0232	0.0201	0.0032
25	17.6	5	24.8375	24.8692	24.8429	0.0223	0.0185	0.0038
30	21.1	5	29.6419	29.6732	29.6483	0.0220	0.0175	0.0045
35	24.6	5	34.4929	34.5236	34.4964	0.0216	0.0191	0.0025
40	28.1	5	40.2362	40.2673	40.2406	0.0218	0.0188	0.0031
44	30.9	5	44.0801	44.1124	44.0841	0.0227	0.0200	0.0028
49	34.5	5	48.9843	49.0150	48.9882	0.0216	0.0188	0.0028
54	38.0	5	54.3914	54.4214	54.3939	0.0211	0.0193	0.0017
58	40.8	5	58.3309	58.3608	58.3323	0.0211	0.0200	0.0010
66	46.4	5	66.6146	66.6431	66.6159	0.0200	0.0191	0.0009
Average =						0.0219	0.0190	0.0030
Standard Deviation =						0.0017	0.0008	0.0012

Seabird vs. Seabird



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Both Seabirds were simultaneously placed in a pressurized tank and set to record at the same interval. The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

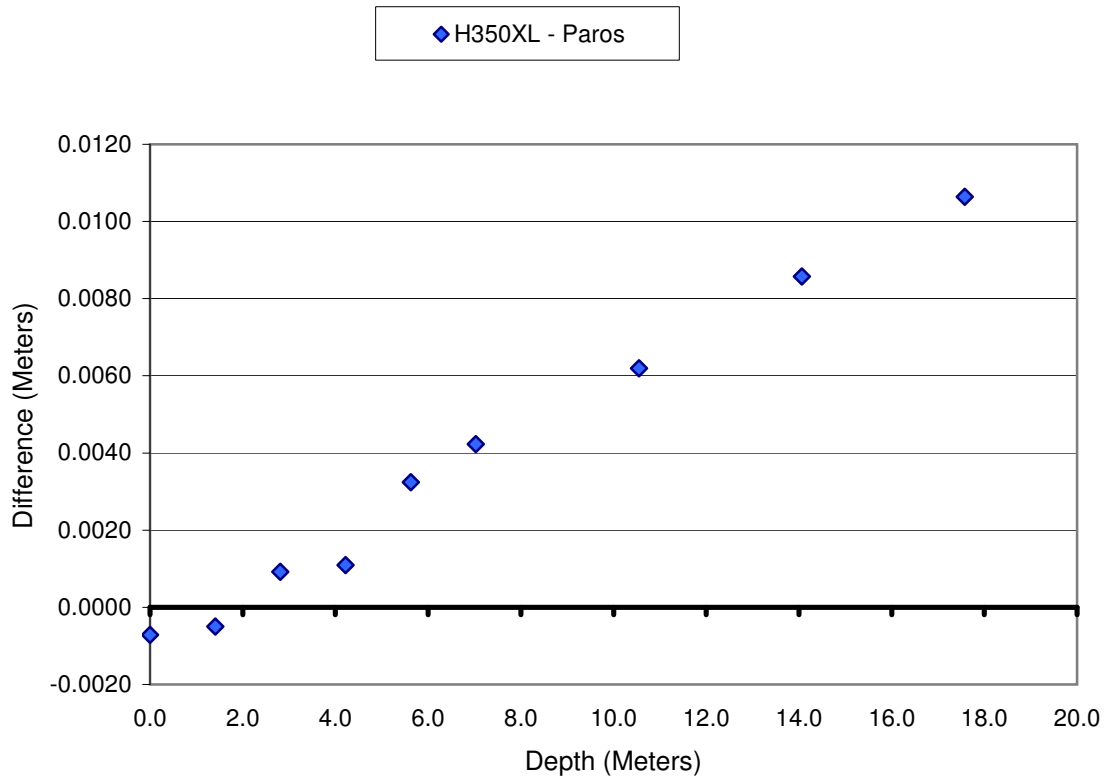
Tide Gauge System Acceptance Test

Serial No.: H350XL 1354
Date of test: 9/15/2009

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	H350XL - Paros PSI	Delta Meters
0	0.0	5	-0.0010	-0.0007
2	1.4	5	-0.0007	-0.0005
4	2.8	5	0.0013	0.0009
6	4.2	5	0.0016	0.0011
8	5.6	5	0.0046	0.0032
10	7.0	5	0.0060	0.0042
15	10.5	5	0.0088	0.0062
20	14.1	5	0.0122	0.0086
25	17.6	5	0.0151	0.0106
Average =			0.0053	0.0037
Standard Deviation =			0.0057	0.0040

H350XL vs. Paros Computed Depths



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Reference readings of a close pressurized system were determined by a Paroscientific Digiquartz Portable Standard pressure sensor (S/N 85673) with a stated accuracy of 0.01% of full scale (0-30 psi). The observed H350XL pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

Tide Gauge System Acceptance Test

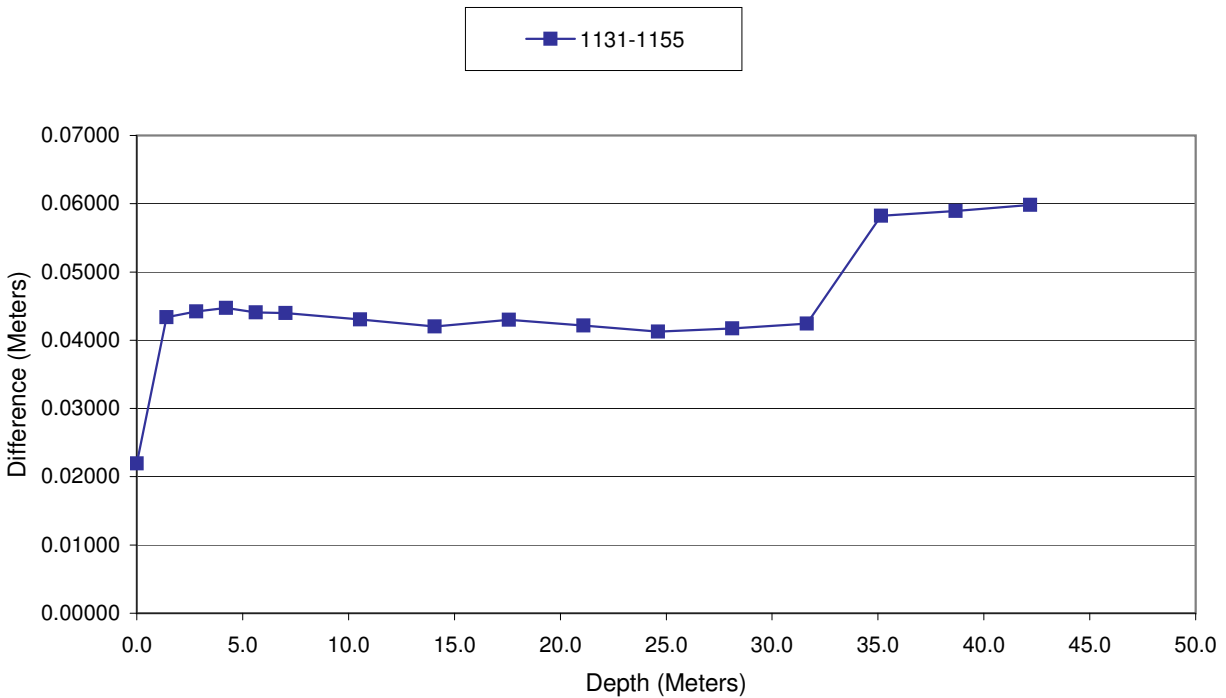
Serial No.: Seabird 1131
Date of test: 9/17/2009

Seabird 1155

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1131 PSI	1155 PSI	1131-1155 Meters
0	0.0	5	-0.1497	-0.1810	0.0220
2	1.4	5	2.0441	1.9824	0.0434
4	2.8	5	3.9064	3.8435	0.0442
6	4.2	5	6.0355	5.9719	0.0447
8	5.6	5	8.3370	8.2744	0.0441
10	7.0	5	10.0530	9.9904	0.0440
15	10.5	5	15.0315	14.9703	0.0430
20	14.1	5	20.1910	20.1312	0.0420
25	17.6	5	24.8857	24.8246	0.0430
30	21.1	5	31.9952	31.9352	0.0422
35	24.6	5	35.3672	35.3085	0.0412
40	28.1	5	41.5487	41.4894	0.0417
45	31.6	5	45.1582	45.0978	0.0424
50	35.2	5	50.8554	50.7972	0.0582
55	38.7	5	55.6496	55.5906	0.0589
60	42.2	5	60.7706	60.7108	0.0598
Average =					0.0447
Standard Deviation =					0.0089

Seabird vs. Seabird



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Both Seabirds were simultaneously placed in a pressurized tank and set to record at the same interval. The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

Tide Gauge System Acceptance Test

Serial No.: Seabird 1156
Date of test: 9/16/2009

Seabird 1157

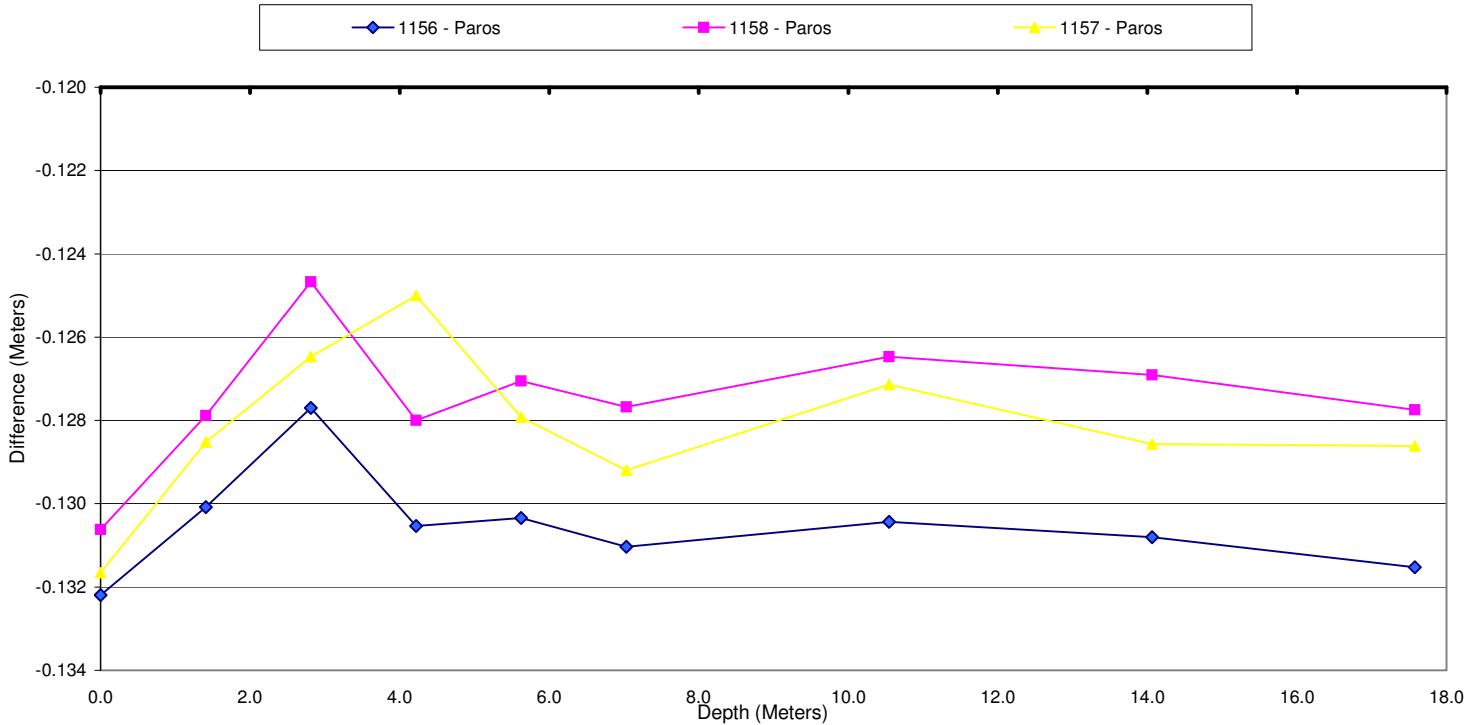
Seabird 1158

Tested by:

CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1156 - Paros PSI	1157 - Paros PSI	1158 - Paros Psi	1156 Delta Meters	1157 Delta Meters	1158 Delta Meters
0	0.0	5	-0.1880	-0.1873	-0.1858	-0.1322	-0.1317	-0.1306
2	1.4	5	-0.1850	-0.1828	-0.1819	-0.1301	-0.1285	-0.1279
4	2.8	5	-0.1816	-0.1799	-0.1773	-0.1277	-0.1265	-0.1247
6	4.2	5	-0.1857	-0.1778	-0.1821	-0.1305	-0.1250	-0.1280
8	5.6	5	-0.1854	-0.1819	-0.1807	-0.1303	-0.1279	-0.1271
10	7.0	5	-0.1864	-0.1838	-0.1816	-0.1310	-0.1292	-0.1277
15	10.5	5	-0.1855	-0.1808	-0.1799	-0.1304	-0.1271	-0.1265
20	14.1	5	-0.1860	-0.1829	-0.1805	-0.1308	-0.1286	-0.1269
25	17.6	5	-0.1871	-0.1829	-0.1817	-0.1315	-0.1286	-0.1277
Average =			-0.1856	-0.1822	-0.1813	-0.1305	-0.1281	-0.1274
Standard Deviation =			0.0018	0.0026	0.0022	0.0012	0.0019	0.0016

Seabirds vs. Paros Computed Depths



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Reference readings of a close pressurized system were determined by a Paroscientific Digiquartz Portable Standard pressure sensor (S/N 85673) with a stated accuracy of 0.01% of full scale (0-30 psi). The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

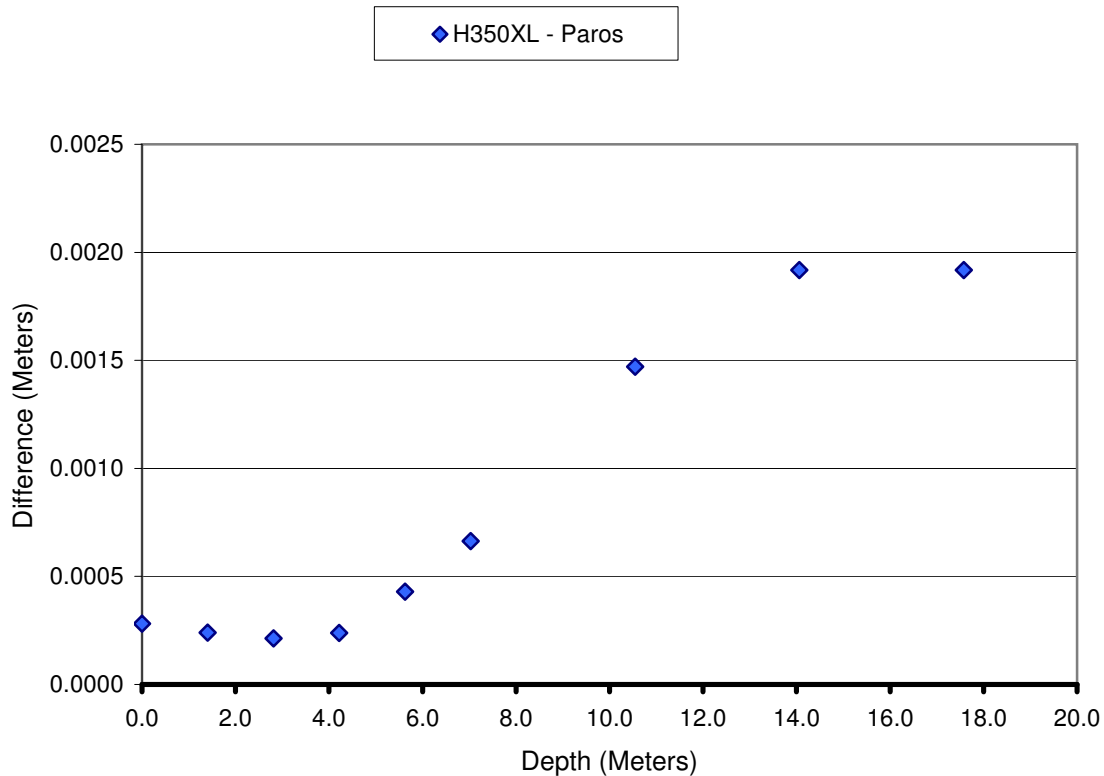
Tide Gauge System Acceptance Test

Serial No.: H350XL 3541
Date of test: 9/18/2009

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	H350XL - Paros PSI	Delta Meters
0	0.0	5	0.0004	0.0003
2	1.4	5	0.0003	0.0002
4	2.8	5	0.0003	0.0002
6	4.2	5	0.0003	0.0002
8	5.6	5	0.0006	0.0004
10	7.0	5	0.0009	0.0007
15	10.5	5	0.0021	0.0015
20	14.1	5	0.0027	0.0019
25	17.6	5	0.0027	0.0019
Average =			0.0012	0.0008
Standard Deviation =			0.0010	0.0007

H350XL vs. Paros Computed Depths



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Reference readings of a close pressurized system were determined by a Paroscientific Digiquartz Portable Standard pressure sensor (S/N 85673) with a stated accuracy of 0.01% of full scale (0-30 psi). The observed H350XL pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

Tide Gauge System Acceptance Test

Serial No.: Seabird 1156
Date of test: 9/16/2009

Seabird 1157

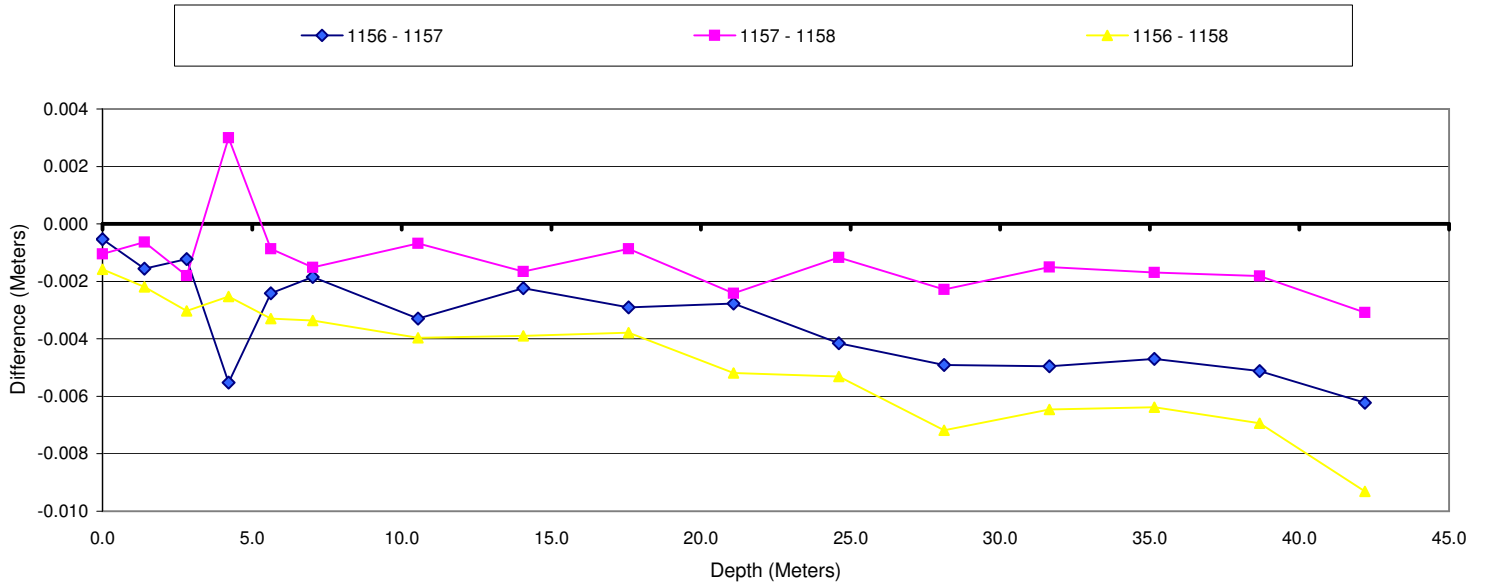
Seabird 1158

Tested by:

CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1156 PSI	1157 PSI	1158 PSI	1156 - 1157	1157 - 1158	1156 - 1158
						Meters	Meters	Meters
0	0.0	5	-0.1880	-0.1873	-0.1858	-0.0005	-0.0010	-0.0016
2	1.4	5	1.9899	1.9922	1.9931	-0.0016	-0.0006	-0.0022
4	2.8	5	3.9755	3.9772	3.9798	-0.0012	-0.0018	-0.0030
6	4.2	5	5.9248	5.9326	5.9284	-0.0055	0.0030	-0.0025
8	5.6	5	7.8760	7.8795	7.8807	-0.0024	-0.0009	-0.0033
10	7.0	5	10.0619	10.0646	10.0667	-0.0018	-0.0015	-0.0034
15	10.5	5	14.9578	14.9625	14.9635	-0.0033	-0.0007	-0.0040
20	14.1	5	19.9936	19.9968	19.9991	-0.0022	-0.0017	-0.0039
25	17.6	5	25.1738	25.1779	25.1792	-0.0029	-0.0009	-0.0038
30	21.1	5	31.2946	31.2985	31.3019	-0.0028	-0.0024	-0.0052
35	24.6	5	35.7457	35.7516	35.7532	-0.0041	-0.0012	-0.0053
40	28.1	5	41.7067	41.7137	41.7170	-0.0049	-0.0023	-0.0072
45	31.6	5	45.6863	45.6933	45.6954	-0.0049	-0.0015	-0.0065
50	35.2	5	50.5655	50.5722	50.5746	-0.0047	-0.0017	-0.0064
55	38.7	5	54.9319	54.9392	54.9418	-0.0051	-0.0018	-0.0069
60	42.2	5	61.3677	61.3765	61.3809	-0.0062	-0.0031	-0.0093
Average =						-0.0034	-0.0013	-0.0046
Standard Deviation =						0.0017	0.0013	0.0021

Seabird vs. Seabird



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Both Seabirds were simultaneously placed in a pressurized tank and set to record at the same interval. The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

CALIBRATION SHEETS

SBE 26plus Temperature Calibration - S/N 1158.....	1
SBE 26plus Pressure Sensor Offset Correction - S/N 1158	2
Digiquartz Calibration - S/N 106177.....	3

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1158

SBE 26plus TEMPERATURE CALIBRATION DATA

CALIBRATION DATE: 28-Jan-08

ITS-90 COEFFICIENTS

a0 = 2.542298e-004

a1 = 2.500167e-004

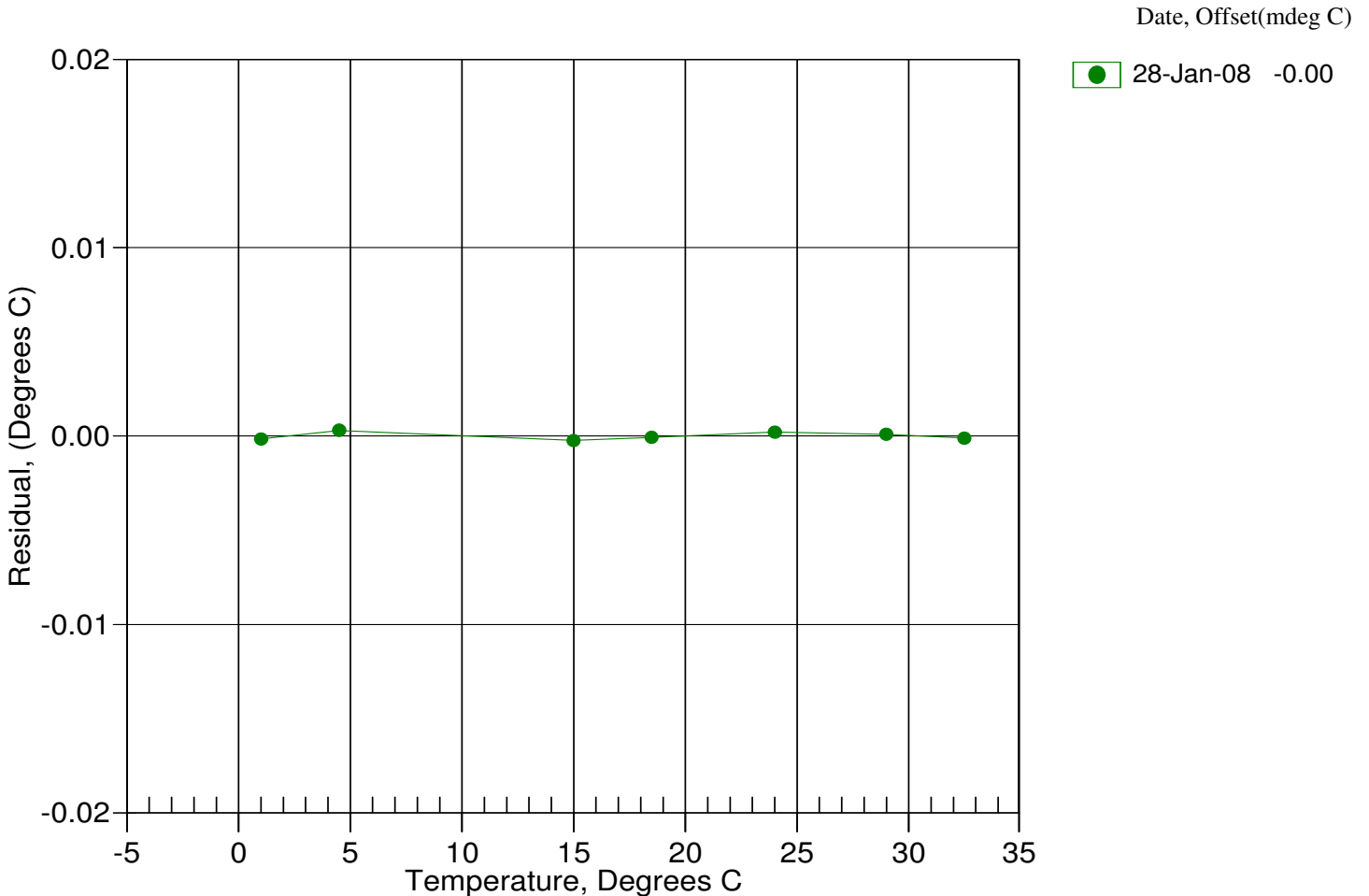
a2 = -1.621469e-006

a3 = 1.521068e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	591321.2	0.9998	-0.0002
4.5000	503718.3	4.5003	0.0003
15.0000	317383.8	14.9998	-0.0002
18.5000	273741.3	18.4999	-0.0001
24.0000	218226.9	24.0002	0.0002
29.0000	178653.7	29.0001	0.0001
32.5000	155810.7	32.4999	-0.0001

Temperature ITS-90 = $1 / \{ a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)] \} - 273.15$ (°C)

Residual = instrument temperature - bath temperature





Sea-Bird Electronics, Inc. FAX: (425) 643-9954

1808 136th Place NE, Bellevue, Washington 98005 USA Tel:(425)643-9866

Website: <http://www.seabird.com>

Email: seabird@seabird.com

26P48650-1158

01 February 2008

Pressure Range: 100 psia

Pressure sensor Serial Number: 106177

Pressure sensor Type: Digiquartz

Pressure offset correction for SBE 26plus Wave and Tide Recorder

Pressure sensor output in the SBE 26plus Wave and Tide Recorder is sensitive to ambient pressure (including elevation and atmospheric pressure) and orientation of the instrument. As part of the test of this instrument, the output of the pressure sensor was measured in the orientation noted below. This data was averaged and compared to the output of a precision barometer at an elevation of 43 feet above sea level. The difference between these two measurements has been entered into the SBE 26plus as an offset correction. The slope correction for the SBE 26plus is nominally set to 1.0 for new instruments. The offset correction should be recalculated by the end-user in a manner appropriate for the intended use of the instrument.

ATMOSPHERIC CALIBRATION DATA

Orientation: Vertical

Pressure Sensor Range: 100 psia

Reference Pressure (psia)	SBE 26plus pressure (psia)	Difference (psia)
14.5683	14.7247	-0.1564

These coefficients should be entered into the SBE 26plus.

OFFSET = -0.1564

SLOPE = 1



Horizontal Orientation



Vertical Orientation

CALIBRATION COEFFICIENTS

SERIAL NO : 106177

PRESSURE TRANSDUCER

DATE : 10-23-2007

MODEL : 2100A-219	PRESSURE RANGE : 0 to 100 psia	TEMP. RANGE : -40 to 107 deg C	PORT : oil filled
----------------------	-----------------------------------	-----------------------------------	----------------------

TEMPERATURE COEFFICIENTS

X = temperature period
(μsec)

$$U = X - U_0$$

Temperature : (deg C)

$$\text{Temp} = Y_1U + Y_2U^2 + Y_3U^3$$

U ₀	5.807334	μsec
Y ₁	-3987.881	deg C/ μsec
Y ₂	-10566.65	deg C/ μsec^2
Y ₃	0	

PRESSURE COEFFICIENTS

T = pressure period
(μsec)

$$C = C_1 + C_2U + C_3U^2$$

$$D = D_1 + D_2U$$

$$T_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$$

Pressure : (psia)

$$P = C \left(1 - \frac{T_0^2}{T^2}\right) \left(1 - D \left(1 - \frac{T_0^2}{T^2}\right)\right)$$

C ₁	586.7856	psia
C ₂	-4.048706	psia/ μsec
C ₃	-1173.257	psia/ μsec^2

D ₁	0.027369
D ₂	0

T ₁	27.94202	μsec
T ₂	0.606043	$\mu\text{sec}/\mu\text{sec}$
T ₃	20.45836	$\mu\text{sec}/\mu\text{sec}^2$
T ₄	55.01164	$\mu\text{sec}/\mu\text{sec}^3$
T ₅	0	

(10-23-2007)

PAROSCIENTIFIC, INC.4500 148th AVENUE N.E.
REDMOND, WA. 98052

CUSTOMER : SEABIRD ELECTRONICS, INC.

SALES ORDER : 24775

PREPARED BY : AJY



CALIBRATION COEFFICIENTSSERIAL NO : **106177**

PRESSURE TRANSDUCER

DATE : **10-23-2007**

MODEL : 2100A-219	PRESSURE RANGE : 0 to 100 psia	TEMP. RANGE : -40 to 107 deg C	PORT : oil filled
----------------------	-----------------------------------	-----------------------------------	----------------------

PRESSURE COEFFICIENTS AT FIXED TEMPERATURE

(only valid at specified temperature)

T = pressure period (μsec)

Pressure equation : (psia)

$$P = C \left(1 - \frac{T_0^2}{T^2}\right) \left(1 - D \left(1 - \frac{T_0^2}{T^2}\right)\right)$$

Temperature: **21.0 C**

C (psia)	586.7737				
D	0.027369				
T ₀ (μsec)	27.93936				

(10-23-2007)

PAROSCIENTIFIC, INC.4500 148th AVENUE N.E.
REDMOND, WA. 98052CUSTOMER : **SEABIRD ELECTRONICS, INC.**SALES ORDER : **24775**PREPARED BY : **AJY**

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GPS STATION OBSERVATION LOG (15-Apr-2003)	Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) 946 2719 A	Station PID, if any:	Date (UTC): 4/9/09
	General Location: AKUN BAY	Airport ID, if any:	Station 4-Character ID: 719A

Project Name: Unimak Pass Hydro Survey	Project Number: GPS-	Station Serial # (SSN):	Session ID:(A,B,C etc) A
--	--------------------------------	-------------------------	------------------------------------

NAD83 Latitude N 54° 14' 16.9"	NAD83 Longitude W 165° 32' 27.9"	NAD83 Ellipsoidal Height meters	Agency Full Name: SOA Surveys, LLC Operator Full Name: Cody Mayfield Phone #: (907) 561-0136 e-mail address: cody@soa-surveys.com
Observation Session Times (UTC): Sched. Start _____ Stop _____	Epoch Interval = 15 Seconds Elevation Mask = 10 Degrees	NAVD88 Orthometric Ht. meters	
Actual Start 01:52 Stop 06:26		GEOID99 Geoid Height meters	

GPS Receiver: Manufacturer & Model: NOVATEL DL4+ P/N: 01017390 DL4+ S/N: NYB0604009 Firmware Version: 3.012 <input type="checkbox"/> CamCorder Battery, <input checked="" type="checkbox"/> 12V DC, <input type="checkbox"/> 110V AC, <input type="checkbox"/> Other	GPS Antenna: NOVATEL Manufacturer & Model, & NGS antenna code*: GPS-702 P/N: 01017187 S/N: NU405230012 Cable Length, meters: Vehicle is Parked N/A meters (direction) from antenna.	Antenna plumb before session? <input checked="" type="radio"/> (Y/N) Circle Antenna plumb after session? <input checked="" type="radio"/> (Y/N) Yes or No Antenna oriented to true North? <input checked="" type="radio"/> (Y/N) -If no, explain Weather observed at antenna ht. <input checked="" type="radio"/> (Y/N) Antenna ground plane used? <input checked="" type="radio"/> (Y/N) Antenna radome used? <input checked="" type="radio"/> (Y/N) If yes, describe. Eccentric occupation (>0.5 mm)? <input checked="" type="radio"/> (Y/N) Use Any obstructions above 10'? <input checked="" type="radio"/> (Y/N) Use Radio interference source nearby <input checked="" type="radio"/> (Y/N) Vis. form
--	--	---


Tripod or Ant. Mount: Check one: <input type="checkbox"/> Fixed-Height Tripod, <input checked="" type="checkbox"/> Slip-Leg Tripod, <input type="checkbox"/> Fixed Mount Manufacturer & Model: Dutch Hill P/N: S/N: N/A Last Calibration date:	** ANTENNA HEIGHT ** (see back of form for measurement illustration)	Before Session Begins: measure and record both Meters AND Feet	After Session Ends: measure and record both Meters AND Feet
	A= Datum point to Top of Tripod (Tripod Height)		
	B= Additional offset to ARP if any (Tribrach/Spacer)		

Tribrach: Check one: <input type="checkbox"/> None, <input type="checkbox"/> Wild GDF 22, <input type="checkbox"/> Topcon, <input type="checkbox"/> Other (describe)	H= Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)	0.998	3.274	0.998	3.27
Last Calibration date:	Note: Meters = Feet X (0.3048) Height Entered Into Receiver = _____ meters.	Please note &/or sketch ANY unusual conditions. Be Very Explicit as to where and how Measured!			

Barometer: Manufacturer & Model: P/N: S/N: Last Calibration or check Date:	Weather DATA	Time (UTC)	Dry-Bulb Temp		WetBulb Temp		Rel. % Humidity	Atm. Pressure		Weather Codes *
			Fahrenheit	Celsius	Fahrenheit	Celsius		inches Hg	millibar	
N/A	Before	N/A								
	Middle									
	After									
N/A	Average of Readings									* See back of form for codes

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

HI Measurement is slant height to top of notch

1.043 

Note: Entries are Required in all Unshaded areas. * Antenna code is provided by NGS coordinator in the ant_info file.

Table of Weather Codes -- for entry into Weather Data Table on front of form:						Data File Name(s): 719A099a.pdc / 719A099a.pdc
CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND	(Standard NGS Format = aaaadddd.xxx) where aaaa=4-Character ID, ddd=Day of Year, s=Session ID, xxx=file dependant extension
0	NO PROBLEMS encountered	GOOD More than 15 miles	NORMAL 32° F to 80°F	CLEAR Below 20%	CALM Under 5mph (8km/h)	Updated Station Description: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Visibility Obstruction Form: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Photographs of Station: <input type="checkbox"/> Attached <input type="checkbox"/> Submitted earlier Pencil Rubbing of Mark: <input type="checkbox"/> Attached
1	PROBLEMS encountered	FAIR 7 to 15 miles	HOT Over 80°F (27 C)	CLOUDY 20% to 70%	MODERATE 5 to 15 mph	
2	-- NOT USED --	POOR Less than 7 miles	COLD Below 32° F (0 C)	OVERCAST Over 70%	STRONG over 15mph (24km/h)	
Examples: Code 00000 = 0 - No problems. 0 - good visibility. 0 - normal temperature. 0 - clear sky. 0 - calm wind Code 12121 = 1 - Problems. 2 - poor visibility. 1 - hot temperature. 2 - overcast. 1 - moderate wind						LOG CHECKED BY: NCW

NATIONAL GEODETIC SURVEY PENCIL RUBBING FORM

4-char ID: ~~719A~~ 719A Day of Year ("Julian Day"): 99

Designation: 9462719 A PID: _____

Stamping: 2719 A 2009

Mark Type / Agency Inscription: SS ROD / NOS

Location: AKun Island County: _____

Rubbing By: Nathan Wardwell Date: 4/9/09

Agency: JOA Surveys LLC Phone: (907) 561-0136

Remarks: _____

INSTRUCTIONS:

Place the blank form (or other blank paper) over the mark and rub over the entire disk with a pencil. For rod marks, rub only the designation and date stamping from the rim of the aluminum logo cap. If it is impossible to make a rubbing of the mark, or if the rubbing appears indistinct, a sketch and/or photograph may be substituted.



NATIONAL GEODETIC SURVEY STATION DESCRIPTION / RECOVERY FORM

4-char ID: 7219 7PA Designation: 9462719 A

PID: _____ Alias: _____

Country: (USA / _____) State: AK County: _____

Latitude: N 54° 14' 16.9" Longitude: W 165° 32' 27.9" Elevation: _____ (meter / ft)

Original Description (check one):	
<input type="checkbox"/> P	Preliminary (mark has not been set yet)
<input checked="" type="checkbox"/> D	A newly set mark
<input type="checkbox"/> R	A recovered mark
Established by: (NGS / CGS / Other:)	
Date: <u>24/9/09</u> Chief of Party (initials): <u>NCW</u>	

Recovery Description (check one):	
<input type="checkbox"/> F	Full description of a station <u>not</u> in the database
<input type="checkbox"/> T	Full description of a station <u>in</u> the database
<input type="checkbox"/> M	<u>Partial</u> description of a station in the database
Recovered by: (NGS / Other:)	
Date: _____ Chief of Party (initials): _____	

Monument Stability (check one):	
<input type="checkbox"/> A	Of the most reliable nature; expected to hold well
<input checked="" type="checkbox"/> B	Will probably hold position and elevation well
<input type="checkbox"/> C	May hold well, but subject to ground movement
<input type="checkbox"/> D	Of questionable or unknown reliability

Recovery Condition (check one):	
<input type="checkbox"/> G	Recovered in good condition
<input type="checkbox"/> N	Not recovered or not found
<input type="checkbox"/> P	Poor, disturbed, or mutilated
<input type="checkbox"/> X	Surface mark known destroyed

Setting Information:	
Marker Type: (<u>Rod</u>) Disk / Other)	
Setting Type: (Bedrock / Concrete / Other:)	
Y (<u>N</u>)?	Monument contains magnetic material?

Stamping: <u>2719 A 2009</u>	
Agency Inscription: (NGS / CGS / Other:) <u>NOS</u>	
Rod Depth: <u>6.97</u> (m/ft)	Sleeve Depth: <u>NA</u> (m/ft)
Monument is: (<u>flush</u>) projecting / recessed) (cm/ft)	

Special Type (check all applicable):	
<input type="checkbox"/> F	Fault monitoring site
<input checked="" type="checkbox"/> T	Tidal Station
<input type="checkbox"/> --	Control Station: (FBN / CBN / Bench mark)
<input type="checkbox"/> --	Airport Control Station: (PACS / SACS)
Y / N	Mark is suitable for GPS use?

Transportation (check one):	
<input type="checkbox"/> C	Car
<input type="checkbox"/> P	Light truck (pickup, carry-all, etc.)
<input type="checkbox"/> X	Four-Wheel Drive Vehicle
<input checked="" type="checkbox"/>	Other (SnowCat, <u>Plane</u> , <u>Boat</u> ; describe)
Y / N	Pack Time (hike) to mark? (hh:mm):

See Back of Form to add Text Description

General Station Location: The station is located in on the east side of Helianthus Cove in Akun Bay on Akun Island, AK. the station is 211 Km (114 nm) SW of Cold Bay Airport, 78 Km (41 nm) NE of Dutch Harbor Airport and 1,198 Km (647 nm) SW of Anchorage Airport.

(Describe general location; include airline distances to three towns or mapped features.)

Ownership: Akutak Corporation

PO Box 8 AKUTAK, AK 99553 (907) 698-2206 (name, address, phone of landowner)

To Reach Narrative: To reach the station from the intersection of the small boat harbor in Dutch Harbor travel NNE 26 Km (14 nm) to the northside of Akutak Island, then proceed NE for 37 Km (20 nm) to the entrance to Akutak Pass between Akutak and Akun Islands, then proceed East 26 Km (14 nm) to Billings Head at the NE point of Akun Island, then proceed 5 Km (3 nm) South to Akun Bay, then proceed SW 6 Km (3 nm) to Helianthus Cove. (Leg-by-leg distances and directions from major road intersection to mark)
The station is located on a rock ledge/bluff facing north.

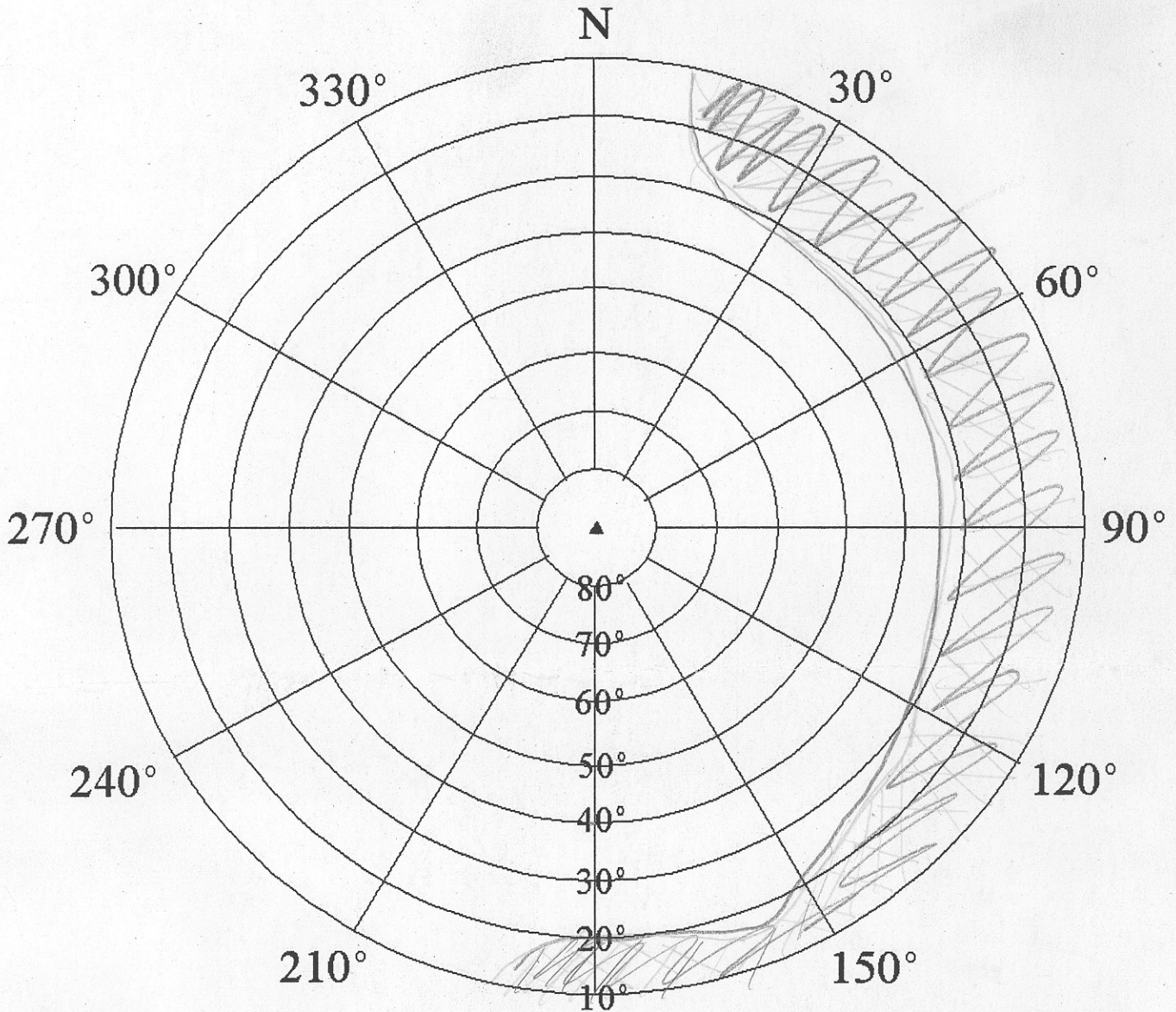
Monument Description and Measurements: The station is a SS Rod in a NOS logo cover driven 6.90 m (22.8 ft) to refusal, 144 m (472 ft) North of the northern intersection of a stream berm and a west facing bluff, 40.32 m (132.3 ft) SSW of a 2.00 m (6.4 ft) high rock outcropping that protrudes from the NW face of a cliff oriented NW, 2.48 m (8.1 ft) East of the grass edge, and set 0.69 m (0.3 ft) below grade.

(Add at least three measurements to permanent, identifiable, nearby objects; and a description of the monument size, shape, height, etc.)

NOTE: - Include a pencil rubbing, sketch, or photographs of mark.

Described by: Nathan Wardwell Phone: (907) 561-0136 e-mail: nathan@jwaasurveys.com

NATIONAL GEODETIC SURVEY VISIBILITY OBSTRUCTION DIAGRAM



INSTRUCTIONS:

Identify obstructions by azimuth (magnetic) and elevation angle (above horizon) as seen from station mark. Indicate distance and direction to nearby structures and reflective surfaces (potential multipath sources).

4-char ID: 719A Designation: 9462719 A

PID: _____ Location: AKUN Island

County: _____ Reconnaissance By: Nathan Wardwell

Height above mark, meters: _____ Agency/Company: JOA Surveys, LLC

Phone: (907) 561-0136 Date: 4/9/09

Check if no obstructions above 10 degrees

NGS Station Description form Station: 9462719 A

General Location:

The station is located on the eastern side of Akun Island in Helianthus Cove 75km (46mi) ENE of Dutch Harbor, 132km (132mi) WSW of Cold Bay and 225km (140mi) WSW of King Cove

Ownership:

Akutan Corporation
PO Box 8
Akutan, AK 99553
907-698-2206

To Reach Narrative:

To reach the tidal bench marks from Dutch Harbor travel NNE 26km (14nm) to the north side of Akutan Island, then proceed NE for 37km (23mi) to the entrance to Akutan Pass between Akutan and Akun islands, then proceed East 26km (16mi) to Billings Head at the NE point of Akun Island, then proceed 5km (3mi) South to Akun Bay, then proceed SW 6km (3mi) to Helianthus Cove. The bench marks are located on a rock ledge/bluff facing north.

Monument Description and Measurements:

This station is a stainless steel rod driven 6.96m (22.8ft) to refusal and encased in an aluminum NOS logo cover with lid set 144m (472ft) North of the northern intersection between a storm berm and a west facing bluff, 40.32m (132.3ft) SSW of a 2.00m (6.4ft) high rock outcropping protruding from the NNW face of a cliff oriented NW, 2.48m (8.1ft) East of the grass edge, and set 0.09m (0.3ft) below grade.

Note – Include a pencil rubbing, sketch, or photographs of mark.

Described by: Nathan Wardwell Phone: 907-561-0136 email: nathan@joasurveys.com



Figure 1 - Stamping of GPS benchmark 9462719 A

PRIMARY BENCH MARK STAMPING: 1 1937
DESIGNATION: 946 2719 TIDAL 1
MONUMENTATION: Tidal bench mark disk
AGENCY: NOS (National Ocean Service)
SETTING CLASSIFICATION: Bedrock

The primary bench mark is set flush on a bedrock ledge projecting into the sea from the northwest point of the headland, 30.08m (98.7ft) West of TIDAL 3, 14.67m (48.13ft) NNE from Tidal Bench Mark 2, 6.48m (21.3ft) ENE of the highest point in the middle of the finger like prolongation stretching seaward in a NE orientation, and 1.37m (4.49ft) above the High Water Line denoted by the barnacles.

Latitude: 54° 14' 22.1" N
Longitude: 165° 32' 23.6" W

New Description/NW 4/7/2009

BENCH MARK STAMPING: 2 1937
DESIGNATION: 946 2719 TIDAL 2
MONUMENTATION: Tidal bench mark disk
AGENCY: NOS (National Ocean Service)
SETTING CLASSIFICATION: Bedrock

The bench mark is set flush on a rock ledge or bluff forming shoreline, 35.91m (117.81ft) WSW from Tidal Bench Mark 3, 15.01m (49.24ft) ENE of Tidal Bench Mark 4, 14.67m (48.13ft) East from TIDAL 1, 11.34m (37.20ft) South from the highest point in the middle of a bedrock prolongation stretching seaward on a NE, 1.49m (4.89 ft) South of the edge of the rock ledge on which the rock is set, and 2.20m (7.21 ft) slant height above the mean high water line denoted by the bottom of the green algae and the top of the barnacles

Latitude: 54° 14' 21.5" N
Longitude: 165° 32' 24.1" W

New Description/NW 4/7/2009

BENCH MARK STAMPING: 3 1937
DESIGNATION: 946 2719 TIDAL 3
MONUMENTATION: Tidal bench mark disk
AGENCY: NOS (National Ocean Service)
SETTING CLASSIFICATION: Bedrock

The bench mark is set flush on a rock ledge or bluff forming shoreline, 35.91m (117.91ft) ENE of Tidal Bench Mark 2, 35.78m (117.39ft) East of the highest point in the middle of a bedrock prolongation stretching seaward

in a NE orientation, 30.08m (98.63 ft) East of TIDAL 1, and 2.5m (8.2 ft) above the mean high water line denoted by the barnacles.

Latitude: 54° 14' 22.0" N
Longitude: 165° 32' 22.3" W

New Description/NW 4/7/2009

BENCH MARK STAMPING: 1938 4
DESIGNATION: 946 2719 TIDAL 4
MONUMENTATION: Tidal bench mark disk
AGENCY: NOS (National Ocean Service)
SETTING CLASSIFICATION: Bedrock

The bench mark is set flush on a bedrock ledge projecting into the sea from the northwest point of the headland, 26.89m (88.22ft) SW from TIDAL 1, 21.06m (69.09ft) SW from the highest point in the middle of the fingerlike bedrock prolongation stretching seaward in a NE orientation, 15.01m (49.27ft) WSW from TIDAL 4, and 2.78m (9.12ft) slant height above the mean high water line denoted by green algae and barnacles.

Latitude: 54° 14' 21.3" N
Longitude: 165° 32' 24.9" W

New Description/NW 4/7/2009

BENCH MARK STAMPING: 2719 A 2009
DESIGNATION: 946 2719 A
MONUMENTATION: Tidal bench mark disk
AGENCY: NOS (National Ocean Service)
SETTING CLASSIFICATION: SS Rod

The bench mark is a SS rod driven 6.96m (22.8 ft) to refusal in a NOS logo cover, 144m (472ft) North of the northern intersection between a storm berm and a west facing bluff, 40.32m (132.2ft) SSW of 2m high rock outcropping that protrudes NW from a NNW facing rock cliff, 2.48m (8.14ft) East of a grass ledge, and 9cm below the top of the logo cover.

Latitude: 54° 14' 16.9" N
Longitude: 165° 32' 27.9" W

New Description/NW 4/7/2009

JOA-141

946-2719
AKUN ISLAND

4/7/09 FB017

INSTALL

Left Dutch harbor at 9:00am local on the R/V Polaris a 65' WWBE boat. 5 people are on board Cody Mayfield (CM) and Nathan Wardwell (NW) (JOA), Mike Ewing (ME) (TerraSand), Rodney Daniels (captain) and Tavia (?) (COOK). The seas were between 3' and 6'.

We arrived @ Akun Cove near tide station 946-2719 @ 4:00 pm local. CM, NW, and ME loaded gear on the skiff and found the 4 historic BMs. We then decided ~~to~~ on a location for the Tide house and orifice pipes. Then we turned in one H350XL and GOES to test transmission.

JOA-141

946-2719
AKUN ISLAND

4/7/09 (2)

JOA-141

AKUN ISLAND - 946-2719

INSTALL

Descriptions~~BAA~~

*

Directions are
Magnetic

Bench MARK 4

stamped: 1938 4

LAT: $54^{\circ} 14' 21.3''$ N (handheld)
LONG: $165^{\circ} 32' 24.9''$ W (Garmin)

- 2.78 m (slant height) above mean high water line on a rock ledge
- 15.01 m (230°) from benchmark 2
~~(4.57 ft)~~ (49.27 ft)
- 26.89 m (4.57 ft) 208° from benchmark from benchmark 1
8.19 88.22
- 21.06 m (~~6.42~~ ft) 216° from the highest point of the ^{fingerlike} bedrock prolongation stretching seaward in a 30° orientation
69.09

4/7/09 FB 017 JOA-141

AKUN ISLAND 946-2719

Install

4/7/09 (3)

Bench Mark 2

stamped: 1937 2

LAT: $54^{\circ} 14' 21.5''$ N (handheld)
LONG: $165^{\circ} 32' 24.1''$ W (Garmin)

- 14.67 m (^{48.13}~~4.47~~ ft) 182° from benchmark 1
- 15.01 m (^{49.24}~~4.57~~ ft) 50° from benchmark 4
- 35.91 m (^{117.81}10.96 ft) 240° from benchmark 3
- 2.20 m (^{7.21}~~0.67~~ ft) slant height above mean high water line (the bottom of the green algae and the top of the barnacles)
- 1.49 m (^{4.89}~~0.45~~ ft) 152° from the edge of the ledge on which the mark is set
- 11.34 m (^{37.20}~~3.46~~ ft) 162° from the ^{highest point on the} fingerlike bedrock prolongation stretching seaward in a 30° orientation

INSTALL

Bench Mark 3

Stamping: 3 1937

LAT: 54° 14' 22.0" N (handheld)

LON: 165° 32' 22.3" W (Garmin)

- 2.5 m (^{8.202}~~0.76~~ ft) above the HW line denoted by the barnacles
- 35.91 m (^{117.01}~~10.76~~ ft) 60° from benchmark 2
- 30.08 m (^{98.68}~~9.17~~ ft) 84° from benchmark 3
- 35.78 m (^{117.39}~~10.91~~ ft) 78° from highest point ~~at the top~~ of the bedrock prolongation in the middle stretching seaward in a 30° orientation

INSTALL

Bench Mark 2

Stamping: 2 1937

LAT: 54° 14' 22.1" N (handheld)

LON: 165° 32' 23.6" W (Garmin)

- 6.48 m (^{21.26}~~1.98~~ ft) 49° from highest point ~~in the middle~~ ^{In the middle} of the fingerlike prolongation stretching seaward in a 30° orientation
- 1.37 m (^{4.49}~~0.42~~ ft) above the HW line denoted by barnacles
- 30.08 m (98.68 ft) 264° from benchmark 3
- 14.67 m (^{48.13}~~4.47~~ ft) 2° from benchmark 2

JOA-141

AKUN ISLAND - 946-2719

4/7/09

INSTALL

BM:

DES: 9462719 A 2009

STAMPING: 2719 A 2009

LAT: 54° 14' 16.9" N

LON: 165° 32' 27.9" W

(handheld)

Garmin

- SS ROD driven 6.96 m to refusal
- Set in NOS logo cover w/ lid
- 2.48m (8.14 ft) 72° of grass edge
- 40.32m (132.28ft) 198° at 2m high rock outcropping protruding from NW face cliff at a orientation of NW
- 9cm below the top of the lid
- 144m (472 ft) 340° of the Northern point where a berm of rocks piled from storms meets a west facing bluff

JOA FB017

AKUN ISLAND 946-2719

4/7/09

INSTALL

Setting BM: 9462719 A 2009

This is a drive Rod located near the tide house

Tip = 10cm
 Section 1 = 122cm
 Section 2 = 122cm
 Section 3 = 122cm
 Section 4 = 122cm
 Section 5 = 122cm
 Section 6 = 74.5cm
 Total = 696.5cm

50A-141

AIKUN Island

946 2719

Density reading 1.027 @

FB 017

AIKUN Island 50A-141

4/2/69 (6)

Leveling C-Test

Unbalanced

~~From~~ To

-562.7

565.3

2.6

BS FS

BS → 2719 A

Top	1671		
Mid	1653	18	16533
Bottom	1636	17	

FS →

Top	2483		
Mid	2216	267	22160 Rock
Bot	1949	267	

Balanced

BS → Rock

Top	2593		
Mid	2452	141	24520
Bot	2311	141	

FS → 2719 A

Top	2030		
Mid	1886	144	1886.7
Bot	1744	142	

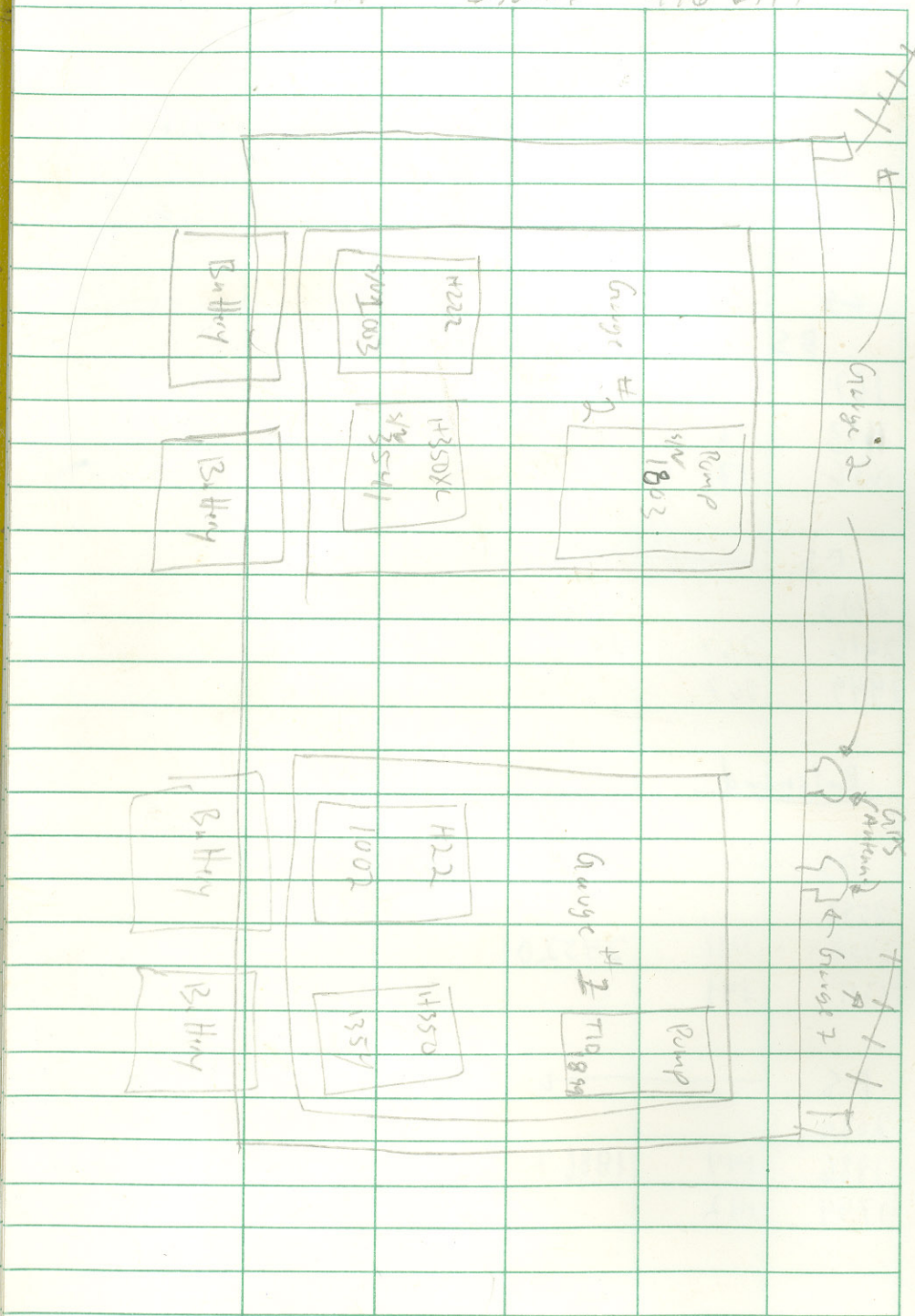
JOA-141

AKUN ISLAND 946-2719

4/8/09 FBO 17 JOA-141

AKUN ISLAND

4/9/09 (7)



TIDE HOUSE SKETCH

Gauge Anchor Deployments

Gauge # 3

LAT : 54° 14' 27.5"

LOn : 165° 32' 52.5"

Depth: 42'

Anchor line length: 60'

SN
 Seabird: 1158
 Power: 010220
 Modem: 010216
 cable: 10988
 Modem Address: 2

Gauge # 1

LAT : 54° 14' 20.5"

LOn : 165° 32' 35.8"

DEPTH: ~35 ft

Anchorline length: 45'

Bubbler

JA

50A-141

AKUN ISLAND

946 2719

Gauge # 2

LAT: 54° 14' 18.0"

LOX: 165° 32' 51.2"

Depth: ~35 ft

Anchorage length: 45'

Bubbler

FB 017

AKUN ISLAND 50A 141

4/9/09

(8)

Mountain
Peak

Lost
Harbor

Helianthus Cove

SE orientation (True)

Daymark

Anchor

Gauge 2

Gauge 2

Gauge 2

Tide Gauge

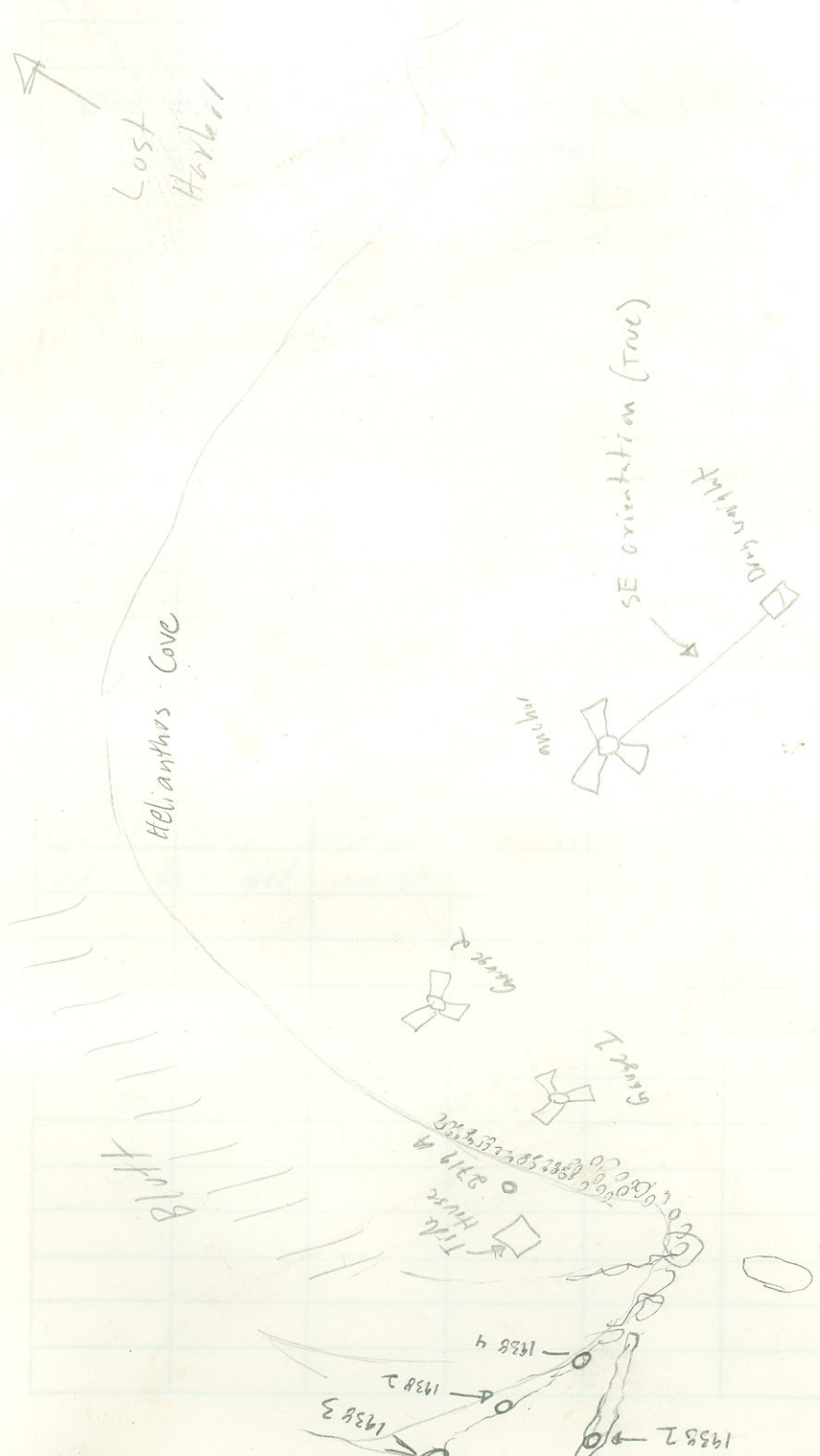
1938 4

1938 2

1938 3

1938 2

Black Hill



JOA 141

AKUN Island 946-2719

4/10/09

FBO17

JOA-141

AKUN ISLAND 946-2719

4/11/09

⑨

Weather dry due to high winds (20kts with 30 kt gusts) preventing us from getting to shore.

Weather was still bad although we were able to get to shore by 10am. We then finished up the last hour of staff shots, downloaded the gauge data, screwed the door shut and piled rocks over the remaining orifice tubing that was exposed.

After getting back to the Polaris we attempted to download data from the SBE 26⁺. We were never able to make the connection the reason for this is ~~because~~ suspected to be the bad weather. The winds, current and surface chop was too bad to hold the skiff stationary. After trying for 30 mins we returned to the vessel to secure the deck and skiff to prepare for the trip to Trident Bay because the weather is forecasted to get worse.

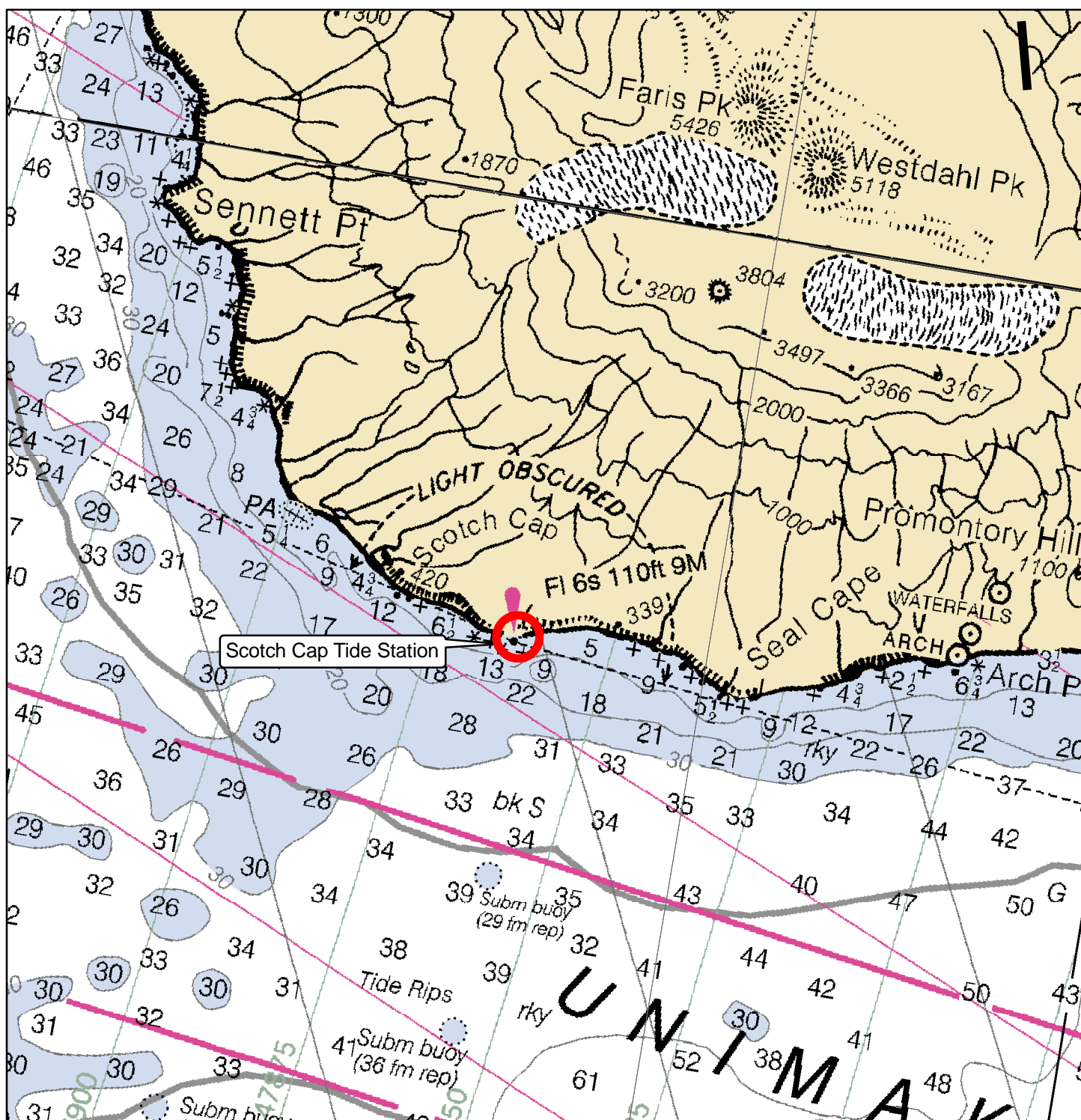
Site Report							
946-2808 Scotch Cap, Unimak Island, AK							
Site Visit	Purpose of Visit	Installation	Team Leader	Nathan Wardwell JOA	Date of Visit	9/4/2009 - 9/5/2009	
Tertiary Station	Installation	April 28, 2009	Removal	September 5, 2009	Number of Days	131	
Project	OCS	OPR-P188-TE-09			JOA	141	
Position (NAD83)	Latitude (N)	54° 23' 37.1"	Longitude (W)	164° 44' 44.6"	Time Meridian	0° (UTC)	
Local Values	Gravity (milligals)	981562	GOES Angles	Elev 22.9° Az 147.1°	Magnetic Declination	11.5° E, +0° 8' W/year	
Contractor	Prime			Tide Consultant			
	TerraSond Ltd. 1617 South Industrial Way, Suite 3 Palmer, AK 99645 (907) 745-7215 ATTN: Kathleen Mildon			John Oswald & Associates, LLC 2000 E. Dowling Rd, Suite 10 Anchorage, AK 99507 (907) 561-0136 phone ATTN: John Oswald			
Owner	United States Coast Guard District 17 Sector Anchorage 510 L Street Suite 100 Anchorage, Alaska 99501 (907) 271-6700						
Location	To reach the tidal bench marks from the Unalaska (Dutch Harbor) City Dock, proceed by boat northeast 30 nautical miles past Akutan Island, then east 47 nautical miles past Akun Island and across Unimak Pass to the southwestern shore of Unimak Island SSE of Scotch Cap to the unmanned Coast Guard light and ruins of the Scotch Cap Lighthouse. The bench marks are located on the rock outcrop below the lighthouse and on the next rock outcrop down the beach to the east. The submersible tide gauges are located to the east in around 10 fathoms, the bubbler gauge is mounted in the ruins of the lighthouse destroyed by the 1946 tsunami.						
Tide House	The tide gauge electronics are housed in a Pelican case mounted inside of the concrete ruins of the lighthouse. The orifice line for the bubbler gauge runs through a hole in the SE facing concrete wall of the lighthouse, down the hill on the ground and down a short cliff to the rock outcrop that the orifice is bolted on. The orifice line is weighted down with large lead weights. The GPS and GOES antennas as well as the solar panel are mounted on the outside wall of the SE facing concrete wall of the lighthouse ruins.						
Primary DCP	Installed	4/28/2009	Removed				
	Sensor	Seabird 26-plus	Serial No.	1155	Slope Constant	0.00000	
	Data Logger	combined in 26-plus	Averaging Interval	180 seconds	Firmware	6.1 d	
	Aprox. Depth	10 Fathoms (18m)	Latitude	N 54° 23' 30.66"	Longitude	W 164° 43' 43.38"	
	Modem	Link Quest	Wake Up Period	120sec	Serial No.	10589	
	Modem Address	3					
	Power	SBE 26-plus has d-cell batteries inside and Link Quest Modem has external battery pack on anchor.					
	Anchor / Rigging	The 1000 pound steel anchor is roughly four feet across with the Seabird mounted in an aluminum tube. An acoustic modem and external power source for the modem are mounted to exterior of tube. A surface bouy line with two hard floats and one small trailing bouy made of hard foam are attached to the end of the buoyline which is 18 fathoms long. A 150' ground line runs south along the bottom from anchor to a 150 lb. steel weight.					
Secondary DCP	Installed	4/28/2009	Removed				
	Sensor	Seabird 26-plus	Serial No.	1156	Slope Constant	0.00000	
	Data Logger	combined in 26-plus	Averaging Interval	180 seconds	Firmware	6.1 d	
	Aprox. Depth	11 Fathoms (20m)	Latitude	N 54° 23' 31.44"	Longitude	W 164° 43' 26.64"	
	Modem	Link Quest	Wake Up Period	120sec	Serial No.	009869	
	Modem Address	2					
	Power	SBE 26-plus has d-cell batteries inside and Link Quest Modem has external battery pack on anchor.					
	Anchor / Rigging	The 1000 pound steel anchor is roughly four feet across with the Seabird mounted in an aluminum tube. An acoustic modem and external power source for the modem are mounted to exterior of tube. A surface bouy line with two hard floats and one small trailing bouy made of hard foam are attached to the end of the buoyline which is 18 fathoms long. A 150' ground line runs south along the bottom from anchor to a 150 lb. steel weight.					
Tertiary DCP	Installed	4/28/2009	Removed				
	Sensor	Seabird 26-plus	Serial No.	1131	Slope Constant	0.00000	
	Data Logger	combined in 26-plus	Averaging Interval	180 seconds	Firmware	6.1 d	
	Aprox. Depth	10 Fathoms (18m)	Latitude	N 54° 23' 27.42"	Longitude	W 164° 43' 10.44"	
	Modem	Link Quest	Wake Up Period	120sec	Serial No.	010215	
	Modem Address	1					
	Power	SBE 26-plus has d-cell batteries inside and Link Quest Modem has external battery pack on anchor.					
	Anchor / Rigging	The 1000 pound steel anchor is roughly four feet across with the Seabird mounted in an aluminum tube. An acoustic modem and external power source for the modem are mounted to exterior of tube. A surface bouy line with two hard floats and one small trailing bouy made of hard foam are attached to the end of the buoyline which is 18 fathoms long. A 150' ground line runs south along the bottom from anchor to a 150 lb. steel weight.					
Backup DCP	Installed	4/27/2009	Removed				
	Sensor	DAA H350XL	Serial No.	1051	Level Point to orifice "0"	0.183	
			Averaging Interval	181 seconds	Slope Constant in Gauge	0.68396	
	Data Logger	DAA H350XL			Firmware	2.12	
	GOES Radio	DAA H222	Serial No.		GPS timing	Yes	
	GOES Address	9070B6CE	Channel	170	Format	NGWLMS	
	Interval	1 hour	Offset	0:02:10	Transmit Window	10 seconds	
	Power	Two batteries with a 20watt solar panel with solar controller.					
	Orifice Mount	The Orifice is mounted with a clamp to a section of Uni-Strut that is bolted to an area of the bedrock outcrop below the tide house. Orifice was dry at install, roughly a -1.4' low tide. Tubing was joined to 1/4" cable and weighted with lead weights and concrete wedge anchors.					
	Comments	This gauge installed as a partial tide check for the primary offshore gauges.					
Tidal Bench Marks	Primary	Recovered	Established	Designations			
	9462808 Tidal 2	2	3	9462808 TIDAL 2, 9462808 TIDAL 4, 9462808 A, 9462808 B, 9462808 C			
Leveling	Date	Order	Type	Bench Marks Connected			
	4/27/2009	Third	Optical	9462808 TIDAL 2, 9462808 TIDAL 4, 9462808 A, 9462808 B, 9462808 C			
	9/4/2009	Third	Optical	9462808 TIDAL 2, 9462808 TIDAL 4, 9462808 A, 9462808 B, 9462808 C			
	NAVD88 Level Tie	No NAVD88 marks within 1.6km (1 mi).					
Comments	Install level run included Gauge 4 orifice "0".						
GPS & OPUS	Bench Mark	Date	Session Length	Latitude (N)	Longitude (W)	Ellipsoid Height (m)	
	9462808 Tidal 4	4/27/2009	4hours 59 min.	54° 23' 39.14616"	164° 44' 23.20766"	22.637	
	Comments	Link to OPUS DB Datashet http://beta.ngs.noaa.gov/OPUS/getDatashet.asp?PID=BBBH99&style=modern					
Station History	See the '9462719 Tide Note.pdf' document.						

TO REACH STATEMENT

946 2808
Scotch Cap, Alaska

To reach the bench marks from the Dutch Harbor Spit Dock, proceed NNE 14.0 km (7.6 nm) to Priest Rock, then NE for 39.8 km (21.5 nm) to the entrance to Akutan Pass, then east for 75.7 km (40.9 nm) to Scotch Cap. The bench marks are along the rock outcrops at either end of the bight below the lighthouse. The tide gauge was located in the destroyed lighthouse and the sensors were located offshore to the ESE.

SCOTCH CAP, ALASKA (946-2808)



0 0.5 1 2 3 4 Nautical Miles

Station Number: 946-2808

Station Name: SCOTCH CAP, AK

Latitude: 54-23-41 N

Longitude: 164-44-19 W

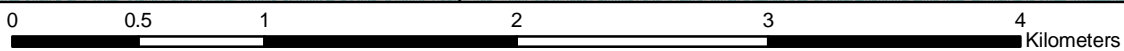
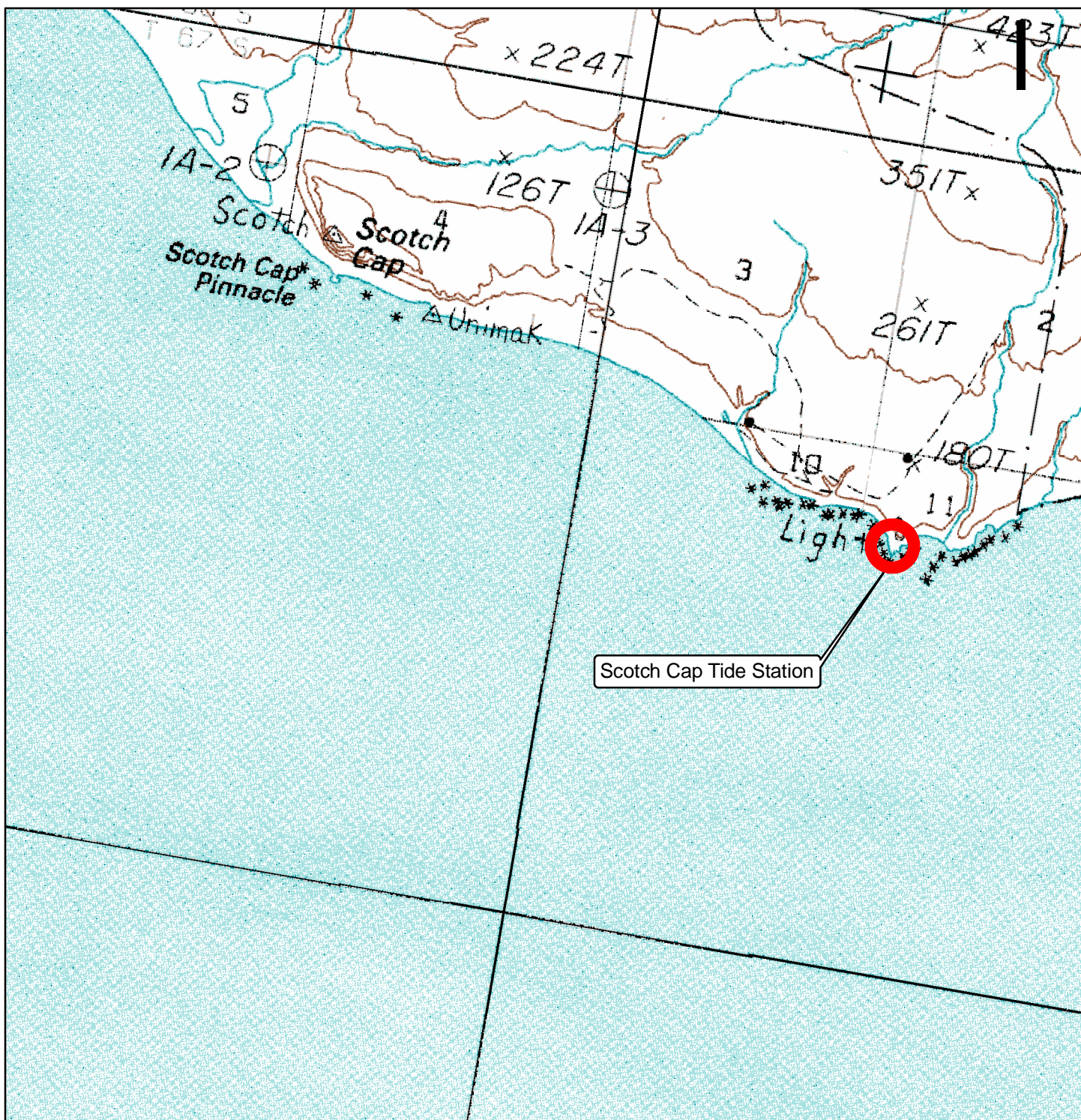
NOAA Chart: 16520, 22nd Ed., Mar/04

Display Scale: 1:150,000

Chart Scale = 1:300,000

USGS Quad: Unimak (B-3)

SCOTCH CAP, ALASKA (946-2808)



Station Number: 946-2808

USGS Quad: UNIMAK B-3

Station Name: SCOTCH CAP, AK

Map Scale = 1:30,000

Latitude: 54-23-38 N

Longitude: 164-44-38 W

BENCHMARK SKETCH

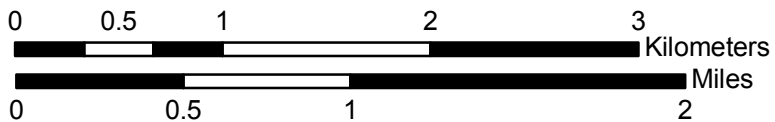
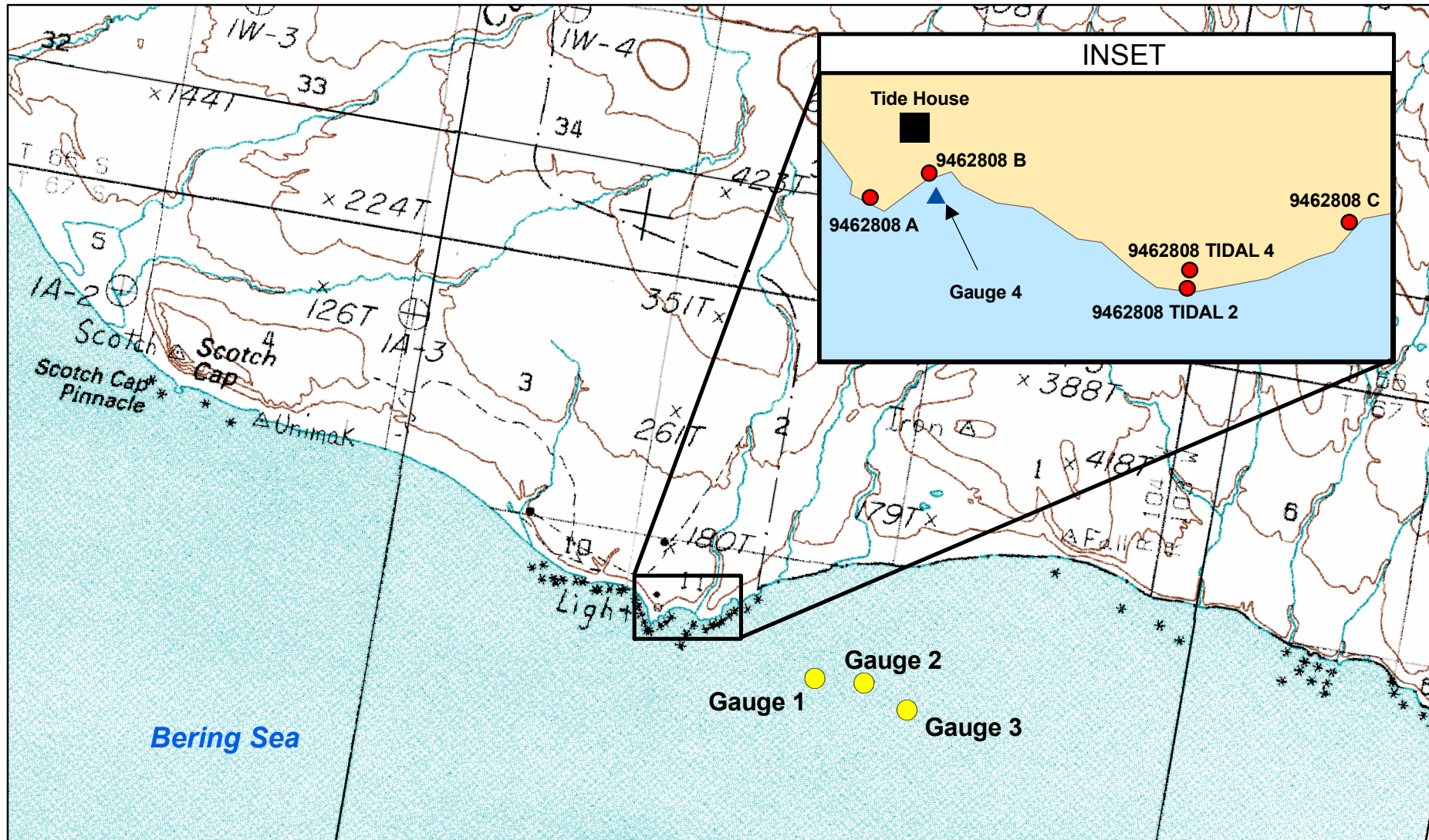
JOA

STATION NAME

STATION NO.

SCOTCH CAP, ALASKA

946-2808



Location of Gauge
Lat: 54-23-32.6 N
Lon: 164-43-39.4 W

**Abstract of Conventional Leveling on Historic Station Datum
Scotch Cap, Unimak Island Alaska
946-2808**

Connected bench marks: 9462808 Tidal 2, 9462808 Tidal 4, 9462808 A, 9462808 B, 9462808 C
 Primary bench mark: 9462808 Tidal 2

	<u>Initial leveling</u>	<u>Closeout leveling</u>
Date	4/27/09 - 4/28/09	9/4/2009
Level/SN	NA2/5191316	NA2/5191316
Rod	Two piece Crane Metric	Two piece Crane Metric
Observer	N. Wardwell	N. Wardwell
Rod person	M. Ewing	G. Gray
C Factor (mm/m)	0.03833	0.02333
Fieldbook Pages	JOA 017 pg. 13	JOA 017 pg. 30

Installation Leveling									
(all values in meters)									
Bench Mark		Distance	Diff. of Elevation (DE)			Closure	Mean DE	Station Datum	
From	To		Forward	Reverse	Elevation			Bench Mark	
9462808 A	9462808 B	90	-1.3680	1.3680	0.0000	-1.3680	6.5808	5.2128	9462808 A
9462808 B	9462808 TIDAL 4	330	1.2613	-1.2647	-0.0034	1.2630	6.4758	6.4758	9462808 TIDAL 4
9462808 TIDAL 4	9462808 TIDAL 2	10	-0.8127	0.8130	0.0003	-0.8128	5.6630	5.6630	9462808 TIDAL 2
Spur to Bench Mark C									
9462808 TIDAL 4	9462808 C	100	-0.8910	0.8900	-0.0010	-0.8905	5.5853	5.5853	9462808 C
Spur to Orifice									
9462808 B	Top of Pipe	30	-4.8590	4.8590	0.0000	-4.8590	0.3538	0.3538	Top of Pipe
Top of Pipe	Orifice "0"	0	-0.183	Note 5		-0.183	0.1708	0.1708	Orifice "0"

June Levels to Orifice									
(all values in meters)									
Bench Mark		Distance	Diff. of Elevation (DE)			Closure	Mean DE	Station Datum	
From	To		Forward	Reverse	Elevation			Bench Mark	
9462808 B	Orifice LP	30	-4.8940	4.8950	0.0010	-4.8945	0.3183	5.2128	9462808 B
Orifice LP	Orifice "0"	0	-0.155	Note 6		-0.1550	0.1633	0.1633	Orifice "0"

Closeout Levels									
(all values in meters)									
Bench Mark		Distance	Diff. of Elevation (DE)			Closure	Mean DE	Station Datum	
From	To		Forward	Reverse	Elevation			Bench Mark	
9462808 A	9462808 B	90	-1.3660	1.3670	0.0010	-1.3665	6.5808	5.2143	9462808 A
9462808 B	9462808 TIDAL 4	330	1.2610	-1.2620	-0.0010	1.2615	6.4758	6.4758	9462808 TIDAL 4
9462808 TIDAL 4	9462808 TIDAL 2	10	-0.8130	0.8127	-0.0003	-0.8128	5.6630	5.6630	9462808 TIDAL 2
Spur to Bench Mark C									
9462808 TIDAL 4	9462808 C	100	-0.8910	0.8893	-0.0017	-0.8902	5.5856	5.5856	9462808 C

Comparison									
(all values in meters)									
Bench Mark		Distance	Diff. of Elevation (DE)			Closure	Mean DE	Station Datum	
From	To		Install	Closeout	Elevation			Bench Mark	
9462808 A	9462808 B	90	-1.3680	-1.3665	-0.0015	-1.3672	6.5808	5.2136	9462808 A
9462808 B	9462808 TIDAL 4	330	1.2630	1.2615	0.0015	1.2622	6.4758	6.4758	9462808 TIDAL 4
9462808 TIDAL 4	9462808 TIDAL 2	10	-0.8128	-0.8128	0.0000	-0.8128	5.6630	5.6630	9462808 TIDAL 2
9462808 TIDAL 4	9462808 C	100	-0.8905	-0.8902	-0.0003	-0.8904	5.5854	5.5854	9462808 C
9462808 B	Orifice "0"	0	-5.0420	-5.0495	0.0075	-5.0458	0.1679	0.1679	Orifice "0"

- Notes :
- 1 - Levels for 9462808 A, 9462808 B, 9462808 C, 9462808 TIDAL 4 and 9462808 TIDAL 2 were run using three wire techniques.
 - 2 - Differences for these marks were obtained from the O9462808 outpt file from the NEWWIZ HP 200 program
 - 3 - The station datum (STND) elevation of 5.663 m for primary benchmark 9462808 TIDAL 2 was provided by CO-OPS (Manoj Samant) via email on 5/6/09.
 - 4 - Single wire levels were used to level from 9462808 B to Top of Pipe
 - 5 - A steel tape was used to tape the separation between the Top of Pipe and the Orifice "0"
 - 6 - A steel tape was used to tape the separation between the Orifice LP and the Orifice "0"

Closeout Leveling		
Compiled by:	N. Wardwell	9/5/09
Verified by:	E. Opegard	10/6/09
		<i>dates</i>

Datum Offset Computation Worksheet

Scotch Cap, Unimak Island Alaska 946-2808

all values in meters

Current as of: Sep 04, 2009

Type of Visit: Removal of Tide Station

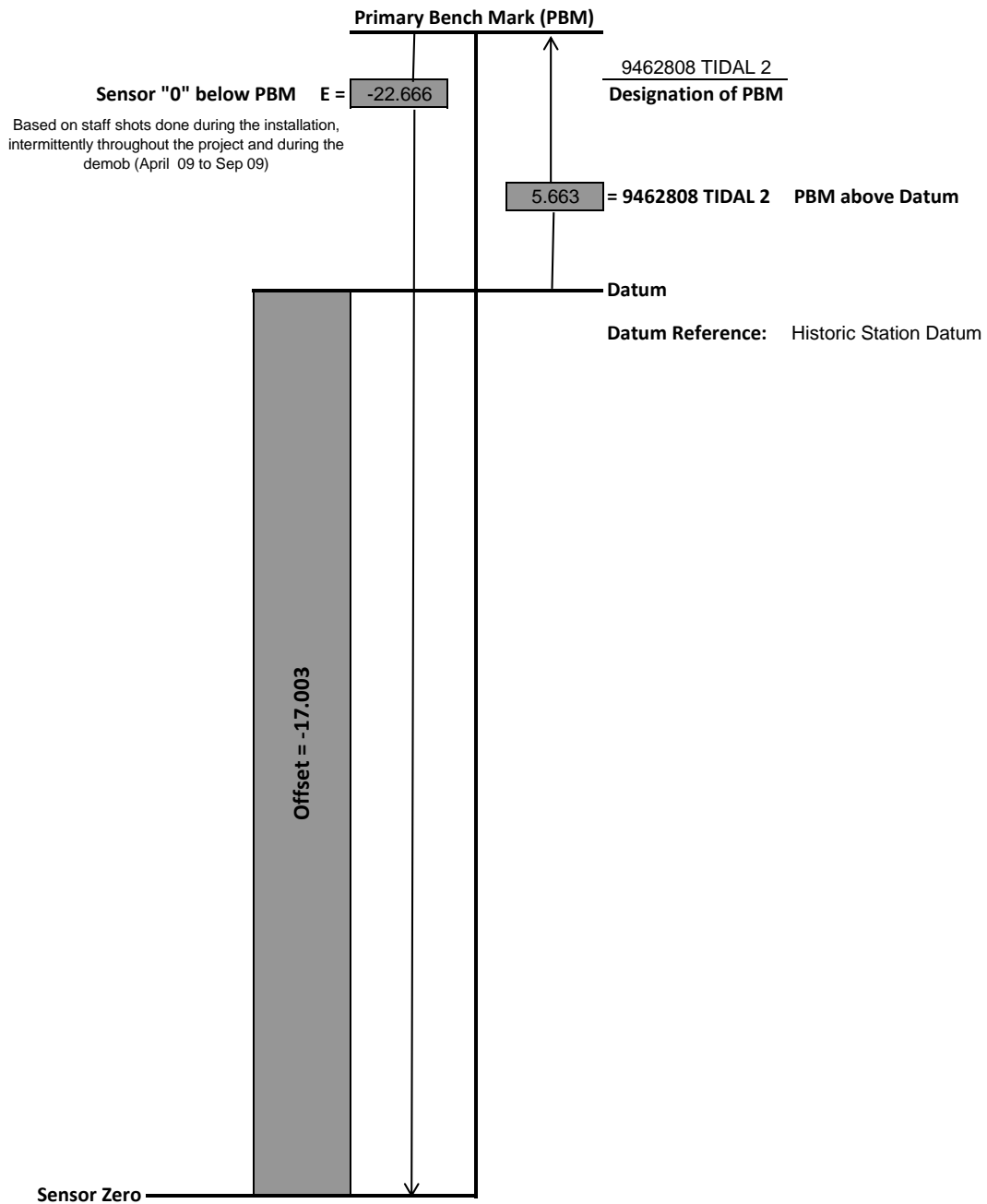
Sensor: The primary water level sensor is also referred to as Gauge #3, and is a submerged ParoScientific pressure sensor.

Offset = D (PBM above Datum) + E (Sensor "0" below PBM)

Offset = 5.663 + -22.666

Offset = -17.003

The offset is the elevation of the Primary Water Level sensor zero or orifice zero above the datum of choice.



Water Density Observations and Slope Constant

Scotch Cap, Unimak Island Alaska

946-2808

Date	Time	Density
04/09/09	22:31	1.027
04/10/09	03:23	1.027
04/15/09	02:30	1.021
04/15/09	04:18	1.024
06/14/09	19:32	1.025
06/14/09	20:05	1.025
06/14/09	21:00	1.024
06/14/09	21:26	1.024
06/24/09	21:24	1.020
06/24/09	21:36	1.020
06/24/09	21:48	1.022
06/24/09	22:22	1.024
06/24/09	23:05	1.022
06/24/09	23:13	1.023
09/05/09	20:59	1.021
09/05/09	21:50	1.022
09/05/09	22:29	1.023
09/05/09	23:04	1.024

Average Density =	1.0232
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Final slope constant =	0.686504
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(see Note 1 below)

 Density of surface water measured by calibrated hydrometer. Samples obtained during staff (water leveling)
 The tide gauge pressure readings (PSI) are multiplied by the final slope constant to determine the corrected

$$\frac{\text{PSI to Pa Conversion Factor}}{\text{Gravity * Water Density * 1000}}$$

For N 54 23 37.1 and W 164 44 44.6 this equation is equivalent to:

$$\frac{6894.757}{9.8156 * 1.023 * 1000}$$

Gravity is calculated using the online NGS predicted gravity model for location and height:

http://www.ngs.noaa.gov/cgi-bin/grav_pdx.pl

Summary of Staff Observations on Historic Station Datum

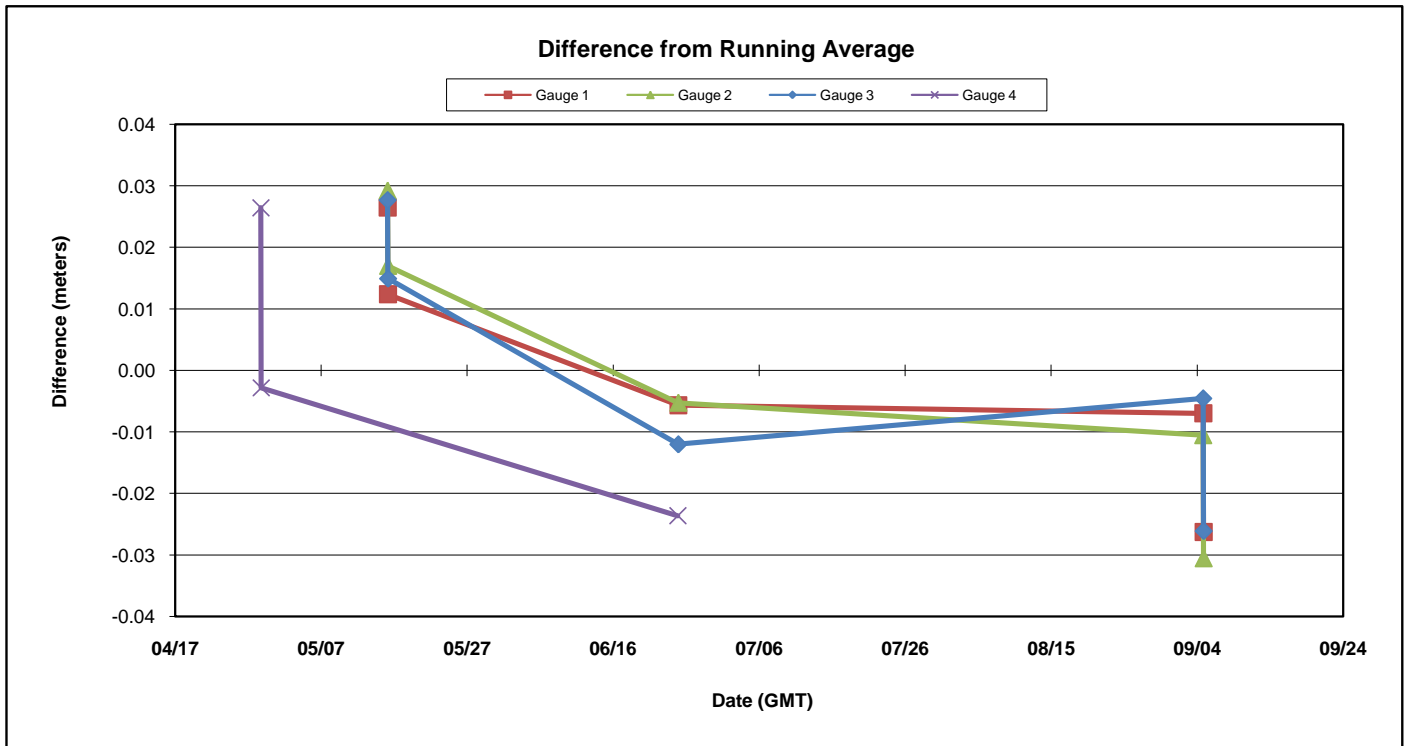
Scotch Cap, Unimak Island Alaska

946-2808

all values in meters
Bold = rejected

	Gauge 1	Gauge 2	Gauge 3	Gauge 4
Average	-17.915	-19.683	-17.003	0.182
St Dev	0.020	0.024	0.021	0.025
Count	5	5	5	3

Date (2009)	Gauge 1	Gauge 2	Gauge 3	Gauge 4	gauge 1	gauge 2	gauge 3	gauge 4
					N	N	N	N
04/27	-18.258	-20.067	-17.390	-0.262	5	5	5	4
04/28	-17.809	-19.598	-16.930	0.208	4	4	4	5
04/28	-17.787	-19.571	-16.900	0.179	9	9	9	8
05/16	-17.889	-19.654	-16.975	0.326	11	11	11	11
05/16	-17.903	-19.666	-16.988	0.335	10	10	10	10
06/13	-17.794	-19.557	-16.875	0.319	22	22	22	22
06/24	-17.941	-19.706	-17.025	0.158	9	9	9	6
06/24	-17.921	-19.689	-17.015	0.301	11	11	11	11
09/04	-17.922	-19.694	-17.007	0.226	15	15	15	15
09/04	-17.942	-19.714	-17.029	0.236	16	16	16	16



- Note 1: All staff constants on this sheet were computed using raw water level readings from the tide gauges but staff readings relative to historic station datum. The average staff constants represent the value that must be added to each of the tide gauges' raw water level readings to produce station datum tide readings.
- Note 2: Staff shots observed near bench mark 2808 C are used to compute the final staff constant for gauges 1, 2 and 3.
- Note 3: Staff shots observed near bench mark 2808 B are used to compute the final staff constant for gauge 4.
- Note 4: The staff constants expressed a unique behavior due to local tidal dynamics. An analysis of this behavior, the stability of the data from all 4 gauges and the methodology for computing the final staff constant are explained in the document "9462808 Tide Note.pdf"
- Note 5: Barometric pressure measured at Scotch Cap using a Sutron barometer were subtracted from the pressure measured by the submersible sensors (Gauges 1 - 3).

**Staff Shot Observations on Historic Station Datum
Scotch Cap, Unimak Island Alaska
946-2808**

Elev TBM 1 = 2.942

Bold = rejected

reject observations with residuals greater than 7 cm

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading				Staff - Stage				Residual			
						Gauge 1 - SN 1155	Gauge 2 - SN 1156	Gauge 3 - SN 1131	Gauge 4 - SN 1051	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 1	Gauge 2	Gauge 3	Gauge 4
04/27 22:24	TBM 1	0.158	2.900	0.220	0.420	18.509	20.322	17.646		-18.089	-19.902	-17.226		0.169	0.165	0.164	
04/27 22:30	TBM 1	0.158	2.890	0.260	0.470	18.578	20.372	17.692		-18.108	-19.902	-17.222		0.150	0.165	0.168	
04/27 22:36	TBM 1	0.158	2.890	0.270	0.480	18.624	20.423	17.758	0.643	-18.144	-19.943	-17.278	-0.163	0.114	0.124	0.112	0.099
04/27 22:42	TBM 1	0.158	2.880	0.250	0.470	18.675	20.479	17.796	0.719	-18.205	-20.009	-17.326	-0.249	0.053	0.058	0.064	0.013
04/27 22:48	TBM 1	0.158	2.875	0.200	0.425	18.730	20.542	17.871	0.739	-18.305	-20.117	-17.446	-0.314	-0.047	-0.050	-0.056	-0.052
04/27 22:54	TBM 1	0.158	2.860	0.250	0.490	18.773	20.589	17.912	0.727	-18.283	-20.099	-17.422	-0.237	-0.025	-0.032	-0.032	0.025
04/27 23:00	TBM 1	0.158	2.875	0.350	0.575	18.841	20.638	17.962	0.823	-18.266	-20.063	-17.387	-0.248	-0.008	0.004	0.003	0.014
04/27 23:06						18.871	20.675	17.999	0.862								
04/27 23:12						18.927	20.728	18.048	0.870								
04/27 23:18						18.977	20.777	18.103	0.877								
04/27 23:24	TBM 1	0.158	2.875	0.290	0.515	18.991	20.804	18.130	0.949	-18.476	-20.289	-17.615	-0.434	-0.218	-0.222	-0.225	-0.172
04/27 23:30	TBM 1	0.158	2.875	0.600	0.825	19.054	20.870	18.195	0.997	-18.229	-20.045	-17.370	-0.172	0.029	0.022	0.020	0.090
04/27 23:36	TBM 1	0.158	2.865	0.480	0.715	19.109	20.905	18.231	1.070	-18.394	-20.190	-17.516	-0.355	-0.136	-0.123	-0.126	-0.093
Observed by: N. Wardwell										average:	-18.258	-20.067	-17.390	-0.262			
Computed by: C. Mayfield										stdev:	0.040	0.043	0.047	0.035			
Notes: Wave height 2 - 3 meters										count:	5	5	5	4			
Leveled from 2808 B to a rock (TBM 1). Then did staff shots off TBM 1. See Pg. 22 in field notes.																	
Staff shots from 22:24 to 22:30 were taken before the bubbler (SN 1051) was installed																	
This set of staff shots were taken in a pool with damp wave influence.																	

Elev TBM 5 = 2.665

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading				Staff - Stage				Residual			
						Gauge 1 - SN 1155	Gauge 2 - SN 1156	Gauge 3 - SN 1131	Gauge 4 - SN 1051	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 1	Gauge 2	Gauge 3	Gauge 4
04/28 17:54	TBM 2	1.086	2.532	0.250	1.469	19.149	20.928	18.251	1.117	-17.680	-19.459	-16.782	0.352	0.129	0.139	0.148	0.144
04/28 18:00	TBM 2	1.086	2.482	0.300	1.569	19.104	20.876	18.203	1.086	-17.535	-19.307	-16.634	0.483	0.274	0.290	0.296	0.275
04/28 18:06	TBM 2	1.086	2.623	0.080	1.208	19.043	20.826	18.151	1.026	-17.835	-19.618	-16.943	0.182	-0.026	-0.021	-0.013	-0.026
04/28 18:12	TBM 2	1.086	2.596	0.150	1.305	18.982	20.766	18.092	0.962	-17.677	-19.461	-16.787	0.343	0.132	0.137	0.143	0.135
04/28 18:18	TBM 2	1.086	2.599	0.100	1.252	18.925	20.707	18.042	0.926	-17.673	-19.455	-16.790	0.326	0.136	0.142	0.139	0.118
04/28 18:24	TBM 2	1.086	2.847	0.020	0.924	18.884	20.665	17.993	0.893	-17.960	-19.741	-17.069	0.031	-0.151	-0.144	-0.139	-0.177
04/28 18:30	TBM 2	1.086	2.974	0.340	1.117	18.927	20.621	17.946	0.851	-17.711	-19.504	-16.831	0.266	0.098	0.094	0.099	0.058
04/28 18:36	TBM 2	1.086	2.983	0.160	0.928	18.764	20.562	17.883	0.762	-17.836	-19.634	-16.965	0.166	-0.027	-0.037	-0.035	-0.042
04/28 18:42	TBM 2	1.086	2.875	0.060	0.936	18.721	20.503	17.839	0.725	-17.785	-19.567	-16.903	0.211	0.024	0.031	0.027	0.003
04/28 18:48	TBM 2	1.086	2.994	0.130	0.887	18.666	20.458	17.794	0.670	-17.779	-19.571	-16.907	0.217	0.030	0.027	0.023	0.009
Observed by: N. Wardwell										average:	-17.809	-19.598	-16.930	0.208			
Computed by: C. Mayfield										stdev:	0.031	0.034	0.030	0.038			
Notes: Wave height 1 - 2 meters										count:	4	4	4	5			
Leveled from 2808 B to a rock (TBM 2). Then did staff shots off TBM 5. See pg. 22 in field notes.																	

Elev TBM 5 = 2.665

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading				Staff - Stage				Residual			
						Gauge 1 - SN 1155	Gauge 2 - SN 1156	Gauge 3 - SN 1131	Gauge 4 - SN 1051	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 1	Gauge 2	Gauge 3	Gauge 4
04/28 19:00	TBM 2	0.063	2.102	0.150	0.776	18.572	20.365	17.699	0.619	-17.796	-19.589	-16.923	0.157	-0.010	-0.018	-0.023	-0.022
04/28 19:06	TBM 2	0.063	2.185	0.300	0.843	18.547	20.326	17.660	0.557	-17.704	-19.483	-16.817	0.286	0.082	0.088	0.083	0.107
04/28 19:12	TBM 2	0.063	2.201	0.150	0.677	18.502	20.286	17.616	0.502	-17.825	-19.609	-16.939	0.175	-0.039	-0.038	-0.039	-0.004
04/28 19:18	TBM 2	0.063	2.202	0.170	0.696	18.459	20.243	17.571	0.491	-17.763	-19.547	-16.875	0.205	0.023	0.024	0.025	0.026
04/28 19:24	TBM 2	0.063	2.202	0.170	0.696	18.425	20.203	17.533	0.428	-17.729	-19.507	-16.837	0.268	0.057	0.064	0.063	0.089
04/28 19:30	TBM 2	0.063	2.393	0.250	0.585	18.386	20.172	17.498	0.431	-17.801	-19.587	-16.913	0.154	-0.015	-0.016	-0.013	-0.025
04/28 19:36	TBM 2	0.063	2.392	0.200	0.536	18.345	20.130	17.458	0.378	-17.809	-19.594	-16.922	0.158	-0.023	-0.023	-0.022	-0.021
04/28 19:42	TBM 2	0.063	2.402	0.250	0.576	18.314	20.096	17.427	0.336	-17.738	-19.520	-16.851	0.240	0.048	0.051	0.049	0.061
04/28 19:48	TBM 2	0.063	2.494	0.250	0.484	18.277	20.066	17.391	0.315	-17.793	-19.582	-16.907	0.169	-0.007	-0.011	-0.007	-0.010
04/28 19:54	TBM 2	0.063	2.445	0.160	0.443	18.266	20.043	17.374	0.268	-17.823	-19.600	-16.931	0.175	-0.037	-0.029	-0.031	-0.004
Observed by: N. Wardwell										average:	-17.787	-19.571	-16.900	0.179			
Computed by: C. Mayfield										stdev:	0.035	0.037	0.037	0.029			
Notes: Wave height 1 - 2 meters										count:	9	9	9	8			
Leveled from 2808 B to a rock (TBM 2). Then did staff shots off TBM 5. See pg. 22 in field notes.																	

Elev TBM T1 = 2.851

GMT Time	Bench Mark	Back Sight	Rod Rdg	Rod Cut	Station Datum Water Level	Stage Reading				Staff - Stage				Residual			
						Gauge 1 - SN 1155	Gauge 2 - SN 1156	Gauge 3 - SN 1131	Gauge 4 - SN 1051	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 1	Gauge 2	Gauge 3	Gauge 4
05/16 02:30	TBM 3	0.643	2.306	0.330	1.518	19.441	21.206	18.527	1.238	-17.923	-19.688	-17.009	0.280	-0.034	-0.034	-0.033	-0.046
05/16 02:36						19.453	21.216	18.537	1.246								
05/16 02:42						19.467	21.235	18.553	1.261								
05/16 02:48	TBM 3	0.643	2.306	0.460	1.648	19.496	21.261	18.581	1.289	-17.848	-19.613	-16.933	0.359	0.041	0.041	0.043	0.033
05/16 02:54	TBM 3	0.643	2.306	0.440	1.628	19.511	21.278	18.598	1.301	-17.883	-19.650	-16.970	0.327	0.006	0.004	0.006	0.001
05/16 03:00	TBM 3	0.643	2.306	0.480	1.648	19.541	21.306	18.626	1.335	-17.893	-19.658	-16.978	0.313	-0.004	-0.004	-0.002	-0.013
05/16 03:06	TBM 3	0.643	2.306	0.480	1.668	19.570	21.334	18.659	1.352	-17.902	-19.666	-16.991	0.316	-0.013	-0.012	-0.015	-0.010
05/16 03:12	TBM 3	0.643	2.306	0.520	1.708	19.602	21.369	18.689	1.399	-17.894	-19.661	-16.981	0.309	-0.005	-0.007	-0.005	-0.017
05/16 03:18	TBM 3	0.643	2.306	0.540	1.728	19.627	21.395	18.717	1.403	-17.899	-19.667	-16.989	0.325	-0.010	-0.010	-0.013	-0.001
05/16 03:24	TBM 3	0.643	2.306	0.560	1.748	19.646	21.411	18.734	1.427	-17.898	-19.663	-16.986	0.321	-0.009	-0.009	-0.010	-0.005
05/16 03:30	TBM 3	0.643	2.306	0.580	1.768	19.657	21.426	18.744	1.439	-17.889	-19.658	-16.976	0.329	0.000	-0.004	0.000	0.003
05/16 03:36						19.684	21.446	18.769	1.467								
05/16 03:42						19.713	21.479	18.802	1.483								
05/16 03:48	TBM 3	0.627	2.175	0.550	1.853	19.735	21.495	18.815	1.506	-17.882	-19.642	-16.962	0.347	0.007	0.012	0.014	0.021
05/16 03:54	TBM 3	0.627	2.175														

**Staff Shot Observations on Historic Station Datum
Scotch Cap, Unimak Island Alaska
946-2808**

Elev TBM C = 3.469

GMT Time	Bench Mark	Back Sight	Rod Rdd	Rod Cut	Station Datum Water Level	Stage Reading				Staff - Stage				Residual				
						Gauge 1 - SN 1155	Gauge 2 - SN 1156	Gauge 3 - SN 1131	Gauge 4 - SN 1051	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 1	Gauge 2	Gauge 3	Gauge 4	
06/13 19:30	TBM 4	0.119	2.742	0.490	1.336	19.156	20.915	18.231	1.042	-17.820	-19.579	-16.895	0.294	-0.026	-0.022	-0.020	-0.025	
06/13 19:36	TBM 4	0.119	2.742	0.490	1.336	19.121	20.883	18.202	0.998	-17.785	-19.547	-16.866	0.338	0.009	0.010	0.009	0.019	
06/13 19:42	TBM 4	0.119	2.742	0.460	1.306	19.100	20.864	18.172	0.976	-17.794	-19.558	-16.866	0.330	0.000	-0.001	0.009	0.011	
06/13 19:48	TBM 4	0.119	2.742	0.440	1.286	19.081	20.848	18.165	0.975	-17.795	-19.562	-16.879	0.311	-0.001	-0.005	-0.004	-0.008	
06/13 19:54	TBM 4	0.119	2.742	0.430	1.276	19.066	20.826	18.142	0.949	-17.790	-19.550	-16.866	0.327	0.004	0.007	0.009	0.008	
06/13 20:00	TBM 4	0.119	2.742	0.390	1.236	19.037	20.804	18.120	0.828	-17.801	-19.568	-16.884	0.308	-0.007	-0.011	-0.009	-0.011	
06/13 20:06	TBM 4	0.119	2.742	0.360	1.206	19.011	20.770	18.092	0.880	-17.805	-19.564	-16.886	0.326	-0.011	-0.007	-0.011	0.007	
06/13 20:12	TBM 4	0.119	2.742	0.310	1.156	18.987	20.752	18.068	0.882	-17.831	-19.596	-16.912	0.274	-0.037	-0.039	-0.037	-0.045	
06/13 20:18	TBM 4	0.119	2.742	0.310	1.156	18.970	20.734	18.054	0.863	-17.814	-19.578	-16.898	0.293	-0.020	-0.021	-0.023	-0.026	
06/13 20:24	TBM 4	0.119	2.742	0.280	1.126	18.945	20.706	18.027	0.834	-17.819	-19.580	-16.901	0.292	-0.025	-0.023	-0.026	-0.027	
06/13 20:30	TBM 4	0.119	2.742	0.280	1.126	18.928	20.689	18.008	0.813	-17.802	-19.563	-16.882	0.313	-0.008	-0.006	-0.007	-0.006	
06/13 20:36	TBM 4	0.119	2.742	0.290	1.136	18.911	20.673	17.992	0.791	-17.775	-19.537	-16.856	0.345	0.019	0.020	0.019	0.026	
06/13 20:42	TBM 4	0.119	2.742	0.240	1.086	18.895	20.655	17.973	0.781	-17.809	-19.569	-16.887	0.305	-0.015	-0.012	-0.012	-0.014	
06/13 20:48	TBM 4	0.119	2.742	0.240	1.086	18.880	20.646	17.958	0.764	-17.794	-19.560	-16.872	0.322	0.000	-0.003	0.003	0.003	
06/13 20:54	TBM 4	0.119	2.742	0.240	1.086	18.860	20.619	17.936	0.743	-17.774	-19.533	-16.850	0.343	0.020	0.024	0.025	0.024	
06/13 21:00	TBM 4	0.119	2.742	0.210	1.056	18.846	20.609	17.928	0.732	-17.790	-19.553	-16.872	0.324	0.004	0.004	0.003	0.005	
06/13 21:06	TBM 4	0.119	2.742	0.190	1.036	18.833	20.593	17.913	0.724	-17.797	-19.557	-16.877	0.312	-0.003	0.000	-0.002	-0.007	
06/13 21:12	TBM 4	0.119	2.742	0.155	1.001	18.809	20.573	17.897	0.715	-17.808	-19.572	-16.896	0.286	-0.014	-0.015	-0.021	-0.033	
06/13 21:18	TBM 4	0.119	2.742	0.220	1.066	18.799	20.565	17.886	0.697	-17.733	-19.499	-16.820	0.369	0.061	0.058	0.055	0.050	
06/13 21:24	TBM 4	0.119	2.742	0.210	1.056	18.795	20.557	17.880	0.687	-17.739	-19.501	-16.824	0.369	0.055	0.056	0.051	0.050	
06/13 21:30	TBM 4	0.119	2.742	0.145	0.991	18.790	20.554	17.873	0.676	-17.799	-19.563	-16.882	0.315	-0.005	-0.006	-0.007	-0.004	
06/13 21:36	TBM 4	0.119	2.742	0.150	0.996	18.792	20.553	17.871	0.677	-17.796	-19.557	-16.875	0.319	-0.002	0.000	0.000	0.000	
Observed by: J. Hazen, L. Gates, P. McCarthy, J. Barneau, L. Bennett										average:	-17.941	-19.557	-16.875	0.319				
Computed by: N. Wardwell										stdev:	0.023	0.023	0.023	0.024				
Notes: Wave height 0.1 - 0.3 meters										count:	22	22	22	22				
TBM C is renamed to TBM 4 to maintain TBM naming convention.																		

Elev TBM B = 3.325

GMT Time	Bench Mark	Back Sight	Rod Rdd	Rod Cut	Station Datum Water Level	Stage Reading				Staff - Stage				Residual				
						Gauge 1 - SN 1155	Gauge 2 - SN 1156	Gauge 3 - SN 1131	Gauge 4 - SN 1051	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 1	Gauge 2	Gauge 3	Gauge 4	
06/24 20:54	TBM 5	0.253	3.584	0.235	0.229	18.154	19.914	17.234	17.234	-17.825	-19.685	-17.005	0.266	0.016	0.020	0.020	0.020	
06/24 21:00	TBM 5	0.253	3.584	0.280	0.274	18.124	19.953	17.271	17.271	-17.920	-19.679	-16.997	0.291	0.021	0.026	0.028	0.028	
06/24 21:06	TBM 5	0.253	3.584	0.325	0.319	18.227	19.991	17.307	17.307	-17.908	-19.672	-16.988	0.287	0.033	0.033	0.037	0.037	
06/24 21:12	TBM 5	0.253	3.584	0.350	0.344	18.259	20.025	17.348	17.348	-17.915	-19.681	-17.004	0.267	0.026	0.024	0.021	0.021	
06/24 21:18	TBM 5	0.253	3.584	0.400	0.394	18.318	20.080	17.400	17.400	-17.924	-19.686	-17.006	0.169	0.017	0.019	0.019	0.011	
06/24 21:24	TBM 5	0.253	3.584	0.415	0.409	18.366	20.133	17.454	17.454	-17.957	-19.724	-17.045	0.160	-0.016	-0.019	-0.020	0.000	
06/24 21:30	TBM 5	0.253	3.584	0.465	0.459	18.417	20.185	17.504	17.504	-17.958	-19.726	-17.045	0.158	-0.017	-0.021	-0.020	0.002	
06/24 21:36	TBM 5	0.253	3.584	0.505	0.499	18.478	20.248	17.561	17.561	-17.979	-19.749	-17.062	0.153	-0.038	-0.044	-0.037	-0.005	
06/24 21:42	TBM 5	0.253	3.584	0.550	0.544	18.525	20.290	17.617	17.617	-17.981	-19.746	-17.073	0.156	-0.040	-0.044	-0.048	-0.002	
06/24 21:48	TBM 5	0.253	3.584	0.615	0.609	18.599	20.366	17.679	17.679	-17.990	-19.757	-17.070	0.154	-0.049	-0.052	-0.045	-0.004	
Observed by: J. Hazen, L. Gates										average:	-17.941	-19.706	-17.025	0.158				
Computed by: N. Wardwell										stdev:	0.028	0.031	0.031	0.006				
Notes: TBM B is renamed to TBM 5 to maintain naming convention										count:	9	9	9	9				
TBM B is based on elevations of Benchmark 2808-B-2009 (see field book 1, page 26).																		
Staff shots from 20:54 to 21:12 were taken when bubbler (SN 1051) readings were biased by fresh water, thus they are omitted.																		

Elev TBM C = 3.469

GMT Time	Bench Mark	Back Sight	Rod Rdd	Rod Cut	Station Datum Water Level	Stage Reading				Staff - Stage				Residual				
						Gauge 1 - SN 1155	Gauge 2 - SN 1156	Gauge 3 - SN 1131	Gauge 4 - SN 1051	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 1	Gauge 2	Gauge 3	Gauge 4	
06/24 22:24	TBM 4	0.771	3.813	0.560	0.987	18.900	20.669	17.997	17.997	-17.913	-19.682	-17.010	0.266	0.008	0.006	0.005	-0.035	
06/24 22:30	TBM 4	0.771	3.813	0.610	1.037	18.966	20.730	18.061	18.061	-17.929	-19.693	-17.024	0.267	-0.008	-0.005	-0.009	-0.034	
06/24 22:36	TBM 4	0.771	3.813	0.695	1.122	19.028	20.795	18.119	18.119	-17.906	-19.673	-16.997	0.291	0.015	0.015	0.018	-0.010	
06/24 22:42	TBM 4	0.771	3.813	0.740	1.167	19.085	20.853	18.171	18.171	-17.877	-19.618	-16.986	0.290	0.003	0.002	0.011	-0.011	
06/24 22:48	TBM 4	0.771	3.813	0.770	1.197	19.119	20.887	18.218	18.218	-17.922	-19.690	-17.021	0.287	-0.001	-0.002	-0.006	-0.014	
06/24 23:00	TBM 4	0.754	3.296	0.360	1.287	19.180	20.947	18.268	18.268	-17.941	-19.689	-17.013	0.290	-0.020	-0.021	-0.022	-0.011	
06/24 23:06	TBM 4	0.754	3.296	0.455	1.382	19.293	21.061	18.379	18.379	-17.911	-19.679	-16.997	0.325	0.010	0.009	0.018	0.024	
06/24 23:12	TBM 4	0.754	3.296	0.485	1.412	19.326	21.092	18.422	18.422	-17.914	-19.680	-17.010	0.324	0.007	0.008	0.005	0.023	
06/24 23:18	TBM 4	0.754	3.296	0.535	1.462	19.379	21.151	18.473	18.473	-17.917	-19.689	-17.011	0.315	0.004	-0.001	0.004	0.014	
06/24 23:24	TBM 4	0.754	3.296	0.570	1.497	19.424	21.191	18.521	18.521	-17.927	-19.694	-17.024	0.332	-0.006	-0.006	-0.009	0.031	
06/24 23:30	TBM 4	0.754	3.296	0.620	1.547	19.478	21.245	18.574	18.574	-17.931	-19.698	-17.027	0.328	-0.010	-0.010	-0.012	0.027	
Observed by: J. Hazen, L. Gates, K. Ciembrowicz										average:	-17.921	-19.689	-17.015	0.301				
Computed by: N. Wardwell										stdev:	0.010	0.010	0.013	0.024				
Notes: TBM C is renamed to TBM 4 to maintain naming convention.										count:	11	11	11	11				
Wave height 0.2-0.4m																		

Elev TBM 2 = 3.012

GMT Time	Bench Mark	Back Sight	Rod Rdd	Rod Cut	Station Datum Water Level	Stage Reading				Staff - Stage				Residual			
						Gauge 1 - SN 1155	Gauge 2 - SN 1156	Gauge 3 - SN 1131	Gauge 4 - SN 1051	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 1	Gauge 2	Gauge 3	Gauge 4
09/04 20:06	TBM 6	0.271	2.346	0.310	1.247	19.173	20.943	18.252	1.041	-17.926	-19.696	-17.005	0.206	-0.004	-0.002	0.002	-0.020
09/04 20:12	TBM 6	0.271	2.346	0.360	1.297	19.204	20.975	18.293	1.074	-17.907	-19.678	-16.996	0.223	0.015	0.016	0.011	-0.003
09/04 20:18	TBM 6	0.271	2.346	0.370	1.307	19.240	21.011	18.323	1.102	-17.933	-19.704	-17.015	0.205	-0.011	-0.010	-0.008	-0.021
09/04 20:24	TBM 6	0.271	2.346	0.420	1.357	19.270	21.039	18.355	1.134	-17.913	-19.682	-16.998	0.223	0.009	0.012	0.009	-0.003
09/04 20:30	TBM 6	0.271	2.346	0.460	1.397	19.307	21.080	18.396	1.165	-17.910	-19.683	-16.999	0.232	0.012	0.011	0.008	0.006
09/04 20:36	TBM 6	0.271	2.346	0.480	1.417	19.345	21.114	18.430	1.204	-17.928	-19.697	-17.013	0.213	-0.006	-0.003	-0.006	-0.013
09/04 20:42	TBM 6	0.271	2.346	0.500	1.437	19.376	21.145	18.460	1.231	-17.939	-19.708	-17.023	0.206	-0.017	-0.014	-0.016	-0.020
09/04 20:48	TBM 6	0.271	2.346	0.550	1.487	19.406	21.179	18.493	1.259	-17.919	-19.692	-17.006	0.228	0.003	0.002	0.001	0

Site Datum

1983-2001 NTDE

Site Datum	Values in meters
5.663	PBM 946 2808 TIDAL 2
PLANES	
3.260	Highest Tide
2.479	MHW
0.761	MLLW
-0.157	Lowest Tide
Gauge "0"	
-17.915	Gauge 1 ^{1,2}
-19.683	Gauge 2 ^{1,2}
-17.003	Gauge 3 ^{1,2}
Orifice "0"	
0.168	Gauge 4 ^{3,4}

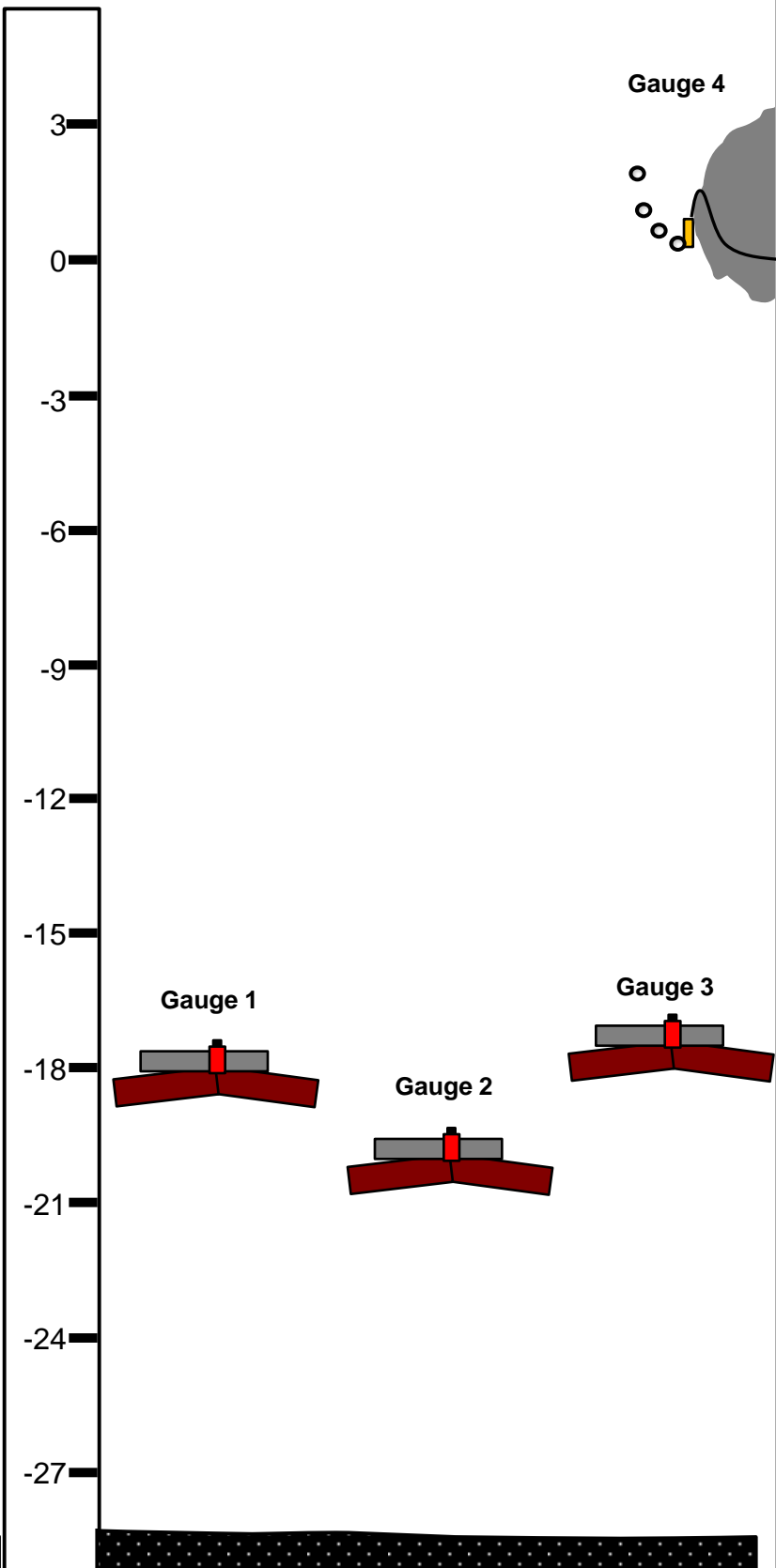
Notes:

1 – Gauges 1, 2, and 3 are Seabird 26+ submersible gauges that are mounted to separate 1000 lb anchors approximately 2000' off shore.

2 - The elevations of gauges 1, 2 and 3 were determined from staff shots. See the '9462719 Tide Note.pdf' document

3 – Gauge 4 was a digital bubbler that was secured to bedrock. This gauge was installed as a virtual tide staff. This gauge was intentionally installed so that is measured partial tides.

4 – The elevation of gauge 4 was determined from spirit leveling and steel tape measurements.



JOA Surveys, LLC
 2000 E. Dowling Rd, #10
 Anchorage, AK 99507
 www.joasurveys.com

STATION:	Scotch Cap	REVISED
Drawn By:	CM	NW
Checked By:	NW	
Date:	5/12/2009	10/28/2009



9462808 A
Scotch Cap, AK
View east
April 26, 2009

9462808 A east.jpg



9462808 A
Scotch Cap, AK
April 26, 2009

9462808 A face.jpg



9462808 A
Scotch Cap, AK
View NW
April 26, 2009

9462808 A NW.jpg



9462808 A
Scotch Cap, AK
View SW
April 26, 2009

9462808 A SW.jpg



9462808 B
Scotch Cap, AK
View east
April 26, 2009

9462808 B east.jpg



9462808 B
Scotch Cap, AK
April 26, 2009

9462808 B face.jpg

9462808 B
Scotch Cap, AK
View NE
April 26, 2009



9462808 B NE.jpg

9462808 B
Scotch Cap, AK
View NW
April 29, 2009



9462808 B NW.jpg

9462808 C
Scotch Cap, AK
April 26, 2009



9462808 C face.jpg

9462808 C
Scotch Cap, AK
View NW
April 27, 2009



9462808 C NW.jpg

9462808 C
Scotch Cap, AK
View SE
April 27, 2009



9462808 C SE.jpg

9462808 C
Scotch Cap, AK
View SW
April 27, 2009



9462808 C SW.jpg



9462808 orifice.jpg



9462808 seabird anchor.jpg



9462808 TIDAL 2 face.jpg



9462808 TIDAL 2 NW.jpg



9462808 TIDAL 2 SE.jpg



9462808 TIDAL 2 standing.jpg

9462808 TIDAL 2
Scotch Cap, AK
View SW
April 27, 2009



9462808 TIDAL 4
Scotch Cap, AK
April 26, 2009



9462808 TIDAL 2 SW.jpg

9462808 TIDAL 4 face.jpg

9462808 TIDAL 4
Scotch Cap, AK
View NE
April 27, 2009



9462808 TIDAL 4
Scotch Cap, AK
View NW
April 27, 2009



9462808 TIDAL 4 NE.jpg

9462808 TIDAL 4 NW.jpg

9462808 TIDAL 4
Scotch Cap, AK
View SE
April 27, 2009



9462808 TIDAL 4
Scotch Cap, AK
View west
April 27, 2009



9462808 TIDAL 4 SE.jpg

9462808 TIDAL 4 west.jpg



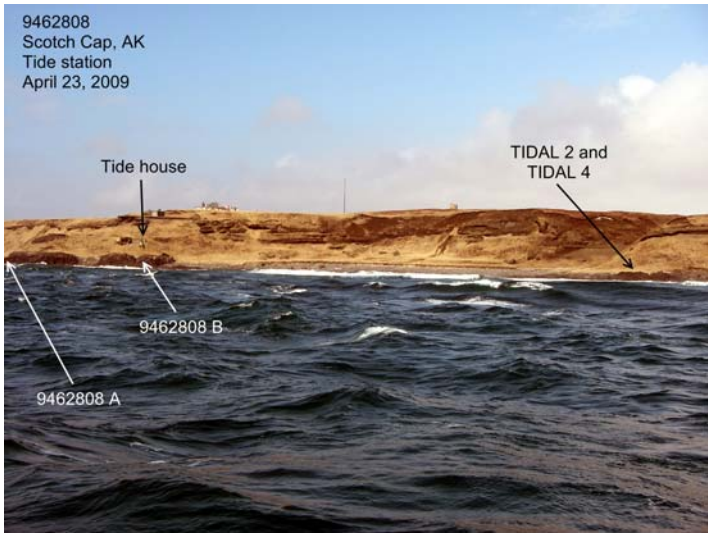
9462808
Scotch Cap, AK
Tide gauges
April 27, 2009

9462808 tide gauges.jpg



9462808
Scotch Cap, AK
Tide station
April 26, 2009

9462808 tide station 1.jpg



9462808
Scotch Cap, AK
Tide station
April 23, 2009

9462808 tide station 2.jpg



9462808
Scotch Cap, AK
September 5, 2009

9462808 all gauges 2.jpg



9462808
Scotch Cap, AK
September 5, 2009

9462808 all gauges.jpg



9462808
Scotch Cap, AK
Gauge 1 modem
September 5, 2009

9462808 Gauge 1 modem closeup.jpg



9462808
Scotch Cap, AK
Gauge 1
September 5, 2009

9462808 Gauge 1 modem.jpg



9462808
Scotch Cap, AK
Gauge 1
September 5, 2009

9462808 Gauge 1 mount.jpg



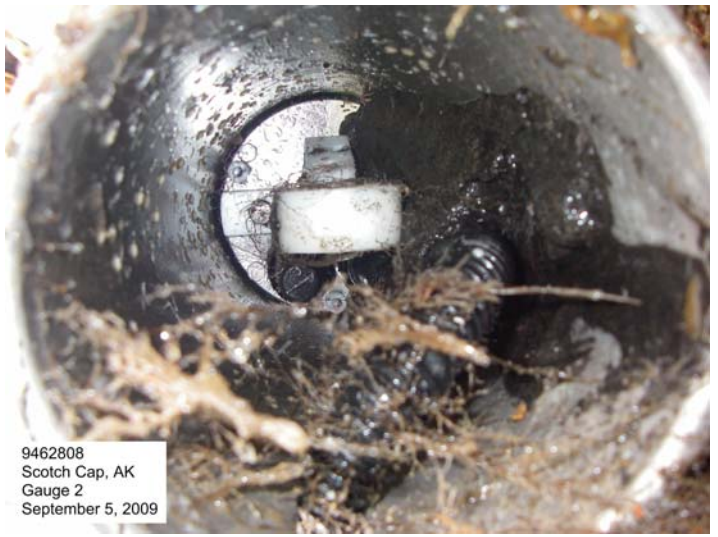
9462808
Scotch Cap, AK
Gauge 1
September 5, 2009

9462808 Gauge 1 retrieved.jpg



9462808
Scotch Cap, AK
Gauge 2
September 5, 2009

9462808 Gauge 2 modem.jpg



9462808
Scotch Cap, AK
Gauge 2
September 5, 2009

9462808 Gauge 2 orifice 2.jpg



9462808
Scotch Cap, AK
Gauge 2
September 5, 2009

9462808 Gauge 2 orifice.jpg



9462808
Scotch Cap, AK
Gauge 2
September 5, 2009

9462808 Gauge 2 retrieved 2.jpg



9462808
Scotch Cap, AK
Gauge 2
September 5, 2009

9462808 Gauge 2 retrieved.jpg



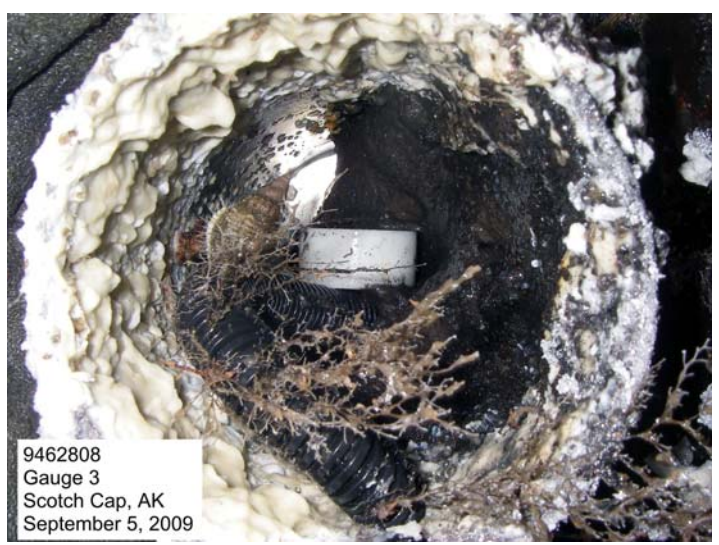
9462808
Scotch Cap, AK
Gauge 3
September 5, 2009

9462808 Gauge 3 mounting tube 2.jpg

9462808
Scotch Cap, AK
Gauge 3
September 5, 2009



9462808 Gauge 3 mounting tube.jpg



9462808
Gauge 3
Scotch Cap, AK
September 5, 2009

9462808 Gauge 3 orifice.jpg



9462808
Scotch Cap, AK
Gauge 3
September 5, 2009

9462808 Gauge 3 retrieved.jpg



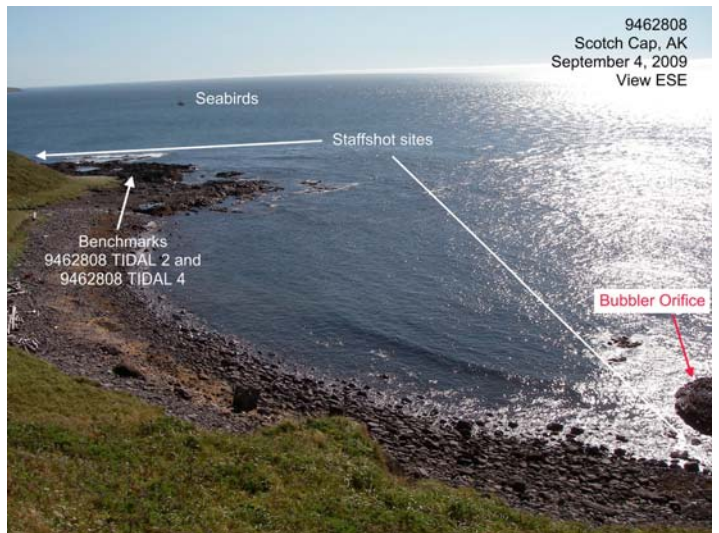
9462808
Scotch Cap, AK
September 4, 2009
View NW

9462808 Lighthouse NW.jpg



9462808
Scotch Cap, AK
September 4, 2009
view SSW

9462808 Powerhouse SSW.jpg



9462808
Scotch Cap, AK
September 4, 2009
View ESE

9462808 vicinity 3 ESE.jpg

9462808
Scotch Cap, AK
September 4, 2009
View ESE

Benchmarks
9462808 TIDAL 2 and
9462808 TIDAL 4



9462808 vicinity ESE.jpg

9462808
Scotch Cap, AK
September 4, 2009
View NNW

9462808 C



9462808 wreck NNW.jpg

Tide Gauge System Acceptance Test

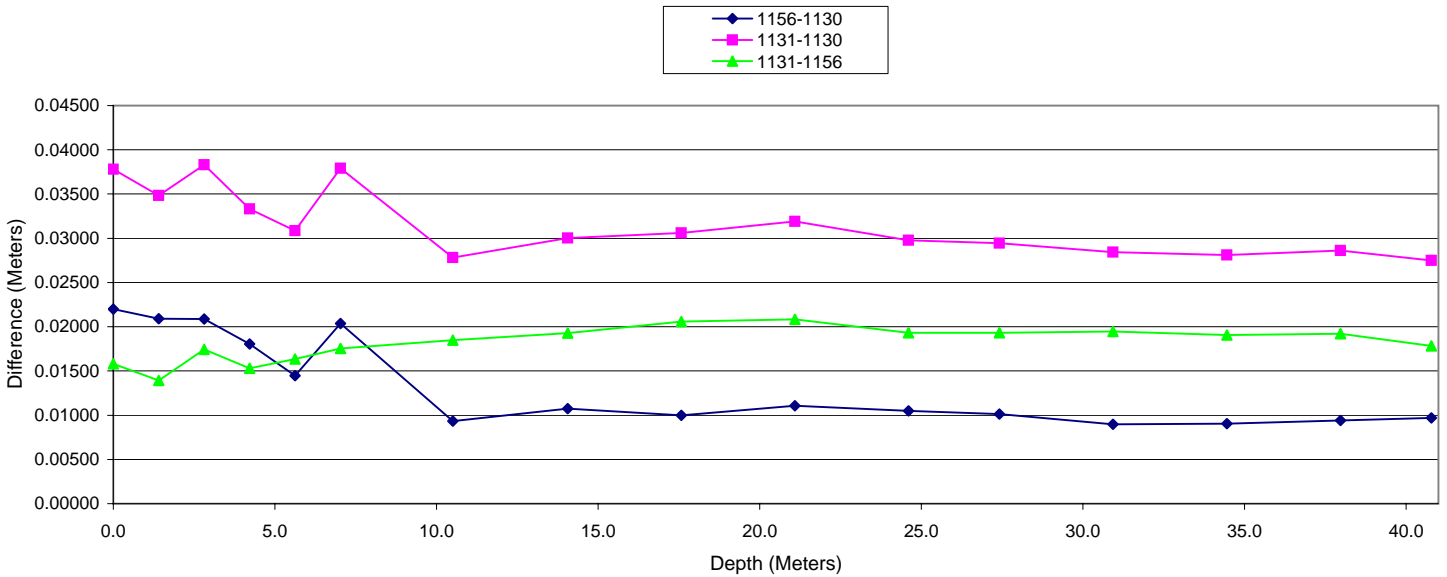
Serial No.: Seabird 1130
Date of test: 3/11/2009

Seabird 1131 Seabird 1156

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1130 PSI	1131 PSI	1156 PSI	1131-1130 Meters	1131-1156 Meters	1156-1130 Meters
0	0.0	5	-0.2611	-0.2073	-0.2298	0.0378	0.0158	0.0220
2	1.4	5	1.9023	1.9519	1.9321	0.0348	0.0139	0.0209
4	2.8	5	4.0331	4.0876	4.0628	0.0383	0.0175	0.0209
6	4.2	5	6.0847	6.1321	6.1104	0.0333	0.0153	0.0180
8	5.6	5	8.0767	8.1206	8.0973	0.0309	0.0164	0.0145
10	7.0	5	12.8743	12.9282	12.9032	0.0379	0.0175	0.0204
15	10.5	5	14.9981	15.0376	15.0113	0.0278	0.0185	0.0093
20	14.1	5	19.9323	19.9750	19.9476	0.0300	0.0193	0.0108
25	17.6	5	24.9116	24.9551	24.9258	0.0306	0.0206	0.0100
30	21.1	5	30.0327	30.0780	30.0484	0.0319	0.0208	0.0111
35	24.6	5	34.5810	34.6234	34.5959	0.0298	0.0193	0.0105
39	27.4	5	38.7660	38.8079	38.7804	0.0294	0.0193	0.0101
44	30.9	5	44.0721	44.1126	44.0849	0.0284	0.0194	0.0090
49	34.5	5	49.2371	49.2771	49.2500	0.0281	0.0191	0.0090
54	38.0	5	54.3271	54.3678	54.3405	0.0286	0.0192	0.0094
58	40.8	5	58.3026	58.3417	58.3164	0.0275	0.0178	0.0097
Average =						0.0316	0.0181	0.0135
Standard Deviation =						0.0038	0.0019	0.0051

Seabird vs. Seabird



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Both Seabirds were simultaneously placed in a pressurized tank and set to record at the same interval. The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

Certificate of Calibration

This certifies that your precision instrument met all of the specifications determined by tests performed on the date listed below. This instrument was subjected to extensive pre-qualifications. It was then calibrated using an automated test system over a period of approximately 20 hours followed by another 20 hour validation test.

WaterLOG calibration standards are traceable to the National Institute of Standards and Technology (NIST). The Model Number and Serial Number of the standard used are listed below.

The test data below is a sampling of the 150 actual data points taken during the pre-shipment validation test on this instrument.

Tested by



TEST REPORT

REPORT DATE: 03/24/2009
 DATE TESTED: 03/23/2009
 MODEL NUMBER: H350XL
 SERIAL NUMBER: S#001051
 NIST TRACEABLE REFERENCE: DH Instruments Model RPM1-G0030 SN40840

<i>Reference Temp.</i>	<i>Measured Temp</i>	<i>Reference Press.</i>	<i>Measured Press.</i>	<i>Delta</i>
-40.1	-40.1	0.000	-0.001	0.001
-39.9	-40.0	4.455	4.454	0.001
-39.9	-40.0	8.968	8.967	0.001
-39.9	-40.0	17.947	17.946	0.001
-39.9	-40.0	26.950	26.949	0.001
-30.0	-30.1	1.462	1.463	-0.001
-30.0	-30.1	5.961	5.961	0.000
-30.0	-30.1	11.967	11.965	0.002
-30.0	-30.1	20.941	20.937	0.004
-30.1	-30.1	29.957	29.951	0.006
-20.0	-19.9	2.955	2.953	0.002
-20.0	-19.9	7.468	7.467	0.001
-20.0	-19.9	14.946	14.943	0.003
-20.0	-19.9	23.953	23.950	0.003
-10.0	-9.9	-0.001	-0.003	0.002
-10.0	-9.9	4.459	4.458	0.001

S#001051

<i>Reference Temp.</i>	<i>Measured Temp</i>	<i>Reference Press.</i>	<i>Measured Press.</i>	<i>Delta</i>
-10.1	-9.9	8.947	8.945	0.002
-9.9	-9.9	17.946	17.947	-0.001
-10.0	-9.9	26.951	26.951	0.000
0.0	0.0	1.463	1.463	0.000
0.0	0.0	5.961	5.961	0.000
-0.1	0.1	11.966	11.966	0.000
0.0	0.1	20.945	20.945	0.000
0.0	0.1	29.951	29.949	0.002
10.1	10.0	2.951	2.951	0.000
10.1	10.0	7.465	7.465	0.000
9.9	10.0	14.943	14.942	0.001
10.1	10.0	23.950	23.947	0.003
20.0	19.9	-0.001	-0.001	0.000
20.0	20.0	4.459	4.459	0.000
20.0	20.0	8.948	8.947	0.001
20.0	20.0	17.949	17.949	0.000
20.0	20.0	26.951	26.950	0.001
30.1	30.1	1.466	1.466	0.000
30.0	30.1	5.966	5.966	0.000
30.0	30.1	11.946	11.944	0.002
29.9	30.1	20.952	20.951	0.001
30.0	30.1	29.957	29.956	0.001
40.0	40.0	2.953	2.951	0.002
40.0	40.0	7.468	7.467	0.001
39.9	40.1	14.943	14.942	0.001
40.0	40.1	23.949	23.947	0.002
49.9	50.0	-0.001	-0.001	0.000
50.0	50.1	4.460	4.460	0.000
50.1	50.1	8.968	8.968	0.000
50.1	50.1	17.948	17.947	0.001
50.1	50.1	26.951	26.950	0.001
60.0	60.0	1.446	1.445	0.001
60.0	60.0	5.968	5.967	0.001
60.0	60.0	11.951	11.949	0.002
60.0	60.0	20.909	20.909	0.000
60.0	60.0	29.945	29.945	0.000

Maximum Deviation From Standard: 0.006, -0.001

Water Tube Test

Operator Name: _____ cm

Date: 4/3/2009

Slope Constant: _____ 0.70308

From Top	Distance between Ports	Water Depth	S/N 1051	Delta
Port 1		0.338	0.339	-0.001
	0.503			
Port 2		0.841	0.842	-0.001
	0.500			
Port 3		1.341	1.342	-0.001
	0.501			
Port 4		1.842	1.842	0.000
	0.497			
Port 5		2.339	2.338	0.001
	0.503			
Port 6		2.842	2.839	0.003
	0.803			
Port 7		3.646	3.643	0.003

- 1) Set the averaging interval to 10 seconds
- 2) Set the slope to "Meters" (0.70308)
- 3) Measure one gauge through all 7 ports, then switch and do the next gauge
- 4) After you insert the tube into a new port, purge the gauge (20PSI, 30 seconds)
- 5) Measure the stage 3 times and write down the stage that appears at least 2 out of 3 times



Sea-Bird Electronics, Inc. FAX: (425) 643-9954

1808 136th Place NE, Bellevue, Washington 98005 USA Tel:(425)643-9866

Website: <http://www.seabird.com>

Email: seabird@seabird.com

26P46158-1131

26-Dec-07

Pressure Range: 100 psia

Pressure sensor Serial Number: 100034

Pressure sensor Type: Digiquartz

Pressure offset correction for SBE 26plus Wave and Tide Recorder

Pressure sensor output in the SBE 26plus Wave and Tide Recorder is sensitive to ambient pressure (including elevation and atmospheric pressure) and orientation of the instrument. As part of the test of this instrument, the output of the pressure sensor was measured in the orientation noted below. This data was averaged and compared to the output of a precision barometer at an elevation of 43 feet above sea level. The difference between these two measurements has been entered into the SBE 26plus as an offset correction. The slope correction for the SBE 26plus is nominally set to 1.0 for new instruments. The offset correction should be recalculated by the end-user in a manner appropriate for the intended use of the instrument.

ATMOSPHERIC CALIBRATION DATA

Orientation: Vertical

Pressure Sensor Range: 100 psia

Reference Pressure (psia)	SBE 26plus pressure (psia)	Difference (psia)
14.6859	14.8150	-0.1291

These coefficients should be entered into the SBE 26plus.

OFFSET = -0.1291

SLOPE = 1



Horizontal Orientation



Vertical Orientation

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1131

SBE 26plus TEMPERATURE CALIBRATION DATA

CALIBRATION DATE: 17-Dec-07

ITS-90 COEFFICIENTS

a0 = 3.451134e-004

a1 = 2.295108e-004

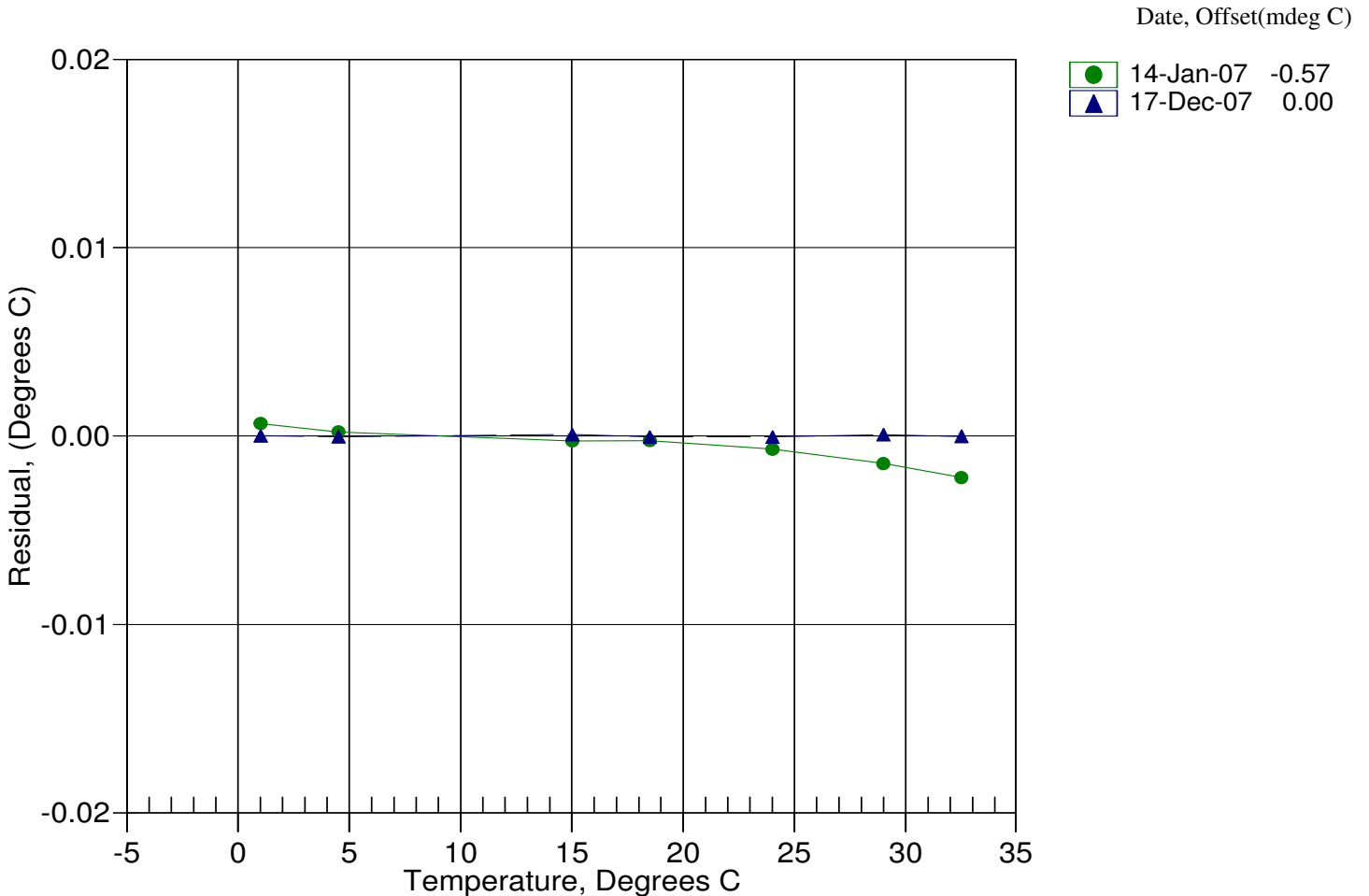
a2 = -6.740324e-008

a3 = 1.118240e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	594854.1	1.0000	0.0000
4.5000	506601.9	4.5000	-0.0000
15.0000	318943.0	15.0001	0.0001
18.4999	275019.8	18.4999	-0.0000
24.0000	219157.0	24.0000	-0.0000
29.0000	179343.3	29.0001	0.0001
32.5001	156366.2	32.5001	-0.0000

Temperature ITS-90 = $1 / \{ a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)] \} - 273.15$ (°C)

Residual = instrument temperature - bath temperature





SEA-BIRD ELECTRONICS, INC.

1808 - 136th Place Northeast, Bellevue, Washington 98005 USA

Phone: (425) 643-9866 Fax: (425) 643-9954 www.seabird.com

Temperature Calibration Report

Customer:	TerraSond LTD		
Job Number:	48974	Date of Report:	12/17/2007
Model Number	SBE 26Plus	Serial Number:	26P46158-1131

Temperature sensors are normally calibrated 'as received', without adjustments, allowing a determination sensor drift. If the calibration identifies a problem, then a second calibration is performed after work is completed. The 'as received' calibration is not performed if the sensor is damaged or non-functional, or by customer request.

An 'as received' calibration certificate is provided, listing coefficients to convert sensor frequency to temperature. Users must choose whether the 'as received' calibration or the previous calibration better represents the sensor condition during deployment. In SEASOFT enter the chosen coefficients using the program SEACON. The coefficient 'offset' allows a small correction for drift between calibrations (consult the SEASOFT manual). Calibration coefficients obtained after a repair apply only to subsequent data.

'AS RECEIVED CALIBRATION'

Performed Not Performed

Date:

Drift since last cal: Degrees Celsius/year

Comments:

'CALIBRATION AFTER REPAIR'

Performed Not Performed

Date:

Drift since Last cal: Degrees Celsius/year

Comments:

CALIBRATION SHEETS

SBE 26plus Temperature Calibration - S/N 1155.....	1
SBE 26plus Pressure Sensor Offset Correction - S/N 1155	2
Digiquartz Calibration - S/N 105824.....	3

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1155

SBE 26plus TEMPERATURE CALIBRATION DATA

CALIBRATION DATE: 28-Jan-08

ITS-90 COEFFICIENTS

a0 = 2.705658e-004

a1 = 2.464623e-004

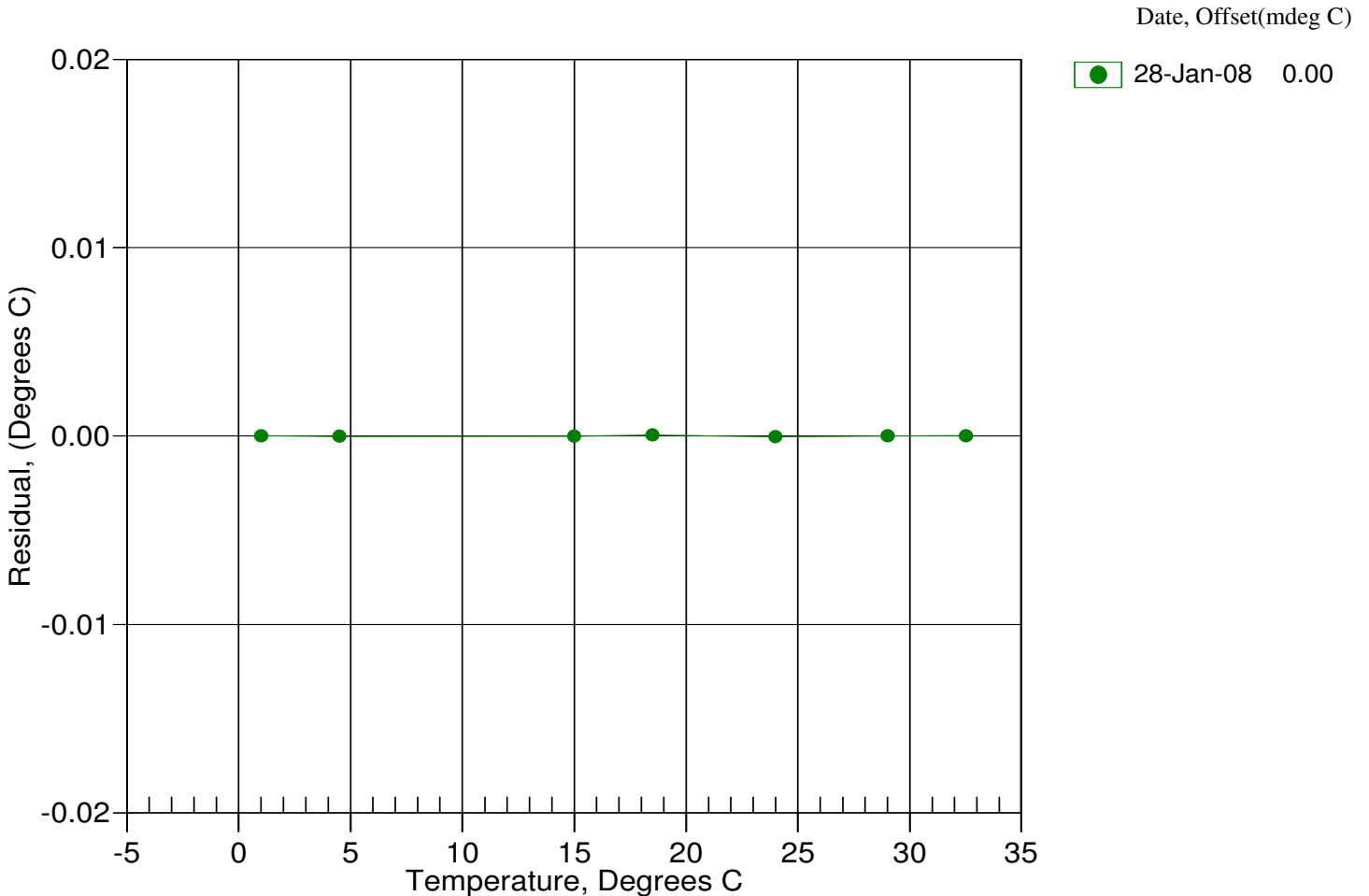
a2 = -1.381867e-006

a3 = 1.470204e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	592390.9	1.0000	0.0000
4.5000	504677.4	4.5000	-0.0000
15.0000	318034.5	15.0000	-0.0000
18.5000	274315.0	18.5001	0.0001
24.0000	218698.1	24.0000	-0.0000
29.0000	179043.1	29.0000	-0.0000
32.5000	156150.4	32.5000	0.0000

Temperature ITS-90 = $1 / \{ a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)] \} - 273.15$ (°C)

Residual = instrument temperature - bath temperature





Sea-Bird Electronics, Inc. FAX: (425) 643-9954

1808 136th Place NE, Bellevue, Washington 98005 USA Tel:(425)643-9866

Website: <http://www.seabird.com>

Email: seabird@seabird.com

26P48650-1155

31 January 2008

Pressure Range: 100 psia

Pressure sensor Serial Number: 105824

Pressure sensor Type: Digiquartz

Pressure offset correction for SBE 26plus Wave and Tide Recorder

Pressure sensor output in the SBE 26plus Wave and Tide Recorder is sensitive to ambient pressure (including elevation and atmospheric pressure) and orientation of the instrument. As part of the test of this instrument, the output of the pressure sensor was measured in the orientation noted below. This data was averaged and compared to the output of a precision barometer at an elevation of 43 feet above sea level. The difference between these two measurements has been entered into the SBE 26plus as an offset correction. The slope correction for the SBE 26plus is nominally set to 1.0 for new instruments. The offset correction should be recalculated by the end-user in a manner appropriate for the intended use of the instrument.

ATMOSPHERIC CALIBRATION DATA

Orientation: Vertical

Pressure Sensor Range: 100 psia

Reference Pressure (psia)	SBE 26plus pressure (psia)	Difference (psia)
14.4115	14.5892	-0.1777

These coefficients should be entered into the SBE 26plus.

OFFSET = -0.1777

SLOPE = 1



Horizontal Orientation



Vertical Orientation

CALIBRATION COEFFICIENTS

SERIAL NO : 105824

PRESSURE TRANSDUCER

DATE : 01-14-2008

MODEL : 2100A-219	PRESSURE RANGE : 0 to 100 psia	TEMP. RANGE : -40 to 107 deg C	PORT : oil filled
----------------------	-----------------------------------	-----------------------------------	----------------------

TEMPERATURE COEFFICIENTS

X = temperature period
(μsec)

$$U = X - U_0$$

Temperature : (deg C)

$$\text{Temp} = Y_1U + Y_2U^2 + Y_3U^3$$

U_0	5.850502	μsec
Y_1	-3995.160	deg C/ μsec
Y_2	-10801.68	deg C/ μsec^2
Y_3	0	

PRESSURE COEFFICIENTS

T = pressure period
(μsec)

$$C = C_1 + C_2U + C_3U^2$$

$$D = D_1 + D_2U$$

$$T_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$$

Pressure : (psia)

$$P = C \left(1 - \frac{T_0^2}{T^2}\right) \left(1 - D \left(1 - \frac{T_0^2}{T^2}\right)\right)$$

C_1	595.3530	psia
C_2	1.500733	psia/ μsec
C_3	-1024.366	psia/ μsec^2

D_1	0.027927
D_2	0

T_1	27.93030	μsec
T_2	0.567381	$\mu\text{sec}/\mu\text{sec}$
T_3	18.93607	$\mu\text{sec}/\mu\text{sec}^2$
T_4	30.99201	$\mu\text{sec}/\mu\text{sec}^3$
T_5	0	

(01-14-2008)

PAROSCIENTIFIC, INC.

4500 148th AVENUE N.E.
REDMOND, WA. 98052

CUSTOMER : SEABIRD ELECTRONICS, INC.

SALES ORDER : 24943

PREPARED BY : AJY

PARO
TEST
18

CALIBRATION COEFFICIENTS

SERIAL NO : 105824

PRESSURE TRANSDUCER

DATE : 01-14-2008

MODEL : 2100A-219	PRESSURE RANGE : 0 to 100 psia	TEMP. RANGE : -40 to 107 deg C	PORT : oil filled
----------------------	-----------------------------------	-----------------------------------	----------------------

PRESSURE COEFFICIENTS AT FIXED TEMPERATURE

(only valid at specified temperature)

T = pressure period (μsec)

Pressure equation : (psia)

$$P = C \left(1 - \frac{T_0^2}{T^2}\right) \left(1 - D \left(1 - \frac{T_0^2}{T^2}\right)\right)$$

Temperature: 21.0 C

C (psia)	595.3158				
D	0.027927				
T ₀ (μsec)	27.92780				

(01-14-2008)

PAROSCIENTIFIC, INC.4500 148th AVENUE N.E.
REDMOND, WA. 98052

CUSTOMER : SEABIRD ELECTRONICS, INC.

SALES ORDER : 24943

PREPARED BY : AJY



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CALIBRATION SHEETS

SBE 26plus Temperature Calibration - S/N 1156.....	1
SBE 26plus Pressure Sensor Offset Correction - S/N 1156	2
Digiquartz Calibration - S/N 105825.....	3

SEA-BIRD ELECTRONICS, INC.

1808 136th Place N.E., Bellevue, Washington, 98005 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 1156
CALIBRATION DATE: 28-Jan-08

SBE 26plus TEMPERATURE CALIBRATION DATA

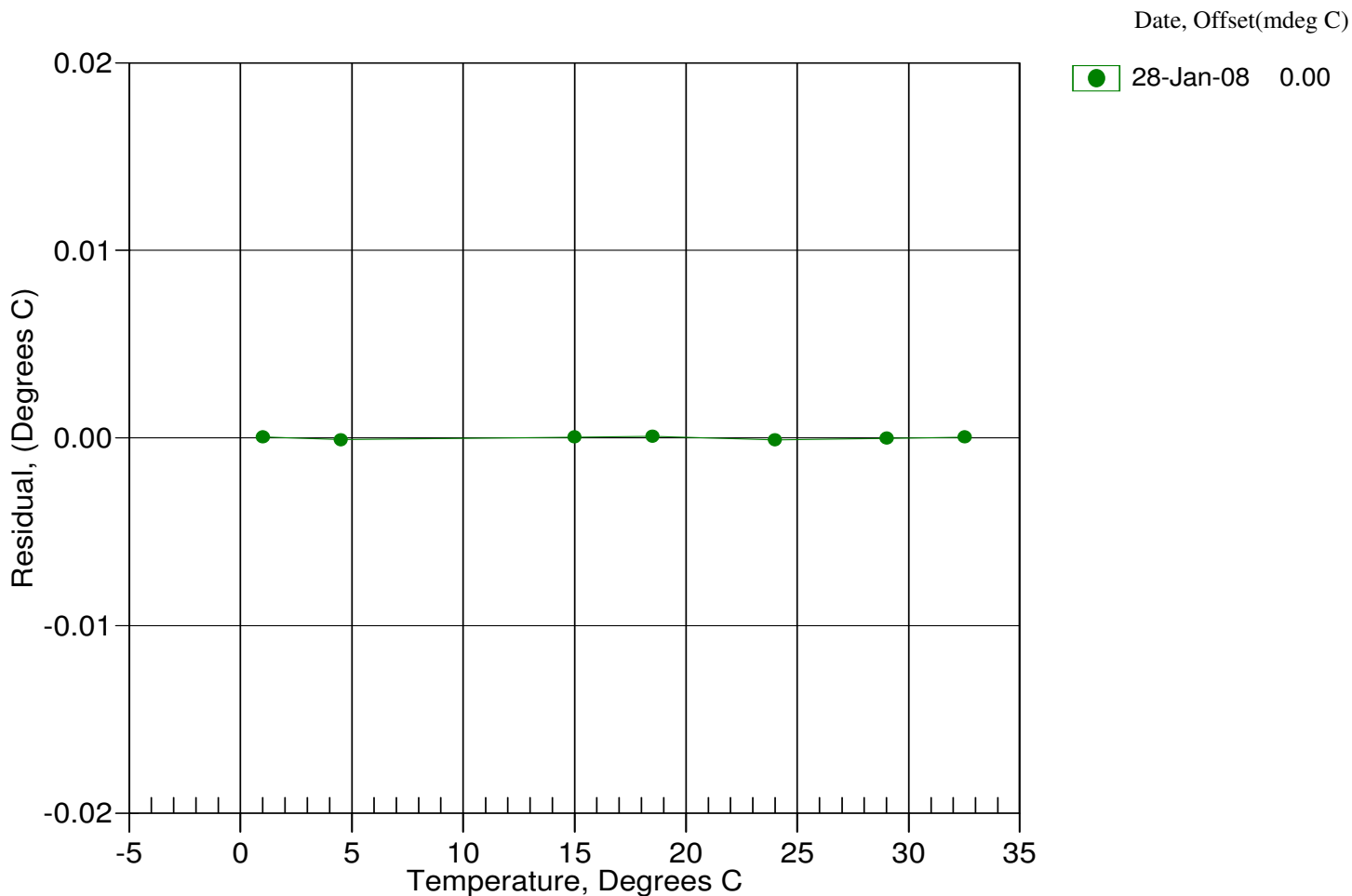
ITS-90 COEFFICIENTS

a0 = 2.657440e-004
a1 = 2.472179e-004
a2 = -1.423969e-006
a3 = 1.478415e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
1.0000	592985.4	1.0001	0.0001
4.5000	505209.6	4.4999	-0.0001
15.0000	318414.1	15.0000	0.0000
18.5000	274656.5	18.5001	0.0001
24.0000	218989.0	23.9999	-0.0001
29.0000	179294.6	29.0000	-0.0000
32.5000	156377.9	32.5000	0.0000

Temperature ITS-90 = $1 / \{ a_0 + a_1[\ln(n)] + a_2[\ln^2(n)] + a_3[\ln^3(n)] \} - 273.15$ (°C)

Residual = instrument temperature - bath temperature





Sea-Bird Electronics, Inc. FAX: (425) 643-9954

1808 136th Place NE, Bellevue, Washington 98005 USA Tel:(425)643-9866

Website: <http://www.seabird.com>

Email: seabird@seabird.com

26P48650-1156

31 January 2008

Pressure Range: 100 psia

Pressure sensor Serial Number: 105825

Pressure sensor Type: Digiquartz

Pressure offset correction for SBE 26plus Wave and Tide Recorder

Pressure sensor output in the SBE 26plus Wave and Tide Recorder is sensitive to ambient pressure (including elevation and atmospheric pressure) and orientation of the instrument. As part of the test of this instrument, the output of the pressure sensor was measured in the orientation noted below. This data was averaged and compared to the output of a precision barometer at an elevation of 43 feet above sea level. The difference between these two measurements has been entered into the SBE 26plus as an offset correction. The slope correction for the SBE 26plus is nominally set to 1.0 for new instruments. The offset correction should be recalculated by the end-user in a manner appropriate for the intended use of the instrument.

ATMOSPHERIC CALIBRATION DATA

Orientation: Vertical

Pressure Sensor Range: 100 psia

Reference Pressure (psia)	SBE 26plus pressure (psia)	Difference (psia)
14.42475	14.61302	-0.18827

These coefficients should be entered into the SBE 26plus.

OFFSET = -0.18827

SLOPE = 1



Horizontal Orientation



Vertical Orientation

CALIBRATION COEFFICIENTSSERIAL NO : **105825**

PRESSURE TRANSDUCER

DATE : **01-14-2008**

MODEL :	PRESSURE RANGE :	TEMP. RANGE :	PORT :
2100A-219	0 to 100 psia	-40 to 107 deg C	oil filled

TEMPERATURE COEFFICIENTS

X = temperature period
(μsec)

U = X - U₀

Temperature : (deg C)

$$\text{Temp} = Y_1U + Y_2U^2 + Y_3U^3$$

U ₀	5.805467	μsec
Y ₁	-4025.558	deg C/ μsec
Y ₂	-10994.17	deg C/ μsec^2
Y ₃	0	

PRESSURE COEFFICIENTS

T = pressure period
(μsec)

$$C = C_1 + C_2U + C_3U^2$$

$$D = D_1 + D_2U$$

$$T_0 = T_1 + T_2U + T_3U^2 + T_4U^3 + T_5U^4$$

Pressure : (psia)

$$P = C \left(1 - \frac{T_0^2}{T^2}\right) \left(1 - D \left(1 - \frac{T_0^2}{T^2}\right)\right)$$

C ₁	597.7045	psia
C ₂	2.401415	psia/ μsec
C ₃	-1058.506	psia/ μsec^2

D ₁	0.027478
D ₂	0

T ₁	27.82368	μsec
T ₂	0.530059	$\mu\text{sec}/\mu\text{sec}$
T ₃	19.58289	$\mu\text{sec}/\mu\text{sec}^2$
T ₄	42.90351	$\mu\text{sec}/\mu\text{sec}^3$
T ₅	0	

(01-14-2008)

PAROSCIENTIFIC, INC.4500 148th AVENUE N.E.
REDMOND, WA. 98052CUSTOMER : **SEABIRD ELECTRONICS, INC.**SALES ORDER : **24945**PREPARED BY : **AJY**

 PARO
TEST
16

CALIBRATION COEFFICIENTSSERIAL NO : **105825**

PRESSURE TRANSDUCER

DATE : **01-14-2008**

MODEL :	PRESSURE RANGE :	TEMP. RANGE :	PORT :
2100A-219	0 to 100 psia	-40 to 107 deg C	oil filled

PRESSURE COEFFICIENTS AT FIXED TEMPERATURE

(only valid at specified temperature)

T = pressure period (μ sec)

Pressure equation : (psia)

$$P = C \left(1 - \frac{T_0^2}{T^2} \right) \left(1 - D \left(1 - \frac{T_0^2}{T^2} \right) \right)$$

Temperature: 21.0 C

C (psia)	597.6621				
D	0.027478				
T ₀ (μ sec)	27.82141				

(01-14-2008)

PAROSCIENTIFIC, INC.4500 148th AVENUE N.E.
REDMOND, WA. 98052

CUSTOMER : SEABIRD ELECTRONICS, INC.

SALES ORDER : 24945

PREPARED BY : AJY


 PARO
TEST
16

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Tide Gauge System Acceptance Test

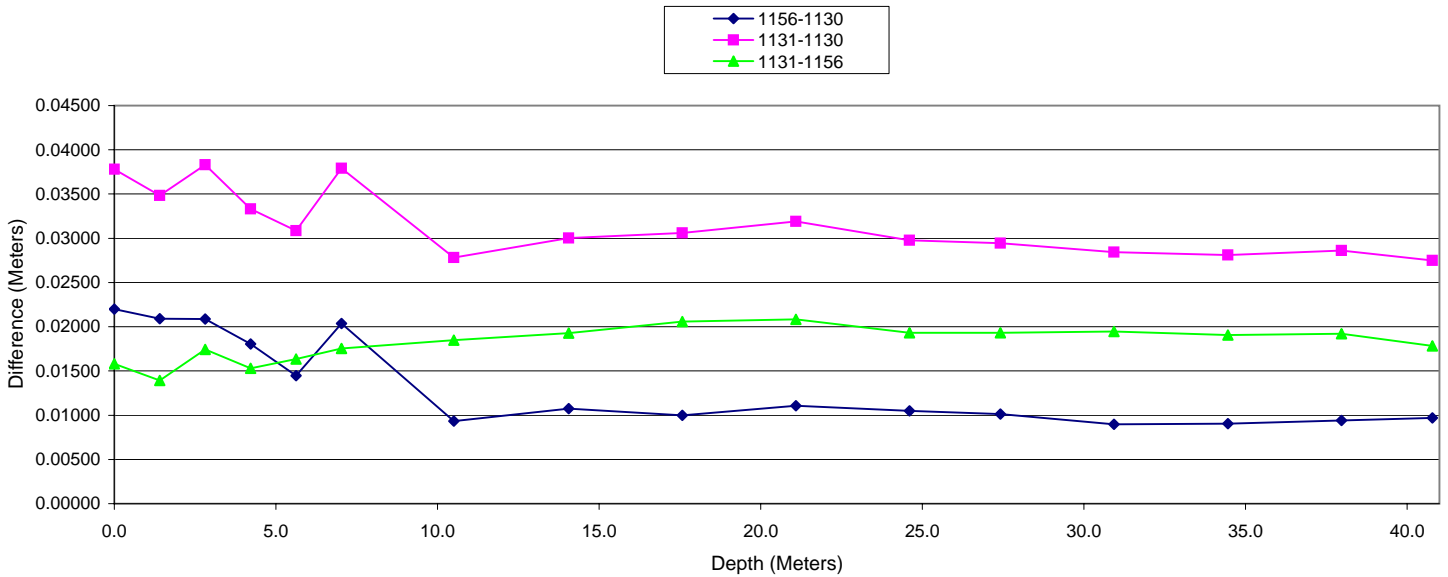
Serial No.: Seabird 1130
Date of test: 3/11/2009

Seabird 1131 Seabird 1156

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1130 PSI	1131 PSI	1156 PSI	1131-1130 Meters	1131-1156 Meters	1156-1130 Meters
0	0.0	5	-0.2611	-0.2073	-0.2298	0.0378	0.0158	0.0220
2	1.4	5	1.9023	1.9519	1.9321	0.0348	0.0139	0.0209
4	2.8	5	4.0331	4.0876	4.0628	0.0383	0.0175	0.0209
6	4.2	5	6.0847	6.1321	6.1104	0.0333	0.0153	0.0180
8	5.6	5	8.0767	8.1206	8.0973	0.0309	0.0164	0.0145
10	7.0	5	12.8743	12.9282	12.9032	0.0379	0.0175	0.0204
15	10.5	5	14.9981	15.0376	15.0113	0.0278	0.0185	0.0093
20	14.1	5	19.9323	19.9750	19.9476	0.0300	0.0193	0.0108
25	17.6	5	24.9116	24.9551	24.9258	0.0306	0.0206	0.0100
30	21.1	5	30.0327	30.0780	30.0484	0.0319	0.0208	0.0111
35	24.6	5	34.5810	34.6234	34.5959	0.0298	0.0193	0.0105
39	27.4	5	38.7660	38.8079	38.7804	0.0294	0.0193	0.0101
44	30.9	5	44.0721	44.1126	44.0849	0.0284	0.0194	0.0090
49	34.5	5	49.2371	49.2771	49.2500	0.0281	0.0191	0.0090
54	38.0	5	54.3271	54.3678	54.3405	0.0286	0.0192	0.0094
58	40.8	5	58.3026	58.3417	58.3164	0.0275	0.0178	0.0097
Average =						0.0316	0.0181	0.0135
Standard Deviation =						0.0038	0.0019	0.0051

Seabird vs. Seabird



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Both Seabirds were simultaneously placed in a pressurized tank and set to record at the same interval. The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

Tide Gauge System Acceptance Test

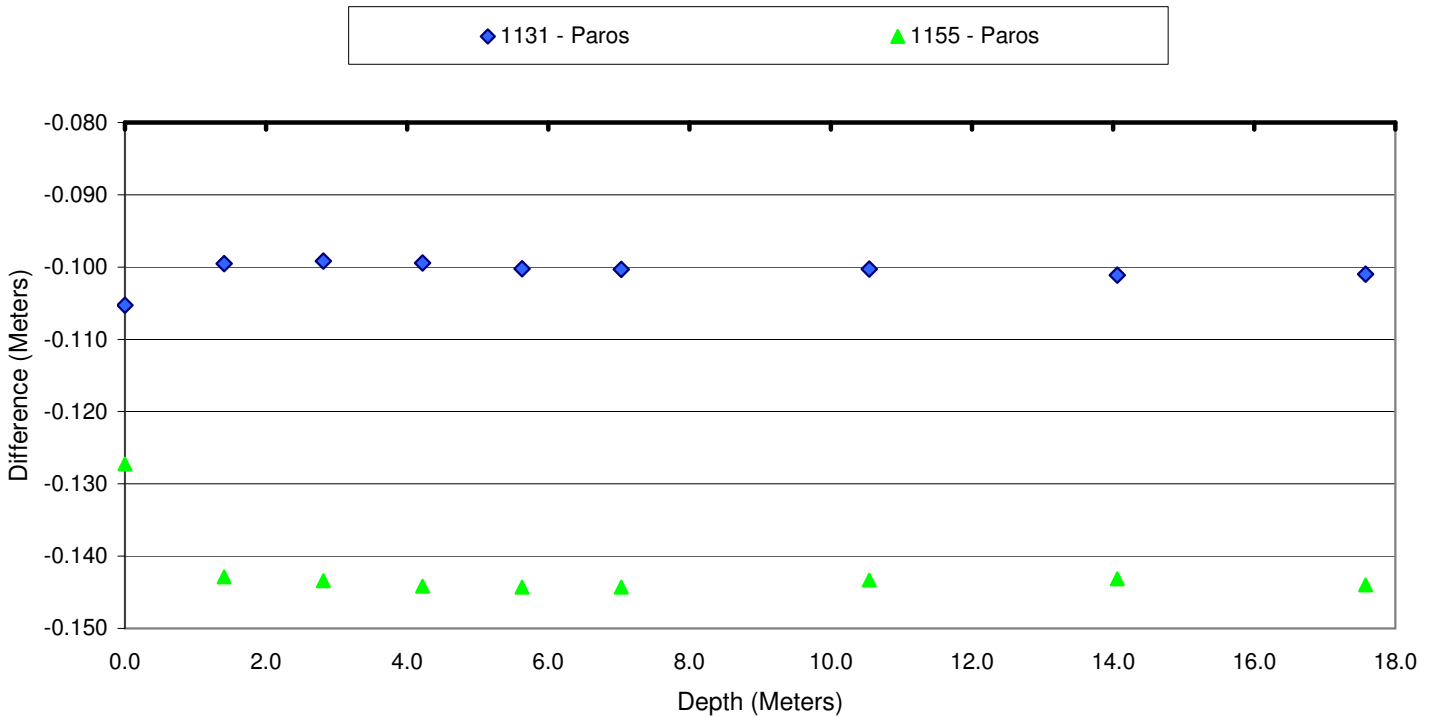
Serial No.: Seabird 1131
Date of test: 9/17/2009

Seabird 1155

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1131 - Paros PSI	1155 - Paros Psi	1131 Delta Meters	1155 Delta Meters
0	0.0	5	-0.1497	-0.1810	-0.1053	-0.1272
2	1.4	5	-0.1416	-0.2032	-0.0995	-0.1429
4	2.8	5	-0.1411	-0.2040	-0.0992	-0.1434
6	4.2	5	-0.1414	-0.2050	-0.0994	-0.1442
8	5.6	5	-0.1425	-0.2052	-0.1002	-0.1443
10	7.0	5	-0.1427	-0.2052	-0.1003	-0.1443
15	10.5	5	-0.1426	-0.2038	-0.1003	-0.1433
20	14.1	5	-0.1438	-0.2036	-0.1011	-0.1431
25	17.6	5	-0.1437	-0.2048	-0.1010	-0.1440
Average =			-0.1432	-0.2018	-0.1007	-0.1419
Standard Deviation =			0.0026	0.0078	0.0018	0.0055

Seabirds vs. Paros Computed Depths



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Reference readings of a close pressurized system were determined by a Paroscientific Digiquartz Portable Standard pressure sensor (S/N 85673) with a stated accuracy of 0.01% of full scale (0-30 psi). The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

Tide Gauge System Acceptance Test

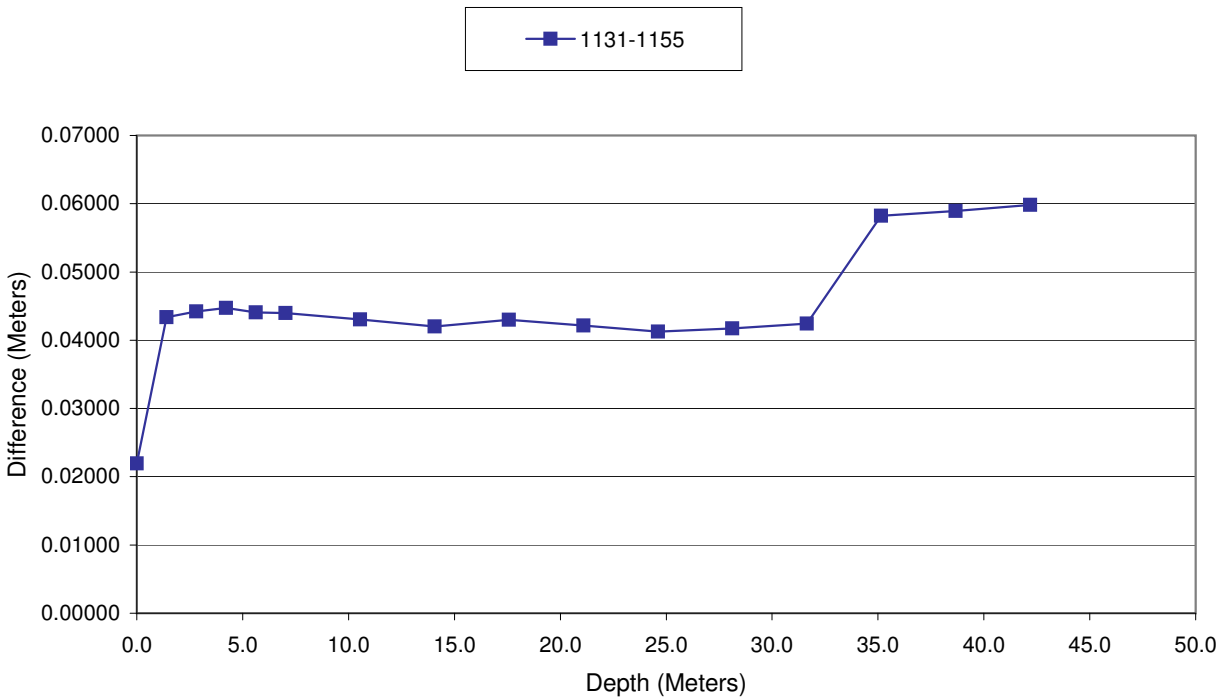
Serial No.: Seabird 1131
Date of test: 9/17/2009

Seabird 1155

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1131 PSI	1155 PSI	1131-1155 Meters
0	0.0	5	-0.1497	-0.1810	0.0220
2	1.4	5	2.0441	1.9824	0.0434
4	2.8	5	3.9064	3.8435	0.0442
6	4.2	5	6.0355	5.9719	0.0447
8	5.6	5	8.3370	8.2744	0.0441
10	7.0	5	10.0530	9.9904	0.0440
15	10.5	5	15.0315	14.9703	0.0430
20	14.1	5	20.1910	20.1312	0.0420
25	17.6	5	24.8857	24.8246	0.0430
30	21.1	5	31.9952	31.9352	0.0422
35	24.6	5	35.3672	35.3085	0.0412
40	28.1	5	41.5487	41.4894	0.0417
45	31.6	5	45.1582	45.0978	0.0424
50	35.2	5	50.8554	50.7972	0.0582
55	38.7	5	55.6496	55.5906	0.0589
60	42.2	5	60.7706	60.7108	0.0598
Average =					0.0447
Standard Deviation =					0.0089

Seabird vs. Seabird



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Both Seabirds were simultaneously placed in a pressurized tank and set to record at the same interval. The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

Tide Gauge System Acceptance Test

Serial No.: Seabird 1156
Date of test: 9/16/2009

Seabird 1157

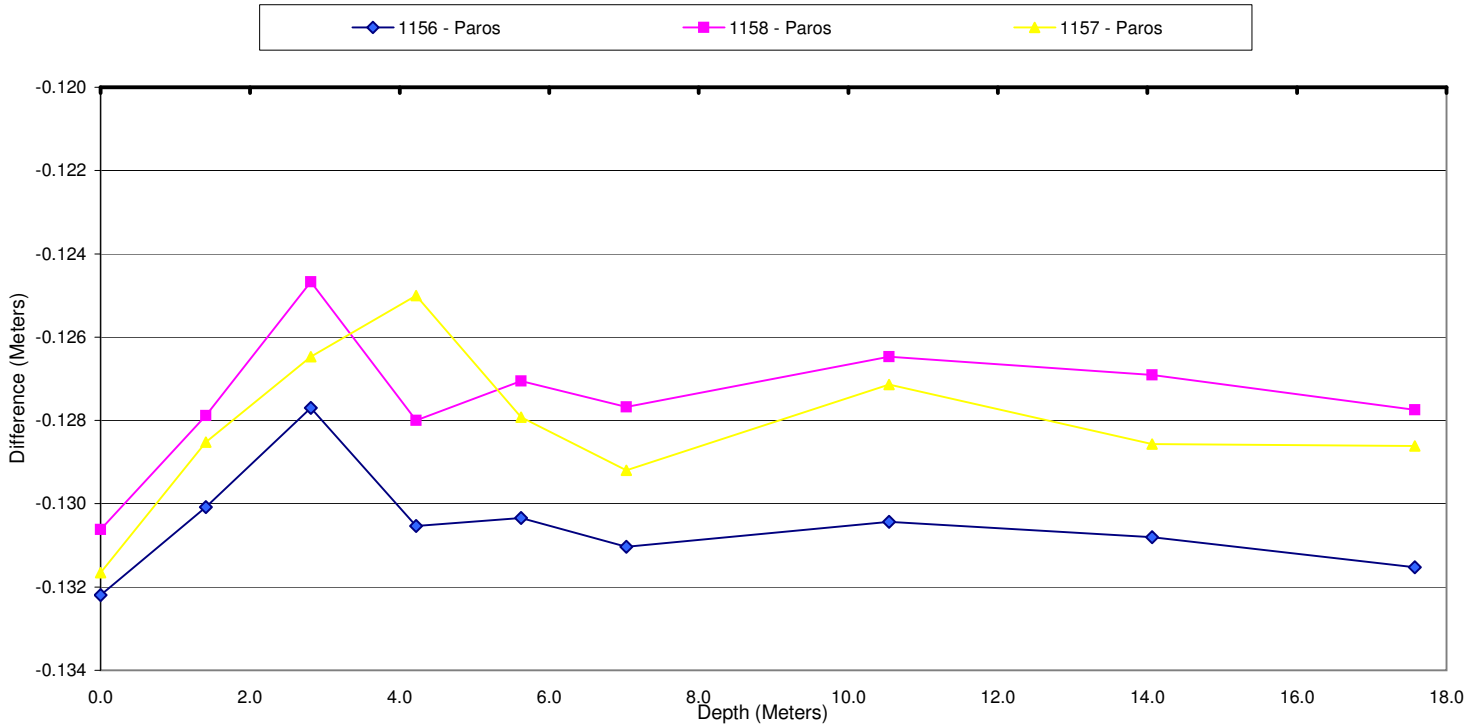
Seabird 1158

Tested by:

CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1156 - Paros PSI	1157 - Paros PSI	1158 - Paros Psi	1156 Delta Meters	1157 Delta Meters	1158 Delta Meters
0	0.0	5	-0.1880	-0.1873	-0.1858	-0.1322	-0.1317	-0.1306
2	1.4	5	-0.1850	-0.1828	-0.1819	-0.1301	-0.1285	-0.1279
4	2.8	5	-0.1816	-0.1799	-0.1773	-0.1277	-0.1265	-0.1247
6	4.2	5	-0.1857	-0.1778	-0.1821	-0.1305	-0.1250	-0.1280
8	5.6	5	-0.1854	-0.1819	-0.1807	-0.1303	-0.1279	-0.1271
10	7.0	5	-0.1864	-0.1838	-0.1816	-0.1310	-0.1292	-0.1277
15	10.5	5	-0.1855	-0.1808	-0.1799	-0.1304	-0.1271	-0.1265
20	14.1	5	-0.1860	-0.1829	-0.1805	-0.1308	-0.1286	-0.1269
25	17.6	5	-0.1871	-0.1829	-0.1817	-0.1315	-0.1286	-0.1277
Average =			-0.1856	-0.1822	-0.1813	-0.1305	-0.1281	-0.1274
Standard Deviation =			0.0018	0.0026	0.0022	0.0012	0.0019	0.0016

Seabirds vs. Paros Computed Depths



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Reference readings of a close pressurized system were determined by a Paroscientific Digiquartz Portable Standard pressure sensor (S/N 85673) with a stated accuracy of 0.01% of full scale (0-30 psi). The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

Tide Gauge System Acceptance Test

Serial No.: Seabird 1156
Date of test: 9/16/2009

Seabird 1157

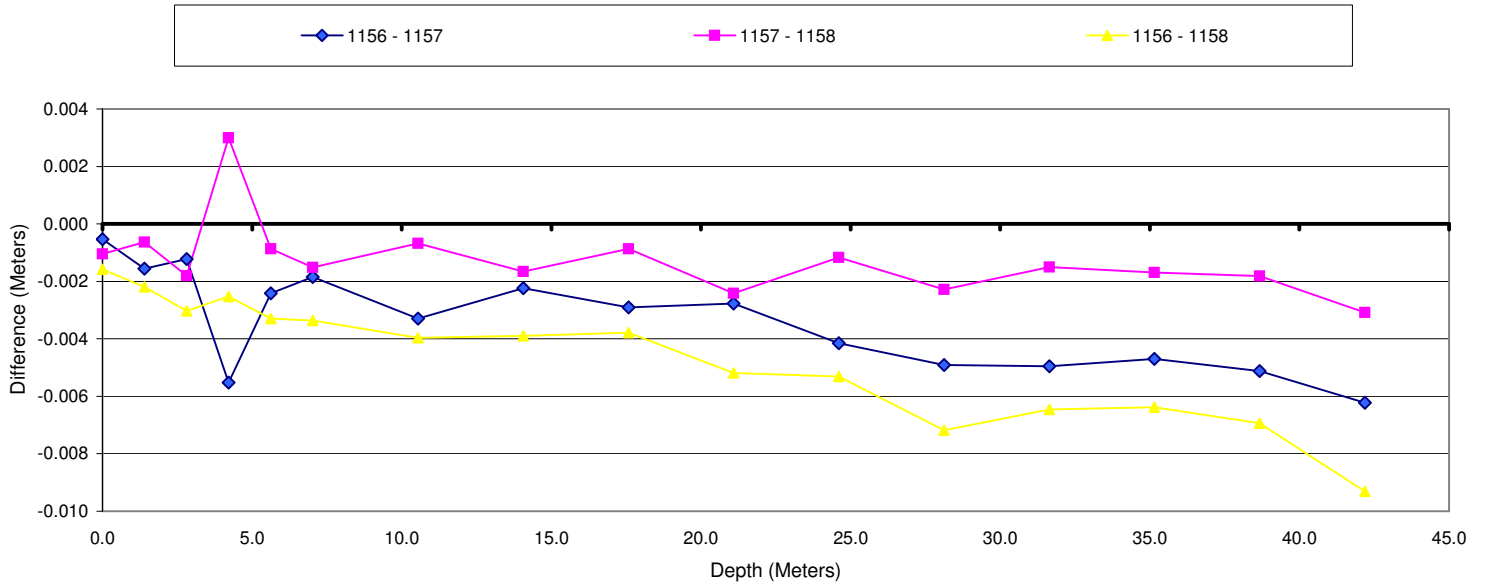
Seabird 1158

Tested by:

CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	1156 PSI	1157 PSI	1158 PSI	1156 - 1157	1157 - 1158	1156 - 1158
						Meters	Meters	Meters
0	0.0	5	-0.1880	-0.1873	-0.1858	-0.0005	-0.0010	-0.0016
2	1.4	5	1.9899	1.9922	1.9931	-0.0016	-0.0006	-0.0022
4	2.8	5	3.9755	3.9772	3.9798	-0.0012	-0.0018	-0.0030
6	4.2	5	5.9248	5.9326	5.9284	-0.0055	0.0030	-0.0025
8	5.6	5	7.8760	7.8795	7.8807	-0.0024	-0.0009	-0.0033
10	7.0	5	10.0619	10.0646	10.0667	-0.0018	-0.0015	-0.0034
15	10.5	5	14.9578	14.9625	14.9635	-0.0033	-0.0007	-0.0040
20	14.1	5	19.9936	19.9968	19.9991	-0.0022	-0.0017	-0.0039
25	17.6	5	25.1738	25.1779	25.1792	-0.0029	-0.0009	-0.0038
30	21.1	5	31.2946	31.2985	31.3019	-0.0028	-0.0024	-0.0052
35	24.6	5	35.7457	35.7516	35.7532	-0.0041	-0.0012	-0.0053
40	28.1	5	41.7067	41.7137	41.7170	-0.0049	-0.0023	-0.0072
45	31.6	5	45.6863	45.6933	45.6954	-0.0049	-0.0015	-0.0065
50	35.2	5	50.5655	50.5722	50.5746	-0.0047	-0.0017	-0.0064
55	38.7	5	54.9319	54.9392	54.9418	-0.0051	-0.0018	-0.0069
60	42.2	5	61.3677	61.3765	61.3809	-0.0062	-0.0031	-0.0093
Average =						-0.0034	-0.0013	-0.0046
Standard Deviation =						0.0017	0.0013	0.0021

Seabird vs. Seabird



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Both Seabirds were simultaneously placed in a pressurized tank and set to record at the same interval. The observed Seabird pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

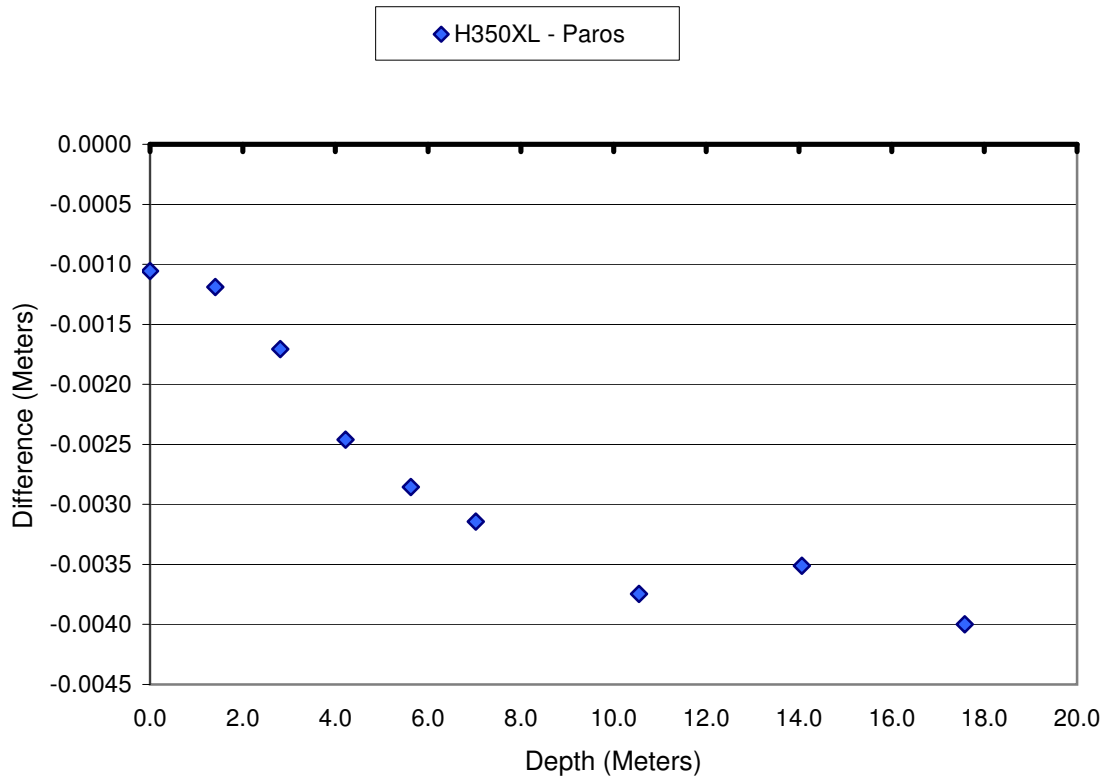
Tide Gauge System Acceptance Test

Serial No.: H350XL 1051
Date of test: 9/15/2009

Tested by: CM

Nominal PSI	Nominal Depth (m)	Number of Measurements	H350XL - Paros PSI	Delta Meters
0	0.0	5	-0.0015	-0.001
2	1.4	5	-0.0017	-0.001
4	2.8	5	-0.0024	-0.002
6	4.2	5	-0.0035	-0.002
8	5.6	5	-0.0041	-0.003
10	7.0	5	-0.0045	-0.003
15	10.5	5	-0.0053	-0.004
20	14.1	5	-0.0050	-0.004
25	17.6	5	-0.0057	-0.004
Average =			-0.004	-0.003
Standard Deviation =			0.002	0.001

H350XL vs. Paros Computed Depths



Method: The tide gauge was checked for system acceptance at the JOA warehouse. Reference readings of a close pressurized system were determined by a Paroscientific Digiquartz Portable Standard pressure sensor (S/N 85673) with a stated accuracy of 0.01% of full scale (0-30 psi). The observed H350XL pressure readings were determined using a 10 second averaging interval. The delta PSI column is the observed pressure minus the reference pressure. The Meters columns were computed by multiplying the appropriate PSI column by 0.70308 for the corresponding fresh water height.

GPS STATION OBSERVATION LOG
(15-Apr-2003)

Station Designation: (circle applicable: FBN / CBN / PAC / SAC / BM) **9462802 TIDAL 4**

Station PID, if any: **TID4** Date (UTC): **4/27/09**

General Location: **Scotch CAP** Airport ID, if any:

Station 4-Character ID: **TID4** Day of Year: **117**

Project Name: **UMMAK PASS Hydro Survey 2009** Project Number: **GPS-**

Station Serial # (SSN): _____ Session ID: (A,B,C etc) **A**

NAD83 Latitude **N 54° 23' 39.2"** NAD83 Longitude **W 164° 44' 23.3"** NAD83 Ellipsoidal Height _____ meters

Agency Full Name: **JOA Surveys LLC**

Operator Full Name: **N. Wardwell**

Observation Session Times (UTC): Sched. Start _____ Stop _____ Epoch Interval = **15** Seconds Elevation Mask = **10** Degrees

NAVD88 Orthometric Ht. _____ meters

Phone #.: (917) **561-0136**

Actual Start **2039** Stop **0135**

GEOID99 Geoid Height _____ meters

e-mail address: **nathan@joasurveys.com**

GPS Receiver: Manufacturer & Model: **NOVATEL 064** P/N: **01017390** S/N: **0009** Firmware Version: _____

GPS Antenna: Manufacturer & Model, & NGS antenna code*: **NOVATEL 702** P/N: **01017187** S/N: **NVH105230012** Cable Length, meters: _____

Antenna plumb before session? (Y/N) Circle

Antenna plumb after session? (Y/N) Yes or No

Antenna oriented to true North? (Y/N) -if no.

Weather observed at antenna ht. (Y/N) explain

Antenna ground plane used? (Y/N)

Antenna radome used? (Y/N) If yes, describe.

Eccentric occupation (>0.5 mm)? (Y/N) Use

Any obstructions above 10°? (Y/N) Use

Radio interference source nearby (Y/N) Vis. form

CamCorder Battery, 12V DC, 110V AC, Other

Vehicle is Parked _____ meters _____ (direction) from antenna.

Tripod or Ant. Mount: Check one: Fixed-Height Tripod, Slip-Leg Tripod, Fixed Mount

Manufacturer & Model: _____

P/N: _____ S/N: _____ Last Calibration date: _____

**** ANTENNA HEIGHT ****
(see back of form for measurement illustration)

	Before Session Begins measure and record both		After Session Ends measure and record both	
	Meters	Feet	Meters	Feet
A = Datum point to Top of Tripod (Tripod Height)	0.852	0.259	0.852	0.259
B = Additional offset to ARP if any (Tribrach/Spacer)	0.000	0.000	—	—

Tribrach: Check one: None, Wild GDF 22, Topcon, Other (describe)

Last Calibration date: _____

H = Antenna Height = A + B = Datum Point to Antenna Reference Point (ARP)

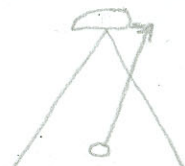
	Before Session Begins		After Session Ends	
	Meters	Feet	Meters	Feet
H = Antenna Height = A + B	0.852	0.259	0.852	0.259

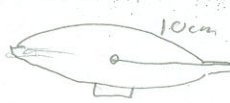
Note: Meters = Feet X (0.3048)
Height Entered Into Receiver = _____ meters.

Please note &/or sketch ANY unusual conditions. Be Very Explicit as to where and how Measured!

Barometer: Manufacturer & Model: P/N: S/N: Last Calibration or check Date:	Weather DATA	Time (UTC)	Dry-Bulb Temp		WetBulb Temp		Rel. % Humidity	Atm. Pressure		Weather Codes*
			Fahrenheit	Celsius	Fahrenheit	Celsius		inches Hg.	millibar	
N/A	Before									
	Middle									
	After									
Psychrometer: Manufacturer & Model: S/N:	Average of Readings									* See back of form for codes

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

 slant HE = 0.858 m

 10cm

Note: Entries are Required in all Unshaded areas. * Antenna code is provided by NGS coordinator in the ant. info file.

Data File Name(s): **0091170.090**
(Standard NGS Format = aaaddds.xxx)
where aa=Station ID, dd=Day of Year, s=Session ID, xxx=file dependent extension

Updated Station Description: Attached Submitted earlier

Visibility Obstruction Form: Attached Submitted earlier

Photographs of Station: Attached Submitted earlier

Pencil Rubbing of Mark: Attached

LOG CHECKED BY: **NCW**

CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
0	NO PROBLEMS encountered	GOOD More than 15 miles	NORMAL 32° F to 80° F	CLEAR Below 20%	CALM Under 5 mph (8 km/h)
1	PROBLEMS encountered	FAIR 7 to 15 miles	HOT Over 80° F (27° C)	CLOUDY 20% to 70%	MODERATE 5 to 15 mph
2	NOT USED	POOR Less than 7 miles	COLD Below 32° F (0° C)	OVERCAST Over 70%	STRONG over 15 mph (24 km/h)

Examples: Code 00000 = 0 - No problems, 0 - good visibility, 0 - normal temperature, 0 - clear sky, 0 - calm wind
Code 12121 = 1 - Problems, 2 - poor visibility, 1 - hot temperature, 2 - overcast, 1 - moderate wind

NATIONAL GEODETIC SURVEY PENCIL RUBBING FORM

4-char ID: T104

Day of Year ("Julian Day"): 117

Designation: 1

PID: _____

Stamping: 1938 4

Mark Type / Agency Inscription: NGS

Location: Scotch Cap

County: _____

Rubbing By: N. Wardwell

Date: 4/27/09

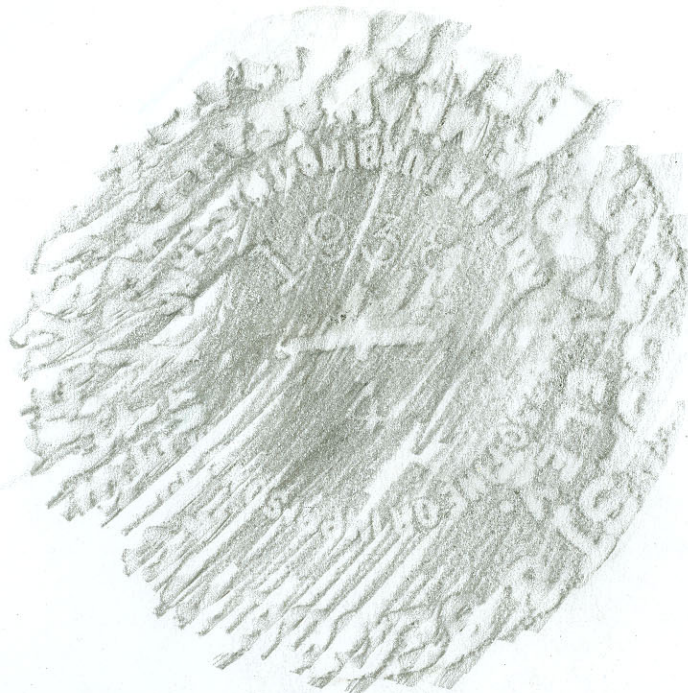
Agency: JOA surveys LLC

Phone: (561) 013

Remarks: _____

INSTRUCTIONS:

Place the blank form (or other blank paper) over the mark and rub over the entire disk with a pencil. For rod marks, rub only the designation and date stamping from the rim of the aluminum logo cap. If it is impossible to make a rubbing of the mark, or if the rubbing appears indistinct, a sketch and/or photograph may be substituted.



NATIONAL GEODETIC SURVEY STATION DESCRIPTION / RECOVERY FORM

4-char ID: T1D4 Designation: _____

PID: _____ Alias: _____

Country: (USA) State: AK County: _____

Latitude: N 54° 23' 39.2" Longitude: W 164° 44' 29.3" Elevation: _____ (meter / ft)

Original Description (check one):	
<input type="checkbox"/> P	Preliminary (mark has not been set yet)
<input type="checkbox"/> D	A newly set mark
<input type="checkbox"/> R	A recovered mark
Established by: (NGS / CGS / Other:)	
Date:	Chief of Party (initials):

Recovery Description (check one):	
<input checked="" type="checkbox"/> F	Full description of a station <u>not</u> in the database
<input type="checkbox"/> T	Full description of a station <u>in</u> the database
<input checked="" type="checkbox"/> M	<u>Partial</u> description of a station in the database
Recovered by: (NGS / <u>Other</u>) <u>JOA Surveys</u>	
Date: <u>4/27/09</u>	Chief of Party (initials): <u>NCW</u>

Monument Stability (check one):	
<input type="checkbox"/> A	Of the most reliable nature; expected to hold well
<input type="checkbox"/> B	Will probably hold position and elevation well
<input type="checkbox"/> C	May hold well, but subject to ground movement
<input type="checkbox"/> D	Of questionable or unknown reliability

Recovery Condition (check one):	
<input checked="" type="checkbox"/> G	Recovered in good condition
<input type="checkbox"/> N	Not recovered or not found
<input type="checkbox"/> P	Poor, disturbed, or mutilated
<input type="checkbox"/> X	Surface mark known destroyed

Setting Information:	
Marker Type: (Rod / Disk / Other)	
Setting Type: (Bedrock / Concrete / Other:)	
Y / N / ?	Monument contains magnetic material?

Stamping: <u>1938</u> <u>4</u>
Agency Inscription: (NGS / <u>CGS</u> / Other:)
Rod Depth: _____ (m/ft) Sleeve Depth: _____ (m/ft)
Monument is: (flush / projecting / recessed) _____ (cm/ft)

Special Type (check all applicable):	
<input type="checkbox"/> F	Fault monitoring site
<input type="checkbox"/> T	Tidal Station
<input type="checkbox"/> --	Control Station: (FBN / CBN / Bench mark)
<input type="checkbox"/> --	Airport Control Station: (PACS / SACS)
Y / N	Mark is suitable for GPS use?

Transportation (check one):	
<input type="checkbox"/> C	Car
<input type="checkbox"/> P	Light truck (pickup, carry-all, etc.)
<input type="checkbox"/> X	Four-Wheel Drive Vehicle
<input checked="" type="checkbox"/> --	Other (SnowCat, <u>Plane</u> , <u>Boat</u> ; describe)
Y / N	Pack Time (hike) to mark? (hh:mm):

See Back of Form to add Text Description

General Station Location: The station is located in at the southern end of Unimak Island 127 Km (79 mi) ENE of Unalaska (Dutch Harbor), 158 Km (99 mi) WSW of King Cove, and 1151 Km (716 mi) WSW of Anchorage.

(Describe general location; include airline distances to three towns or mapped features.)

Ownership: USCG District 17, 510 L St. #160, Arch., AK 99501
907-271-6700 (name, address, phone of landowner)

To Reach Narrative: To reach the station from the intersection of the Unalaska (Dutch Harbor) City Dock, proceed by boat NE 55 Km (34 mi) past Atkun Island, then east 87 Km (54 mi) past Atkun Island and across Unimak Pass to the unmanned Coast Guard light that is 3 Km (2 mi) ESE of Scotch Cap. The benchmark station is located on the rock outcrop at the east end of the light where the lighthouse is located. (Leg-by-leg distances and directions from major road intersection to mark)

Monument Description and Measurements: The station is a disk set in the top of one of the many ridges of volcanic rock which extend into the ocean forming a point, 68.5 m (224.7 ft) ESE of the mouth of a creek where it flows from grass to a cobble beach, 12.9 m (42.3 ft) NNW of benchmark 9462808 TIDAL 2, 6.6 m (21.6 ft) SE of the grass line, and 1.5 m (4.9 ft) above the grassline.

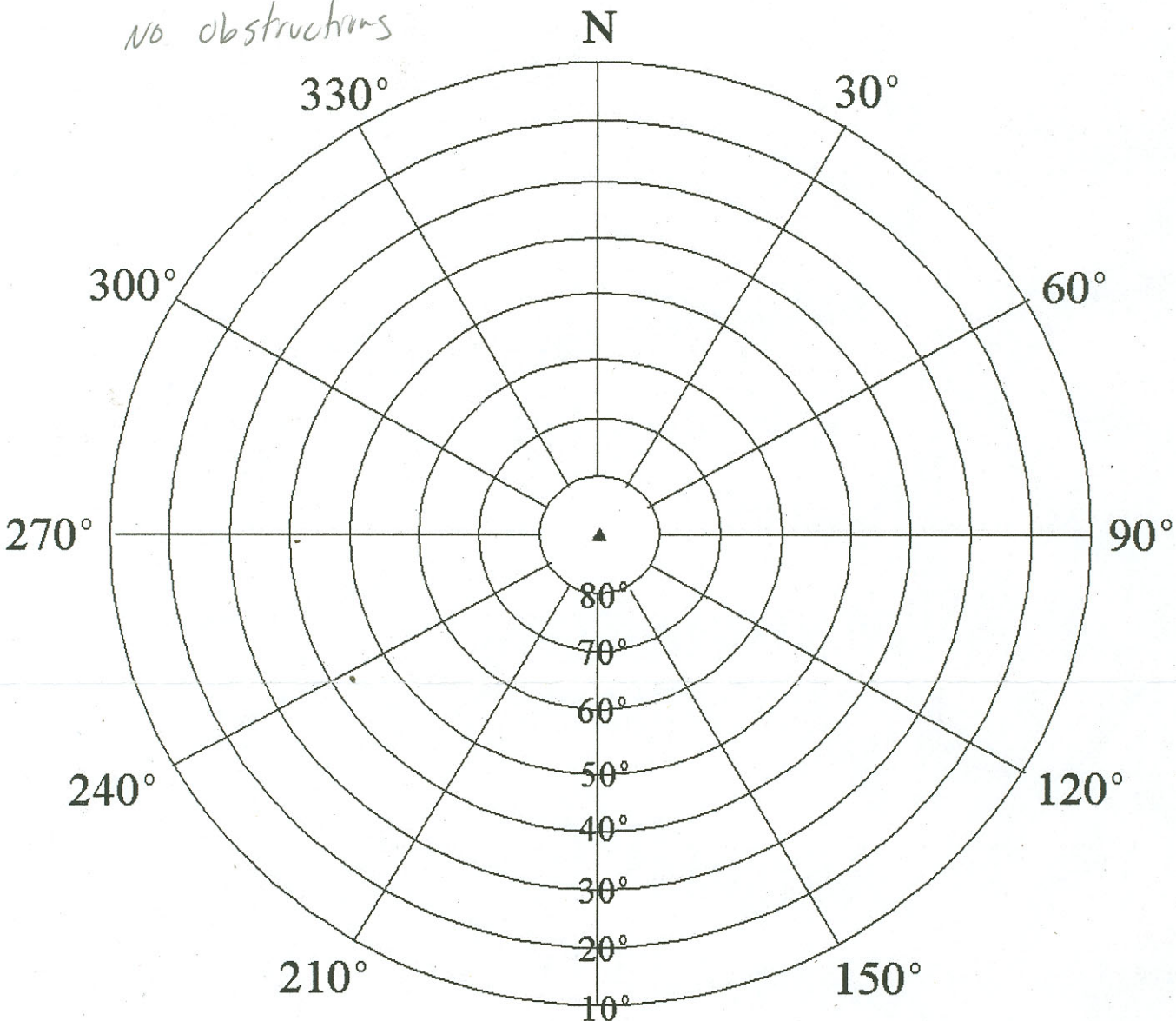
(Add at least three measurements to permanent, identifiable, nearby objects; and a description of the monument size, shape, height, etc.)

NOTE: - Include a pencil rubbing, sketch, or photographs of mark.

Described by: Nathan Wardwell Phone: (907) 561-0136 e-mail: nathan@jgca-surveys.com

NATIONAL GEODETIC SURVEY VISIBILITY OBSTRUCTION DIAGRAM

no obstructions



INSTRUCTIONS:

Identify obstructions by azimuth (magnetic) and elevation angle (above horizon) as seen from station mark. Indicate distance and direction to nearby structures and reflective surfaces (potential multipath sources).

4-char ID: TIDY Designation: _____
PID: _____ Location: scotch Cap, Unimak Island, AK
County: _____ Reconnaissance By: _____
Height above mark, meters: _____ Agency/Company: SOA Surveys, LLC
Phone: (907) 561-0136 Date: 4/27/09

Check if no obstructions above 10 degrees

General Location:

The station is located at the southern end of Unimak Island 127km (79mi) ENE of Unalaska (Dutch Harbor), 158km (99mi) WSW of King Cove and 1151km (716mi) WSW of Anchorage.

Ownership:

United States Coast Guard District 17
Sector Anchorage
510 L Street Suite 100
Anchorage, Alaska 99501
(907) 271-6700

To Reach Narrative:

To reach the station from Unalaska (Dutch Harbor) City Dock, proceed by boat NE 55km (34mi) past Akutan Island, then east 87km (54mi) past Akun Island and across Unimak Pass to the unmanned Coast Guard light that is 3km (2nm) ESE of Scotch Cap. The station is located on the rock outcrop at the east end of the bight where the lighthouse is located.

Monument Description and Measurements:

The station is a disk set in the top of one of many ridges of volcanic rock which extend into the ocean forming a point, 68.5 m (224.7 ft) ESE of the mouth of a creek where it flows from grass to a cobble beach, 12.9 m (42.3 ft) NNW of bench mark 9462808 TIDAL 2, 6.6 m (21.6 ft) SE of the grass line, and 1.5 m (4.9 ft) above the grass line.

Note – Include a pencil rubbing, sketch, or photographs of mark.

Described by: N. Wardwell Phone: 907-561-0136

email: nathan@joasurveys.com

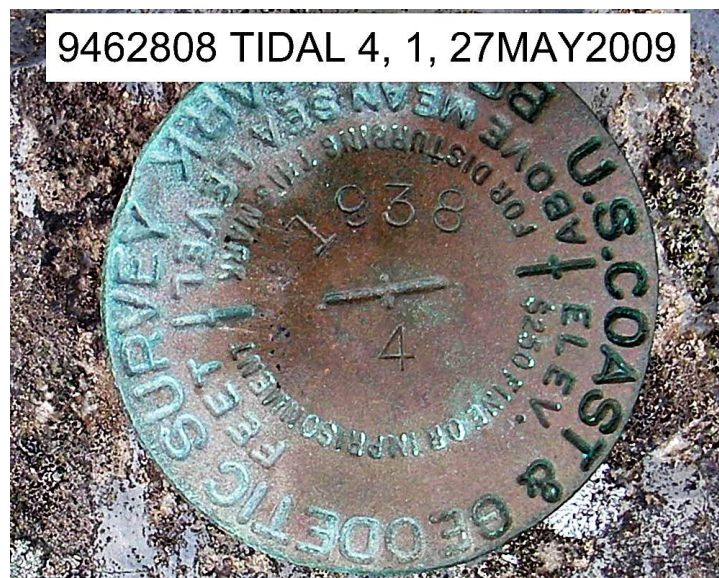


Figure 1 - Stamping of GPS benchmark 9462808 TIDAL 4.

PRIMARY BENCH MARK STAMPING: 2 1937
DESIGNATION: 946 2808 TIDAL 2
MONUMENTATION: Tidal bench mark disk
AGENCY: USC&GS (U.S. Coast & Geodetic Survey)
SETTING CLASSIFICATION: Bedrock Outcrop

The primary bench mark is a disk set in the top of one of many ridges composed of volcanic rock that extend into the ocean, 78.50 m (257.5 ft) SE of a creek outflow from the grass line to a cobble beach, 19.00 m (62.3 ft) SSE of the grass line, and 12.90 m (42.3 ft) south of bench mark 946 2808 TIDAL 4, and 2.30 m (7.5 ft) above the grass line.

Latitude: 54° 23' 38.8"
Longitude: 164° 44' 23.2"

New Description/NW 10/28/2009

BENCH MARK STAMPING: 4 1938
DESIGNATION: 946 2808 TIDAL 4
MONUMENTATION: Tidal bench mark disk
AGENCY: USC&GS (U.S. Coast & Geodetic Survey)
SETTING CLASSIFICATION: Bedrock Outcrop

The bench mark is a disk set in the top of one of many ridges composed of volcanic rock that extend into the ocean, 68.50 m (224.7 ft) SE of a creek outflow from the grass line to a cobble beach, 12.90 m (42.3 ft) north of bench mark 946 2808 TIDAL 2, 6.60 m (21.6 ft) SSE of the grass line, and 1.50 m (4.9 ft) above the grass line.

Latitude: 54° 23' 39.2"
Longitude: 164° 44' 23.3"

New Description/NW 10/28/2009

BENCH MARK STAMPING: 2808 A 2009
DESIGNATION: 946 2808 A
MONUMENTATION: Tidal bench mark disk
AGENCY: NOS (National Ocean Service)
SETTING CLASSIFICATION: Bedrock Outcrop

The bench mark is a disk set in the top of a bedrock projection, 142.0 m (465.9 ft) (sloped) SSW of the orange and white Coast Guard Warning light at the top of the bluff, 67.00 m (219.8 ft) (sloped) SSW of the NW corner of the lighthouse ruins, 39.00 m (128.0 ft) south of the SE corner of a

concrete pad half way up the bluff, and 0.80 m (2.6 ft) above the surrounding bedrock.

Latitude: 54° 23' 37.1"
Longitude: 164° 44' 44.6"

New Description/NW 10/28/2009

BENCH MARK STAMPING: 2808 B 2009
DESIGNATION: 946 2808 B
MONUMENTATION: Tidal bench mark disk
AGENCY: NOS (National Ocean Service)
SETTING CLASSIFICATION: Bedrock Outcrop

The bench mark is a disk set in bedrock at the base of the cliff below the lighthouse ruins, 29.20 m (95.8 ft) east of the west corner of the western most concrete retaining wall, 8.90 m (29.2 ft) south of the west corner of a 17.20 m (56.4 ft) wide concrete retaining wall, 1.20 m (3.9 ft) south of the cliff face, and 0.75 m (2.5 ft) above the surrounding rock.

Latitude: 54° 23' 37.9"
Longitude: 164° 44' 38.3"

New Description/NW 10/28/2009

BENCH MARK STAMPING: 2808 C 2009
DESIGNATION: 946 2808 C
MONUMENTATION: Tidal bench mark disk
AGENCY: NOS (National Ocean Service)
SETTING CLASSIFICATION: Bedrock Outcrop

The bench mark is a disk set in the top of a bedrock outcrop near a cobble beach, 97.08 m (318.5 ft) NE of bench mark 946 2808 TIDAL 4, 11.60 m (38.1 ft) ESE of the grass line, 5.70 m (18.7 ft) south of a 0.12 m (0.4 ft) diameter eyebolt.

Latitude: 54° 23' 41.1"
Longitude: 164° 44' 19.0"

New Description/NW 10/28/2009

10/11/51

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SOUTHWEST ALASKA -176

U. S. COAST AND GEODETIC SURVEY

TIDAL BENCH MARKS

946-2888

Scotch Cap, Unimak Island,
Fox Islands, Aleutian Islands
Lat. 54° 23'.7; Long. 164° 44'.3

BENCH MARK 1 (1937) is a standard disk, stamped "1 1937", set in top of triangular-shaped volcanic boulder, about 55 feet east of storage shed of Scotch Cap Lighthouse and at edge of trail leading to creek. Boulder is 15 feet inside grass line and is at foot of and south of ridge running behind lighthouse buildings. Elevation: 28.38 feet above mean lower low water.

BENCH MARK 2 (1937) is a standard disk, stamped "2 1937", set in sharp upthrust, gray, volcanic rock, about 60 feet north of mast of wreck of "Kohshun Maru". Bench mark is about 10 feet from high water line and about 60 feet south of foot of bluff at point. Elevation: 14.97 feet above mean lower low water.

BENCH MARK 3 (1937) is a standard disk, stamped "3 1937", set in top of rounded boulder surrounded by large timbers of driftwood. Bench mark is about 70 feet west of mid-section of wreck of "Kohshun Maru" and about 50 feet north of high water line. Edge of bluff at point and rocks below lighthouse are on range. Bench mark is about 10 feet outside of grass line. Elevation: 17.19 feet above mean lower low water.

BENCH MARK 4 (1938) is a standard disk, stamped "4 1938", set in top of sharp spine of volcanic rock in same ridge as Bench Mark 2. It is about 30 feet inshore from Bench Mark 2 and about halfway from Bench Mark 2 to base of low bluff. Elevation: 17.63 feet above mean lower low water.

Mean lower low water at Scotch Cap, Unimak Island is based on 50 high waters and 49 low waters, July 30 - August 31, 1938, reduced to mean values. Elevations of other tide planes referred to this datum are as follows:

	<u>Feet</u>
Highest tide (estimated)	8.5
Mean higher high water	5.40
Mean high water	4.80
Half tide level	3.15
Mean low water	1.50
Mean lower low water	0.00
Lowest tide (estimated)	-3.0

JOA-141

Scotch Cap 946-2808

4/12/09

FB017

JOA

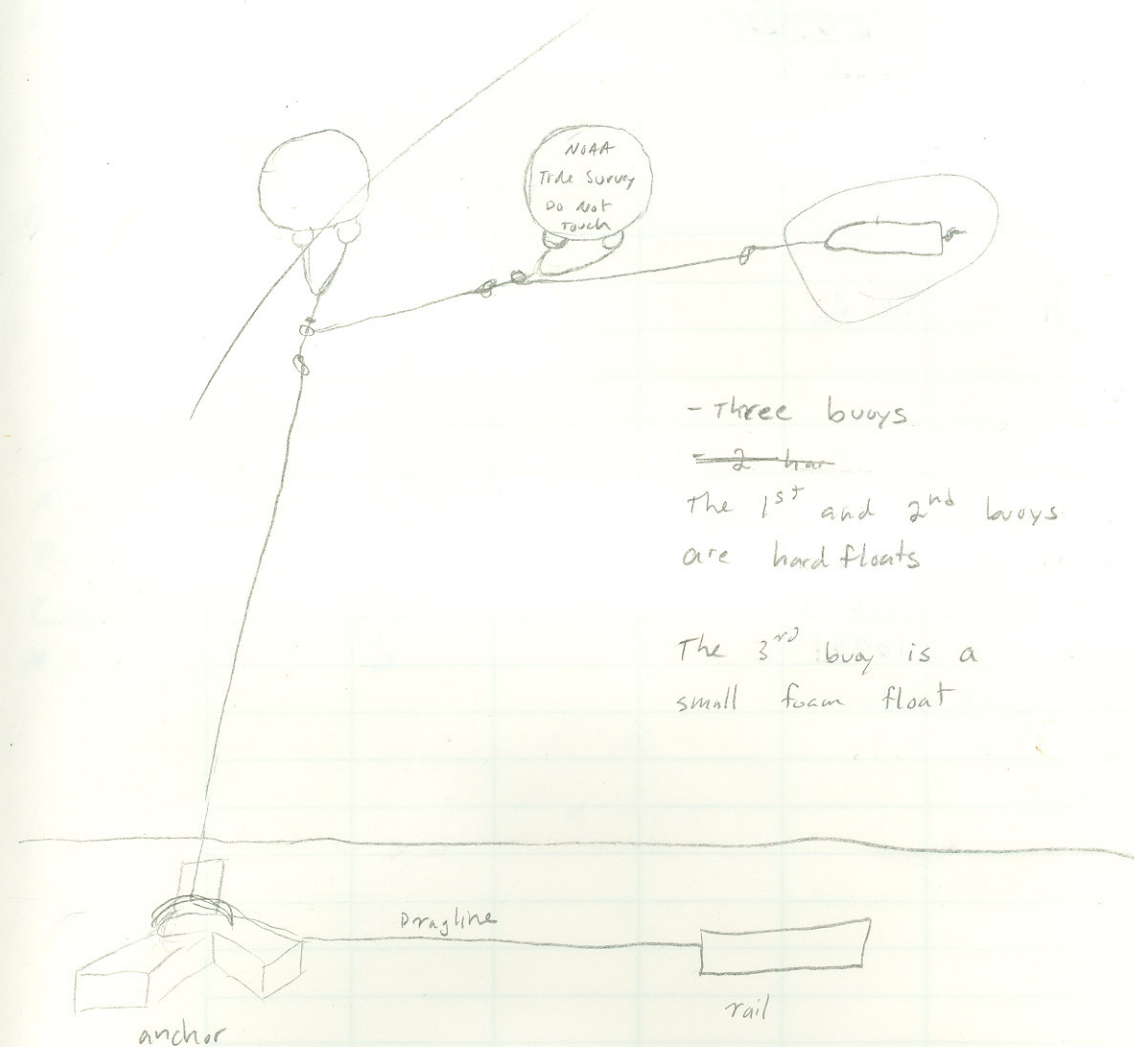
Scotch Cap 946-2808

4/12/09

(10)

	GOES	Pointing	Angles
	West-Cent		West-West
Elev :	16.9°		22.9
Azim :	131.3°		147.1

Water density	Slope
1.024	0.68596
1.025	0.68529
1.026	0.68463
1.027	0.68396
1.028	0.68329
1.029	0.68263
1.030	0.68197

Buoy Design

- three buoys.

~~= 2 buoys~~The 1st and 2nd buoys
are hard floatsThe 3rd buoy is a
small foam float

JOA-141

Scotch Cap 9452808

FB017

JOA-141

Scotch CAP

4/27/09 (18)

GPS BASE Station

One	Two	Trimble	5700	receiver
Two	One	Trimble	Zephyr	Antenna

InstrumentSN

5700 receiver

Antenna

JOA -141

Scotch Cap 946 2808

FB017

JOA -141

Scotch Cap

4/27/09

⑫

Leveling

C-Test

Instrument: NAZ S191316
 Rod: CRANE METRIC

Unbalanced

	BS	FS	Thread	Mean
Rock West	0984			
	0963		21	✓
	0942		21	0963.0 ✓

Rock East	0850	239		
	0611	239		0610.7 ✓
	0371	240		

Balanced

	BS	FS	Thread	Mean
Rock East	0631			
	0495		136	✓ 0495.0 ✓
	0359		136	

Rock West	0970			
✓	0845	125	✓	0845.0 ✓
	0720	125	✓	

unbalanced DE 352.3 ✓
 balanced DE -350.0 ✓
 2.3 ✓

LEVEL SPUR TBMS TO ORIFICE
 BS FS
 0.101 TBMS
 2.434 2.410 ORIFICE LA
 0.124 TBMS

FROM TO FORWARD REVERSE Δ MEAN
 TBMS ORIFICE LA -2.309 2.310 0.001 -2.3095 ✓

✓ By
 Jem
 5/8/09

JOA-141

Scotch CAP 9462808

FB017

JOA-141

Scotch CAP

4/27/09 (13)

DEST: 2808 C 2009

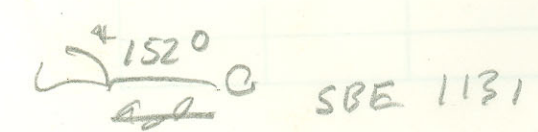
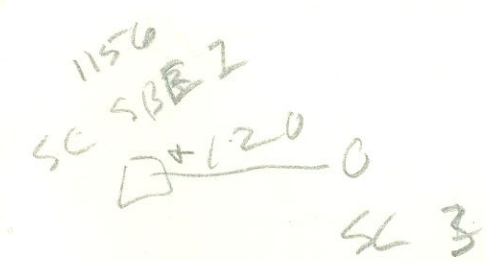
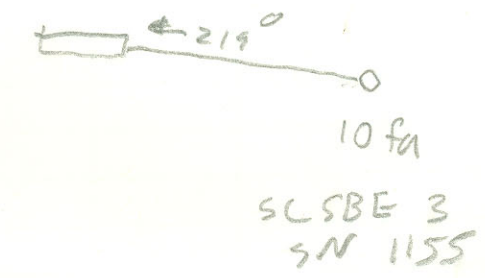
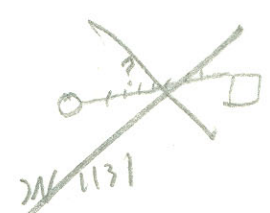
Stamping:

Need to Reciprocal
of coordinates

LAT: 54-23-41.1 N

LOX: 164-44-19.0 W

- Set flush in bedrock
- 97.08 m (318.5 ft) S 45 W of Tidal 4 NE
- 100 m (328 ft) N 25 E of 4.7 m dia by 3.5 m tall
- 5.7 m (18.7 ft) N 6 W of 12 cm diameter iron eyebolt (rusty) in Bedrock near cobble beach
- 11.6 m (38.1 ft) N 78 W of grassline



JOA-141

Scotch CAP 9462808

FS017

JOA-141

Scotch CAP

4/27/69 (15)

DES: 2808 C 2009

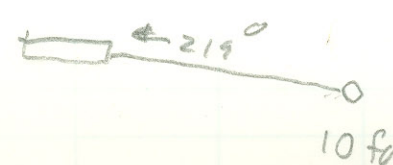
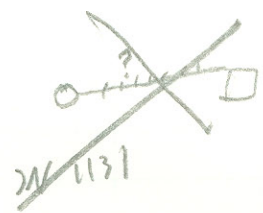
Stamping:

Need to Reciprocal
of coordinates

LAT: 54-23-41.1 N

LOX: 164-44-19.0 W

- Set flush in bedrock
- 97.08 m (ft) S 45 W of Tidal 4 NE
- 100 m (ft) N 25 E of 4.7 m dia by 3.5 m tall
- 5.7 m (ft) N 6 W of 12 cm diameter iron eyebolt (rusty) in Bedrock near cobble beach
- 11.6 m (ft) N 78 W of grassline



SCSBE 3
SN 1155

1156
SCSBE 2
+120

SL 3

+1520
SBE 1131



~~DES~~ 2808 A 2009

Stamping: 2808 A 2009

All Bearings
are True

LAT: 54-23-37.1 N

LON: 164-44-44.6 W

These Bearings need to
be 180'd

The Mark is set in a
0.80 m (long) x 0.40 m (wide)
~~horizontal~~ projection of bedrock

Mark is flush and 0.80 m
above surrounding rock

67 m (219.8 ft) ~~NE~~ NE 13°
NW corner of old light house
(concrete) that was destroyed
in the tsunami

142 m (465.9 ft) North 5° East
of orange and white warning light
at top of bluff

39 m (128.0 ft) North 18° West
of South east corner of a by
concrete pad halfway up of grass bluff

North 84° West of Scotch Cap Pinnacle

Slant ~ Dist to Co

~~DES~~ 2808 B 2009

Stamping: 2808 B 2009

LAT: 54°23' 37.9" N

LON: 164°44' 38.3" W

- set in bedrock ~~at~~ near ledge cliff
- 1.20 m south of rock ledge cliff
- set flush in rock ledge that is
2 m x 2 m x 0.75 m high
- 8.9 m (29.2 ft) N 7° W of the ~~south west~~ west
corner of a 17.2 m (56.4) long concrete
retaining wall
- 3.5 m below top of bluff
- 29.2 m (95.8 ft) S 81° W of the
west corner of the western most concrete
retaining wall that is
- 146.8 m (481.6 ft) N 37° E of the SW corner
of a ^{conglomerate} triangular rock 3.1 m by 6.3 m by 7.4 high
at base of bluff and 21.2 m from
grass edge

JOA-141

Scotch Cap 9462808

FB017

JOA-141

Scotch CAP

4/27/09 (13)

Descriptions

TIDAL 4

Stamping: 1938 4

Need to Reciprocal Bearings

LAT: 54-23-39.2 N

LOX: 164-44-28.3 W

Set flush in Bedrock Ridge

• 12.9 m (6.2 ft) S 22 E of TIDAL 2

• 68.5 m (224.7 ft) N 66 W of mouth of creek where it flows from grass to cobble beach.

• 97.08 m (318.5 ft) SE of 2808 C 2009

• 6.6 m (21.7 ft) N 39 W of grassline

• 1.5 m above grassline

TIDAL 2

LAT: 54°23'38.84" N 23'38.8"

LOX: 164°44'22.82" W 44'23.2"

Need to Reciprocal Bearings

Stamping: $\frac{2}{1937}$

Set Flush in Bedrock Ridge

- 78.5 m (257.5 ft) N 62 W of creek where it flows from grass to cobble beach
- 19 m (62.3 ft) of grassline (N 42 W)
- 12.9 m (42.3 ft) SSE of bench mark Tidal 4

JOA -141

Scotch Cap 94B2808

FB017

JOA -141

Scotch Cap

4/23/09 (12)

	<u>Install</u>		
	Gauge 2		
	Gauge 1		waypoint
LAT:	54° 23.524' N		
LOn:	164° 43.444' W		
DEPTH:	11 fa		
Anchorline length :	18 fa		
	<u>SN</u>		
Seabird	1156		
Modem	009869		
Power	010157		
Cable	10989		
Modem Address	2		

InstallGauge 4

LAT 54° 23' 37.66" N

LOn 164° 44' 37.57" W

Bubbler mounted
to Rock

DEPTH N/A

Anchorline
~~length~~

SN

H3508L ~~1654~~ 1051Pump
RadioBarometer
Baro logger

2415

JON-141

Scotch Cap 9462808

Install

Gauge 3

~~Gauge 2~~

Way point 056

LAT: ~~54° 23.511~~ 54-23.457 NLON: ~~164° 43.723~~ 164-43.174 WDEPTH: ~~15~~ 10 fa

Anchorline

length : 18 fa

SN

Seabird 1131

Modem 010215

Power 010219

Cable 10991

Modem Address 2

FS017

JON 141

Scotch Cap

4/23/09 (11)

Install~~Gauge 3~~

waypoint =

LAT: 54-23.511 N Gauge 2

LON: 164-43.723 W

DEPTH: 10 fa

Anchorline

Length : 18 fa

SN

Seabird

1155

Modem

010589

Power

010573

Cable

10993

Modem Address

3

J0A 141

Scotch Cap

level notes for staff shots
from 1754 to 1848 (UTC) on 4/29/09

Levelled from 2808 B to
a Rock (TBM5)

BS	FS	
0.000		B
2.572	2.550	Rock (TBM5)
	0.023	B

FWD	REV	Δ	MEAN
2.550	2.549	0.001	-2.5495

J0A-141

Scotch Cap

22

level Notes for staff shots
from 00:24 to 02:36 (UTC) on
4/27/09

levelled from 2808 B to a Rock (TBM2)

BS	FS	
0.065		B
2.327	2.337	Rock (TBM2)
	0.054	B

FWD	REV	Δ	Mean
-2.272	2.273	0.001	-2.2725



JOA Surveys, LLC
SURVEYING GPS TIDES HYDROGRAPHY

2000 E. Dowling Road, Suite 10
Anchorage, AK 99507
(907) 561-0136 Phone
(907) 561-0143 Fax
www.joasurveys.com

Tidal Zoning for Unimak Pass 2009

Combined Approach using Conventional and PPK
Water Levels

From: Nathan Wardwell

To: Kathleen Mildon

Date: 2010.01.06

Project Overview

TerraSond Ltd (Terra) was tasked by the Office of Coast Survey to map 748 sqm of critical area in Unimak Pass. JOA Surveys, LLC (JOA) was subcontracted by Terra to provide tide support on this critical area survey. JOA proposed a three tier approach that included the installation of two tertiary tide stations, 1 long term zoning station, at least 15 short term zoning stations and PPK water levels. The tertiary tide stations were installed by JOA and Terra personnel during a 24 day campaign that started at the beginning of April and continued into the beginning of May. Terra began survey operations in May. During the survey operations Terra deployed two seabird submersible pressure sensors at 9 locations in the survey area. Terra also collected PPK water levels using three different survey vessels. JOA removed the two tertiary tide stations and the long term zoning station near the beginning of September. Terra provided JOA with the last of the PPK water levels on November 13th.

The methodology behind the three tier data approach is that Unimak Pass is a tidally complex area due to the interaction of the Bering Sea and the Pacific Ocean. Simultaneous comparison of data at the zoning sites and both the tertiary sites and the permanent NOAA tide stations identified as control in the Project Instructions would help refine the preliminary tidal zoning scheme. The PPK water levels were used to estimate the tidal characteristics in areas that were not properly modeled using the pressure data.

This report is organized into 4 main categories:

- Tidal Zone Determination Methodology
- Least Squares Routine for Deriving Time and Range Correctors
- Final Zoning Factors
- Final Zoning Scheme

Tidal Zoning Determination Methodology

The Unalaska and King Cove tide stations that are part of NOAA's National Water Level Observation Network (NWLON) provided control for tidal determination at the two tertiary tide stations. One tertiary tide station was installed in Heleanthus Cove on Akun Island. The other tertiary tide station was installed on the open coast of Unimak Island at Scotch Cap. In addition a long term zoning station was installed in Sanak Harbor on Sanak Island (Figure 1).

The two tertiary stations were installed in accordance with chapter 4 of the Hydrographic Surveys Specifications and Deliverables dated April 2009 (NOS, 2009). The long term zoning station consisted of one submersible sensor deployed for the duration of the project.

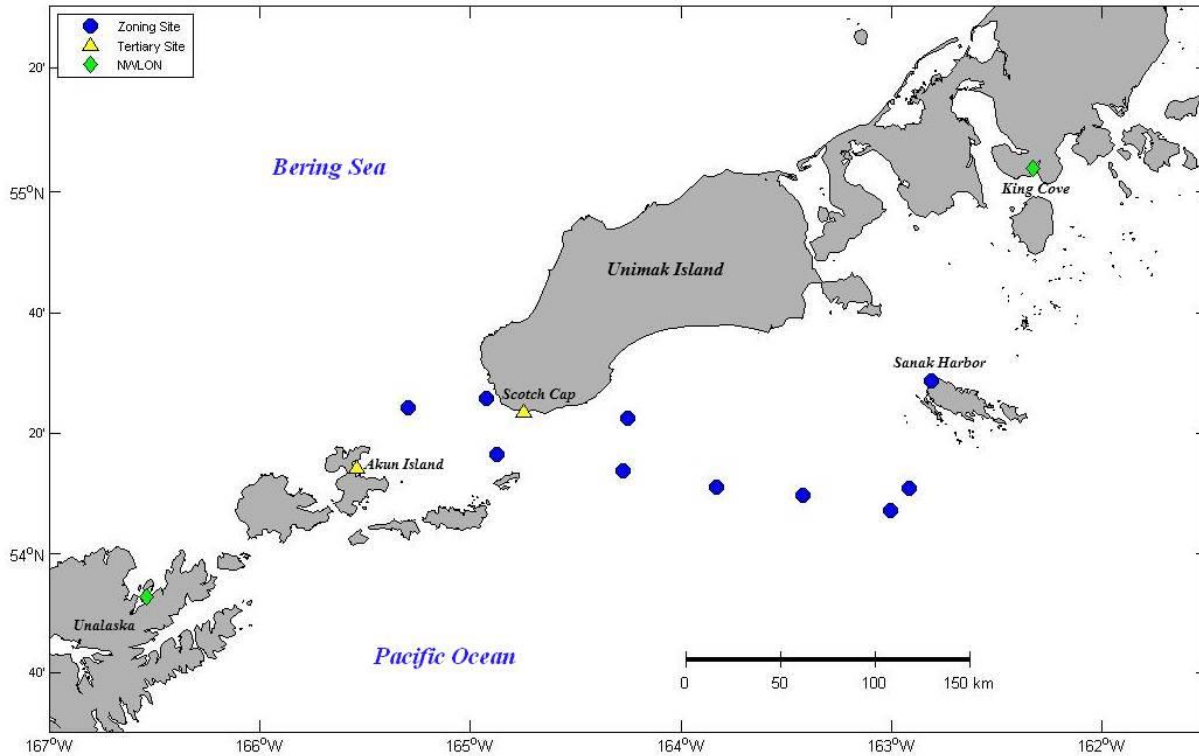


Figure 1 - Overview map of locations at which water level data was collected.

The appropriate NWLON to use as the control stations was based on the Tidal Form Number (F) of each of the sites. The Tidal Form Number was used because it quantifies the ratio of the influence by the primary lunar and solar diurnal constituents to that of the primary lunar and solar semi-diurnal constituents. The Tidal Form Numbers for the two tertiary tide stations (Table 1) were computed using the amplitudes of the tidal harmonic constituents extracted from the water level records at these stations. These amplitudes were extracted using the harmonic analysis Matlab tool T_Tide (Pawlowicz, 2002). The form numbers for the two NWLONS were computed using the tidal harmonic constants published by NOAA on the tides and currents website (tidesandcurrents.noaa.gov). Table 1 shows that Akun is more similar to Unalaska and Scotch Cap is more similar to King Cove.

Table 1 - Tidal Form Number for the two tertiary and two NWLON tide stations.

Station	Station Type	F	Tide Type
King Cove	NWLON	0.8	Mixed, Predominantly Semi-Diurnal
Unalaska	NWLON	1.9	Mixed, Predominantly Diurnal
Scotch Cap	Tertiary	1.2	Mixed, Predominantly Semi-Diurnal
Akun	Tertiary	2.6	Mixed, Predominantly Diurnal

Once the control stations for the tertiary stations were determined, tidal datums at the tertiary sites were computed using the Monthly Means method of simultaneous comparison and the Standard Method of correcting the datums to the 1983 -2001 NTDE equivalent. These methods and their applications are referenced in NOAA's *Computational Techniques for Tidal Datums Handbook* (NOAA, 2003).

For each of the short term zoning stations tidal datums were computed using the Tide-by-Tide method of simultaneous observations (NOAA, 2003). This method of computation provided the three primary parameters that were used to refine the preliminary tidal zoning. These parameters are Mean Range (*MN*), High Water Interval (*HWI*) and Low Water Intervals (*LWI*). This method was also used to derive the *HWI* and *LWI* parameters at the two tertiary stations and the long term zoning station at Sanak Harbor. The *MN* values were interpolated to evenly spaced grids of 1 minute resolution. The *HWI* and *LWI* values at each site were averaged to determine the mean progression of the tide (*MWI*):

$$MWI = 0.5(HWI+LWI)$$

MWI was also interpolated to an evenly spaced grid of 1 minute resolution. The grids were interpolated using the Sandwell and Smith Biharmonic Spline Interpolation algorithm provided in Matlab (Trauth, 2007). This algorithm is not constrained by the coastlines and extrapolates to the extent of the grid.

Contours were extracted from these grids at the intervals specified in the first paragraph of section 4.5.2 in the 2009 Hydrographic Survey Specifications and Deliverables "The minimum requirement is for a new zone for every 0.06 m change in mean range of tide and every 0.3 hour progression in time of tide (Greenwich high and low water intervals)" (NOS, 2009) (Figure 2). The polygons created by the intersection of these contours were used to define the majority of the zones in the final scheme. Several larger zones were manually edited to create smaller zones.

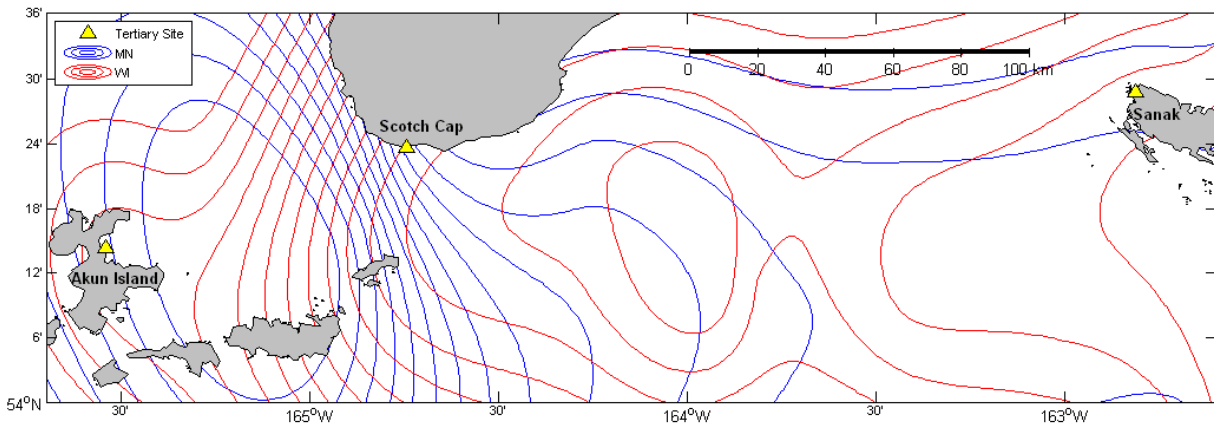


Figure 2 - Contours for MN and WI extracted from the 1 min grids.

Zoning Factors

The zoning factors for the 107 zones used for the Unimak Pass survey were derived four different ways. For the majority of the zones the zoning factors were derived from a surface of values interpolated from comparing the reference station data to the data at the 10 zoning stations. For zones around the edge of the interpolated surface the values were based on the zoning factors in the surrounding zones. This was done because of the NaN values at the edges of the surface. The third method was to fit the data at a reference station to the PPK water levels in a zone. The data were fit in a least squares sense, which is described in the following section. This method was used for zones:

SCOTCH066 SCOTCH079 SCOTCH080 SCOTCH081 SCOTCH082 SCOTCH083
 SCOTCH084 SCOTCH085 SCOTCH086

The fourth method consisted of computing a tide curve for a zone by combining the data at Scotch Cap and Akun in a weighted average. This approach consisted of two steps. The first step consisted of computing the time offset necessary to zone the Scotch Cap and Akun data to the zone of interest. The second step consisted of determining the weights for combining the Scotch Cap and Akun data sets after they were shifted in time. This was accomplished using the model

$$x_3 = z + w_2x_2 + w_1x_1 + \epsilon$$

where x_3 are the PPK heights in the zone, z is a mean offset, x_2 is the time offset data for Scotch Cap, x_1 is the time offset data for Akun, w_2 is the weight of the Scotch Cap data, w_1 is the weight of the Akun data and ϵ is the error. The zones that this method was used for are shown in Table 2. This table also shows the time offsets (dt) and the weights (w). The tide files were assigned pseudo station numbers. The reference station for the zones corresponded with pseudo station number of the files. These pseudo station numbers were used so that the tide files were properly applied in CARIS

Table 2 - Zones for which tide curves were created using both Scotch Cap and Akun.

Zone	Pseudo station number	Scotch dt (minutes)	w	Акun dt (minutes)	w
SCOTCH040	0000040	50	0.47	-83	0.69
SCOTCH050	0000050	15	0.80	94	0.24
SCOTCH052	0000052	11	1.03	126	-0.26

The results from using this fourth method improved the tide busts from 40-50 cm to 15-20 cm in zone SCOTCH040, from 30-35 cm to 10-15 cm in zone SCHOTCH052 and by about 10 cm in zone SCOTCH050.

Following are two figures that show the results of differencing the zoned tide data from the PPK water levels in zone SCOTCH040. Each of these figures shows the geographic location of the PPK water levels (decimated to 30 sec intervals) that were measured in the corresponding zone. The individual PPK water levels are colored by their difference from the tide file for the zone. In figure 3 the differences are

between the PPK water levels and the tide data from Scotch Cap zoned to SCOTCH040. The difference in figure 4 are between the PPK water levels in that zone and the weighted average tide file that was created using data from Scotch Cap and Akun in the least squares routine. Note that in figure 3 the range of the differences is much larger than those in figure 4.

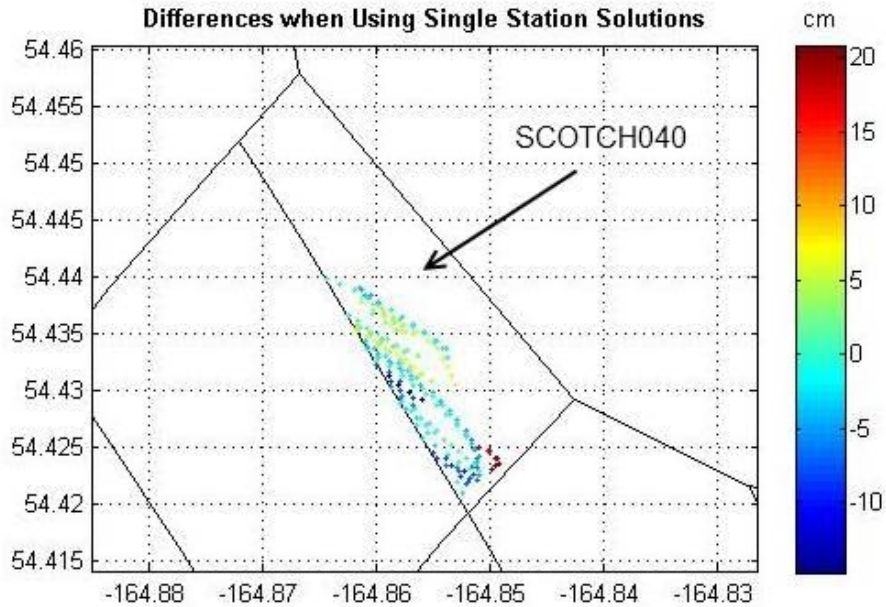


Figure 3 - Difference between the Scotch Cap tide data zoned to SCOTCH040 and the PPK water levels measured in that zone.

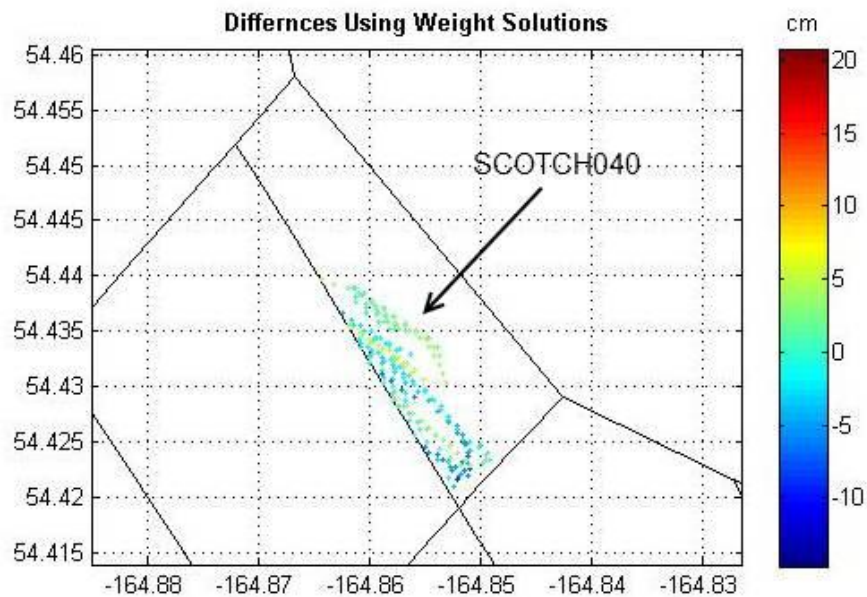


Figure 4 - The difference between the weighted average tide curve (using tide data from Scotch Cap and Akun) and the PPK water levels measured in SCOTCH040.

Least Squares Routine for Deriving Time and Range Correctors

The least squares routine solves for time and range correctors iteratively. The first iteration compares each individual measurement at the zoning site to each corresponding measurement at the reference station shifted back in time by 3 hours. Each following iteration advances the time series at the reference station by dt , where dt is the sampling period at the reference station. During each iteration the algorithm solves for the mean offset between the two water level records (z) and the range corrector (rr). The algorithm iterates through a 6 hour window then finds the time offset (DT) that minimizes the residuals between the data at the zoning site and the reference station. The result is a set of parameters (DT , z and rr) that are used to fit the data at the reference station to the data at the zoning station. This algorithm accepts both continuous and sparse time series. Thus this algorithm can be used with PPK water levels measured sporadically at a zoning site.

Final Zoning Scheme

The final zoning scheme consisted of 107 zones (figure 5). Eighty-three of these zones used Scotch Cap as the reference station, 16 used Akun as the reference station and 5 used the King Cove NWLON as the reference station. Three zones used the (SCOTCH040, SCOTCH050 and SCOTCH052) data from both Scotch Cap and Akun. The data from the roving seabirds collected towards the eastern portion of the survey area are controlled by the King Cove NWLON. This was based on the data collected by the short and long term zoning stations.

There were several areas where the polygons defined by the intersection of the *MWI* and *MN* contours that were divided into smaller zones. These areas were to the western portion of the survey area and around the southeastern coastline of Unimak Island.

Lastly, the three zones that required a weighted average of the data from both Scotch Cap and Akun are located in the vicinity of Unimak Island shoreline. It is suspected that these areas created some tide difficulties because this is close to the transition zone where the semi-diurnal tide from the Pacific Ocean and the Diurnal tide from the Bering Sea merge creating a variation in tide type over short distances. Thus at times while surveying operations were conducted in this region the water levels are more similar to those measured at Scotch Cap whereas at other times the water levels are more similar to those measured at the Akun tide station. These differences are further compounded by the fact that meteorological effects such as water building up along the southern coast of Unimak Island would potentially not be reflected in the water level record at Akun Island.

There is a table at the end of this report that lists the zones, their parameters and the method used to derive the parameters. The methods listed in this table are either grid, single station least squares, or 9462719 and 9462808 weighted average. The grid method refers to zones with parameters derived from the time and range corrector grids described at the beginning of the zoning factors section of this report. The single station least squares method refers to zones with parameters derived using the least squares routine to fit the tide data from only one tertiary tide station to the PPK water levels measured in the zone. The 9462719 and 9462808 weighted average method refers the zones with parameters

derived using the least squares routine to fit the tide data from both Akun (9462719) and Scotch Cap (9462808) to the PPK water levels measured in the zone.

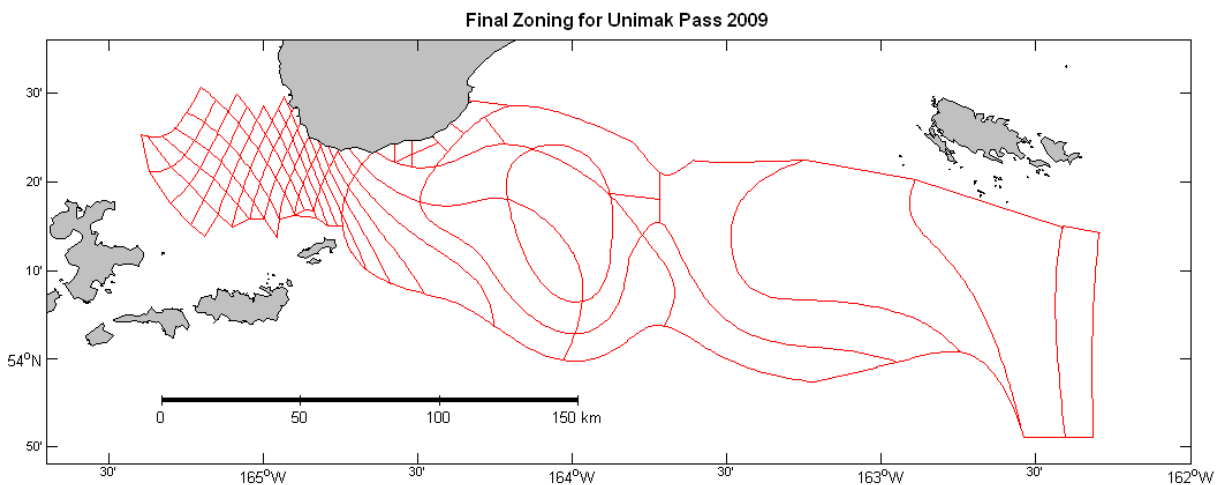


Figure 5 - The final zoning scheme for Unimak Pass.

References

NOAA, "Computational techniques for tidal datums handbook" NOAA special publication NOS CO-OPS 2 (2003), 113p

NOS, "NOS hydrographic surveys specifications and deliverables" U.S. Department of Commerce (2009), 161p

R. Pawlowicz, B. Beardsley, and S. Lentz, "Classical tidal harmonic analysis including error estimates in MATLAB using T_TIDE", Computers and Geosciences 28 (2002), 929-937

M. Trauth, "Matlab recipes for earth sciences 2nd Edition", Springer-Verlag Berlin, Heidelberg (2007), 288p

ZONE	TIME (min)	RANGE	CONTROL STATION	METHOD	ZONE	TIME (min)	RANGE	CONTROL STATION	METHOD
AKUN003	-35	1.10	9462719	grid	SCOTCH040	0	1.00	0000040	9462719 and 9462808 weighted average
AKUN007	-41	1.11	9462719	grid	SCOTCH041	20	0.72	9462808	grid
AKUN002	-36	1.08	9462719	grid	SCOTCH042	29	0.85	9462808	grid
AKUN011	-44	1.13	9462719	grid	SCOTCH043	20	0.77	9462808	grid
AKUN006	-44	1.10	9462719	grid	SCOTCH044	18	0.80	9462808	grid
AKUN001	-40	1.06	9462719	grid	SCOTCH045	30	0.89	9462808	grid
AKUN015	-46	1.13	9462719	grid	SCOTCH046	16	0.84	9462808	grid
AKUN010	-48	1.12	9462719	grid	SCOTCH047	34	0.87	9462808	grid
SCOTCH001	136	0.65	9462808	grid	SCOTCH048	22	0.75	9462808	grid
AKUN005	-49	1.09	9462719	grid	SCOTCH049	14	0.88	9462808	grid
AKUN014	-48	1.15	9462719	grid	SCOTCH050	0	1.00	0000050	9462719 and 9462808 weighted average
AKUN009	-53	1.12	9462719	grid	SCOTCH051	17	0.76	9462808	grid
AKUN004	-52	1.08	9462719	grid	SCOTCH052	0	1.00	0000052	9462719 and 9462808 weighted average
SCOTCH002	124	0.66	9462808	grid	SCOTCH053	7	0.83	9462808	grid
AKUN013	-50	1.16	9462719	grid	SCOTCH054	13	0.78	9462808	grid
AKUN008	-57	1.10	9462719	grid	SCOTCH055	4	0.88	9462808	grid
SCOTCH003	113	0.68	9462808	grid	SCOTCH056	9	0.96	9462808	grid
SCOTCH004	65	0.63	9462808	grid	SCOTCH057	2	0.93	9462808	grid
AKUN012	-57	1.14	9462719	grid	SCOTCH058	0	1.00	9462808	grid
SCOTCH005	81	0.63	9462808	grid	SCOTCH059	31	0.77	9462808	grid
SCOTCH006	105	0.70	9462808	single station least squares	SCOTCH060	2	0.97	9462808	grid
SCOTCH007	101	0.69	9462808	grid	SCOTCH061	25	0.77	9462808	grid
SCOTCH008	88	0.65	9462808	grid	SCOTCH062	5	0.93	9462808	grid
SCOTCH009	63	0.64	9462808	grid	SCOTCH063	14	0.80	9462808	grid
SCOTCH010	90	0.71	9462808	grid	SCOTCH064	-12	0.98	9462808	grid
SCOTCH011	88	0.69	9462808	grid	SCOTCH065	4	0.83	9462808	grid
SCOTCH012	71	0.65	9462808	grid	SCOTCH066	-10	1.00	9462808	grid
SCOTCH013	84	0.73	9462808	grid	SCOTCH067	-5	0.88	9462808	grid
SCOTCH014	75	0.69	9462808	grid	SCOTCH068	-31	0.97	9462808	grid
SCOTCH015	55	0.65	9462808	grid	SCOTCH069	-24	0.93	9462808	grid
SCOTCH016	75	0.71	9462808	grid	SCOTCH070	-38	0.95	9462808	grid
SCOTCH017	73	0.72	9462808	grid	SCOTCH071	-24	0.96	9462808	grid
SCOTCH018	61	0.68	9462808	grid	SCOTCH072	-39	0.98	9462808	grid
SCOTCH019	71	0.75	9462808	grid	SCOTCH073	-39	0.98	9462808	grid
SCOTCH020	39	0.67	9462808	grid	SCOTCH074	-32	0.97	9462808	grid
SCOTCH021	61	0.71	9462808	grid	SCOTCH075	-33	0.97	9462808	grid
SCOTCH022	44	0.67	9462808	grid	KING005	18	0.91	9459881	grid
SCOTCH023	65	0.76	9462808	grid	KING004	11	0.93	9459881	grid
SCOTCH024	60	0.75	9462808	grid	KING003	4	0.94	9459881	grid
SCOTCH025	48	0.70	9462808	grid	KING002	4	0.93	9459881	grid
SCOTCH026	70	0.76	9462808	grid	KING001	4	0.92	9459881	grid
SCOTCH027	57	0.78	9462808	grid	AKUN016	-44	1.06	9462719	grid
SCOTCH028	38	0.70	9462808	grid	SCOTCH076	53	0.65	9462808	grid
SCOTCH029	48	0.74	9462808	grid	SCOTCH077	43	0.66	9462808	grid
SCOTCH030	34	0.69	9462808	grid	SCOTCH078	28	0.73	9462808	grid
SCOTCH031	58	0.79	9462808	grid	SCOTCH079	-30	0.99	9462808	single station least squares
SCOTCH032	44	0.77	9462808	grid	SCOTCH080	-24	0.94	9462808	single station least squares
SCOTCH033	34	0.73	9462808	grid	SCOTCH081	-25	0.94	9462808	single station least squares
SCOTCH034	60	0.78	9462808	grid	SCOTCH082	-12	0.96	9462808	single station least squares
SCOTCH035	47	0.82	9462808	grid	SCOTCH083	-26	0.94	9462808	single station least squares
SCOTCH036	34	0.77	9462808	grid	SCOTCH084	-28	0.98	9462808	single station least squares
SCOTCH037	33	0.72	9462808	grid	SCOTCH085	-35	1.01	9462808	single station least squares
SCOTCH038	52	0.82	9462808	grid	SCOTCH086	-37	1.19	9462808	single station least squares
SCOTCH039	33	0.82	9462808	grid					

APPENDIX II
 Base Station Information

Cold Bay CORS (BAY5) Data Sheet



```

DJ3025 *****
DJ3025  CORS           -   This is a GPS Continuously Operating Reference Station.
DJ3025  DESIGNATION  -   COLD BAY 5 CORS ARP
DJ3025  CORS_ID     -   BAY5
DJ3025  PID         -   DJ3025
DJ3025  STATE/COUNTY-   AK/ALEUTIANS EAST BOROUGH
DJ3025  USGS QUAD   -   COLD BAY A-3
DJ3025
DJ3025                               *CURRENT SURVEY CONTROL
DJ3025
DJ3025*  NAD 83 (CORS)-  55 11 24.98370 (N)    162 42 25.70036 (W)    ADJUSTED
DJ3025*  NAVD 88      -                               ** (meters)          ** (feet)
DJ3025
DJ3025  EPOCH DATE   -           2003.00
DJ3025  X            -   -3,484,296.492 (meters)                                COMP
DJ3025  Y            -   -1,084,761.271 (meters)                                COMP
DJ3025  Z            -           5,213,545.391 (meters)                            COMP
DJ3025  ELLIP HEIGHT-           50.031 (meters)                                (09/??/07) ADJUSTED
DJ3025  GEOID HEIGHT-           15.40 (meters)                                GEOID09
DJ3025  HORZ ORDER  -   SPECIAL (CORS)
DJ3025  ELLP ORDER  -   SPECIAL (CORS)
DJ3025
DJ3025. ITRF positions are available for this station.
DJ3025. The coordinates were established by GPS observations
    
```

DJ3025.and adjusted by the National Geodetic Survey in September 2007.
 DJ3025.The coordinates are valid at the epoch date displayed above.
 DJ3025.The epoch date for horizontal control is a decimal equivalence
 DJ3025.of Year/Month/Day.
 DJ3025
 DJ3025
 DJ3025.The PID for the CORS L1 Phase Center is DJ3026.
 DJ3025
 DJ3025.The XYZ, and position/ellipsoidal ht. are equivalent.
 DJ3025
 DJ3025.The ellipsoidal height was determined by GPS observations
 DJ3025.and is referenced to NAD 83.
 DJ3025
 DJ3025.The geoid height was determined by GEOID09.
 DJ3025
 DJ3025;
 DJ3025;SPC AK 7 - North East Units Scale Factor Converg.
 132,711.433 454,966.556 MT 0.99992487 -0 34 50.2
 DJ3025
 DJ3025!
 DJ3025!SPC AK 7 - Elev Factor x Scale Factor = Combined Factor
 0.99999217 x 0.99992487 = 0.99991704
 DJ3025
 DJ3025 SUPERSEDED SURVEY CONTROL
 DJ3025
 DJ3025.No superseded survey control is available for this station.
 DJ3025
 DJ3025_U.S. NATIONAL GRID SPATIAL ADDRESS: 3UXB4596218363(NAD 83)
 DJ3025_MARKER: STATION IS THE ANTENNA REFERENCE POINT OF THE GPS ANTENNA
 DJ3025
 DJ3025 STATION DESCRIPTION
 DJ3025
 DJ3025'DESCRIBED BY NATIONAL GEODETIC SURVEY 2007
 DJ3025'STATION IS A GPS CORS. LATEST INFORMATION INCLUDING POSITIONS AND
 DJ3025'VELOCITIES ARE AVAILABLE IN THE COORDINATE AND LOG FILES ACCESSIBLE
 DJ3025'BY ANONYMOUS FTP OR THE WORLDWIDE WEB.
 DJ3025' FTP CORS.NGS.NOAA.GOV: CORS/COORD AND CORS/STATION_LOG
 DJ3025' HTTP://WWW.NGS.NOAA.GOV UNDER PRODUCTS AND SERVICES.
 DJ3026 *****
 DJ3026 CORS - This is a GPS Continuously Operating Reference Station.
 DJ3026 DESIGNATION - COLD BAY 5 CORS L1 PHASE CENTER
 DJ3026 CORS_ID - BAY5
 DJ3026 PID - DJ3026
 DJ3026 STATE/COUNTY- AK/ALEUTIANS EAST BOROUGH
 DJ3026 USGS QUAD - COLD BAY A-3
 DJ3026
 DJ3026 *CURRENT SURVEY CONTROL
 DJ3026
 DJ3026* NAD 83(CORS)- 55 11 24.98359(N) 162 42 25.70047(W) ADJUSTED
 DJ3026* NAVD 88 - ** (meters) ** (feet)
 DJ3026
 DJ3026 EPOCH DATE - 2003.00
 DJ3026 X - -3,484,296.540 (meters) COMP
 DJ3026 Y - -1,084,761.284 (meters) COMP
 DJ3026 Z - 5,213,545.456 (meters) COMP
 DJ3026 ELLIP HEIGHT- 50.112 (meters) (09/??/07) ADJUSTED
 DJ3026 GEOID HEIGHT- 15.40 (meters) GEOID09
 DJ3026 HORZ ORDER - SPECIAL (CORS)

DJ3026 ELLP ORDER - SPECIAL (CORS)
 DJ3026
 DJ3026.ITRF positions are available for this station.
 DJ3026.The coordinates were established by GPS observations
 DJ3026.and adjusted by the National Geodetic Survey in September 2007.
 DJ3026.The coordinates are valid at the epoch date displayed above.
 DJ3026.The epoch date for horizontal control is a decimal equivalence
 DJ3026.of Year/Month/Day.
 DJ3026
 DJ3026
 DJ3026.The PID for the CORS ARP is DJ3025.
 DJ3026
 DJ3026.The XYZ, and position/ellipsoidal ht. are equivalent.
 DJ3026
 DJ3026.The ellipsoidal height was determined by GPS observations
 DJ3026.and is referenced to NAD 83.
 DJ3026
 DJ3026.The geoid height was determined by GEOID09.
 DJ3026
 DJ3026
 DJ3026 SUPERSEDED SURVEY CONTROL
 DJ3026
 DJ3026.No superseded survey control is available for this station.
 DJ3026
 DJ3026 U.S. NATIONAL GRID SPATIAL ADDRESS: 3UXB4596218363(NAD 83)
 DJ3026 MARKER: STATION IS THE L1 PHASE CENTER OF THE GPS ANTENNA
 DJ3026
 DJ3026 STATION DESCRIPTION
 DJ3026
 DJ3026'DESCRIBED BY NATIONAL GEODETIC SURVEY
 DJ3026'STATION IS A GPS CORS. LATEST INFORMATION INCLUDING POSITIONS AND
 DJ3026'VELOCITIES ARE AVAILABLE IN THE COORDINATE AND LOG FILES ACCESSIBLE
 DJ3026'BY ANONYMOUS FTP OR THE WORLDWIDE WEB.
 DJ3026' FTP CORS.NGS.NOAA.GOV: CORS/COORD AND CORS/STATION_LOG
 DJ3026' HTTP://WWW.NGS.NOAA.GOV UNDER PRODUCTS AND SERVICES.

OPUS Results for Auxiliary Basestations

Station Location	Latitude	Longitude	Height (APC)
Scotch Cap, Unimak Island	54° 23' 42.45" N	164° 44' 41.89" W	60.2807
Akun Bay, Akun Island	54° 14' 20.13" N	165° 32' 27.78" W	23.45518
Sanak Harbor, Sanak Island	54° 28' 47.17" N	162° 48' 49.16" W	25.7335

APPENDIX III
Post Processing Kinematics Accuracy Summary

The accuracy of the Post Processing Kinematics solution produced by Applanix POSGNSS was evaluated in the processing summary generated for each report. If accuracies were below tolerance, the line was reprocessed. Below are summaries of the results for each vessel.

The Quality percentage is the percentage of positions receiving each quality flag from POSGNSS. The meaning of the flags is as follows:

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

Processing results with less than 95% Q1 flags were rejected and the file re-processed.

RMS Separation between forward and reverse processing solutions was generally less than 10cm. Also, standard deviation between positions was generally less than 10cm at in at least 95% of positions.

Average Baseline Distance is the distance from the vessel to the four base stations. The stations were three a survey-specific stations at Scotch Cap, AK, Akun Island, AK and Sanak Island, AK. Baseline distances did not typically exceed 100km.

PPK Processing Summaries

M/V Bluefin

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	(km)
132	0	100	0	0	0	0	0.073	0.041	0.054	100	0	0	0	0	59.213
133	0	100	0	0	0	0	0.114	0.042	0.095	100	0	0	0	0	32.764
133	100	0.1	0	0	0	0	0.014	0.028	0.041	100	0	0	0	0	32.582
133	100	0.2	0	0	0	0	0.013	0.027	0.039	100	0	0	0	0	32.576
134	100	0.3	0	0	0	0	0.011	0.009	0.016	100	0	0	0	0	49.621
135	100	0.3	0	0	0	0	0.004	0.005	0.022	100	0	0	0	0	49.088
135	0	100	0	0	0	0	0.257	0.121	0.268	100	0	0	0	0	98.895

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	(km)
135	100	0.2	0	0	0	0	0.012	0.011	0.013	100	0	0	0	0	92.595
136	100	0.2	0	0	0	0	0.017	0.013	0.022	100	0	0	0	0	52.713
137	97	3.4	0	0	0	0	0.026	0.016	0.046	100	0	0	0	0	51.868
137	100	0.5	0	0	0	0	0.02	0.051	0.06	100	0	0	0	0	52.007
137	100	0	0	0	0	0	0.017	0.016	0.031	100	0	0	0	0	52.657
138	100	0.1	0	0	0	0	0.02	0.024	0.027	100	0	0	0	0	47.425
138	100	0	0	0	0	0	0.017	0.01	0.025	100	0	0	0	0	54.93
140	100	0	0	0	0	0	0.018	0.018	0.026	100	0	0	0	0	51.993
140	100	0.1	0	0	0	0	0.012	0.012	0.019	100	0	0	0	0	55.266
140	99	0.8	0	0	0	0	0.009	0.028	0.051	100	0	0	0	0	56.439
140	99	1.4	0	0	0	0	0.008	0.025	0.047	100	0	0	0	0	56.347
141	100	0.1	0	0	0	0	0.018	0.017	0.033	100	0	0	0	0	53.71
141	100	0.1	0	0	0	0	0.017	0.012	0.032	100	0	0	0	0	52.602
141	100	0.1	0	0	0	0	0.007	0.011	0.031	100	0	0	0	0	60.296
141	100	0.2	0	0	0	0	0.02	0.05	0.107	100	0	0	0	0	73.994
142	96	3.9	0	0	0	0	0.015	0.023	0.032	100	0	0	0	0	22.486
142	100	0.4	0	0	0	0	0.027	0.016	0.035	100	0	0	0	0	22.483
142	100	0.1	0	0	0	0	0.025	0.02	0.043	100	0	0	0	0	19.823
142	100	0.1	0	0	0	0	0.022	0.019	0.04	100	0	0	0	0	19.82
143	100	0.1	0	0	0	0	0.021	0.021	0.044	100	0	0	0	0	15.854
143	100	0.1	0	0	0	0	0.024	0.021	0.044	100	0	0	0	0	15.854
143	100	0.1	0	0	0	0	0.019	0.014	0.028	100	0	0	0	0	13.423
144	100	0.5	0	0	0	0	0.029	0.022	0.037	100	0	0	0	0	19.002
144	100	0.3	0	0	0	0	0.022	0.025	0.031	99.9	0.1	0	0	0	16.658
144	100	0.3	0	0	0	0	0.029	0.03	0.043	99.9	0.1	0	0	0	16.654
144	100	0.3	0	0	0	0	0.022	0.025	0.031	99.9	0.1	0	0	0	16.658
146	100	0.1	0	0	0	0	0.017	0.025	0.038	99.9	0.1	0	0	0	9.049
147	100	0.2	0	0	0	0	0.014	0.01	0.024	100	0	0	0	0	5.571
147	100	0.1	0	0	0	0	0.029	0.013	0.031	100	0	0	0	0	6.496
148	100	0.3	0	0	0	0	0.02	0.015	0.025	100	0	0	0	0	12.449
149	99	1.1	0	0	0	0	0.008	0.01	0.027	100	0	0	0	0	46.982
149	97	2.7	0	0	0	0	0.016	0.017	0.03	100	0	0	0	0	52.225
149	99	1.2	0	0	0	0	0.019	0.028	0.03	100	0	0	0	0	41.324
149	100	0.5	0	0	0	0	0.006	0.013	0.01	100	0	0	0	0	25.585
149	100	0.1	0	0	0	0	0.008	0.015	0.024	100	0	0	0	0	15.746
149	100	0.3	0	0	0	0	0.006	0.011	0.015	100	0	0	0	0	15.746
149	100	0.1	0	0	0	0	0.009	0.012	0.019	100	0	0	0	0	14.322
149	100	0.1	0	0	0	0	0.01	0.016	0.02	100	0	0	0	0	7.854
150	100	0.3	0	0	0	0	0.019	0.018	0.036	100	0	0	0	0	24.888
150	100	0.1	0	0	0	0	0.012	0.014	0.027	100	0	0	0	0	24.884
152	100	0.1	0	0	0	0	0.018	0.011	0.029	100	0	0	0	0	18.952
153	100	0.3	0	0	0	0	0.02	0.016	0.025	100	0	0	0	0	14.345
153	99	0.6	0	0	0	0	0.02	0.014	0.026	100	0	0	0	0	14.347
153	100	0.3	0	0	0	0	0.02	0.016	0.025	100	0	0	0	0	14.345

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	(km)
153	100	0.1	0	0	0	0	0.037	0.013	0.047	99.9	0.1	0	0	0	22.114
153	100	0.2	0	0	0	0	0.034	0.014	0.045	99.9	0.1	0	0	0	22.11
154	0	100	0	0	0	0	0.038	0.042	0.042	100	0	0	0	0	49.702
154	100	0.1	0	0	0	0	0.023	0.018	0.033	100	0	0	0	0	49.514
154	100	0.2	0	0	0	0	0.023	0.019	0.035	100	0	0	0	0	49.506
154	100	0.1	0	0	0	0	0.018	0.024	0.037	100	0	0	0	0	39.666
154	100	0.1	0	0	0	0	0.016	0.024	0.033	100	0	0	0	0	39.658
154	0	100	0	0	0	0	0.069	0.092	0.158	100	0	0	0	0	47.775
154	100	0.3	0	0	0	0	0.003	0.013	0.011	100	0	0	0	0	45.999
155	100	0.1	0	0	0	0	0.022	0.01	0.028	100	0	0	0	0	35.78
156	100	0.4	0	0	0	0	0.011	0.035	0.037	100	0	0	0	0	54.082
157	100	0.5	0	0	0	0	0.004	0.014	0.023	100	0	0	0	0	34.122
157	100	0.1	0	0	0	0	0.019	0.02	0.043	100	0	0	0	0	29.832
157	100	0.2	0	0	0	0	0.008	0.011	0.027	100	0	0	0	0	29.826
158	100	0.1	0	0	0	0	0.086	0.029	0.083	94.4	5.6	0	0	0	76.696
158	100	0.1	0	0	0	0	0.086	0.029	0.083	94.4	5.6	0	0	0	76.696
158	100	0.1	0	0	0	0	0.086	0.029	0.083	94.4	5.6	0	0	0	76.696
158	94	5.8	0	0	0	0	0.031	0.021	0.056	98.7	1.3	0	0	0	33.478
158	100	0.1	0	0	0	0	0.03	0.024	0.046	100	0	0	0	0	27.133
159	100	0.1	0	0	0	0	0.015	0.01	0.029	99.9	0.1	0	0	0	50.099
159	100	0.1	0	0	0	0	0.012	0.01	0.02	99.9	0.1	0	0	0	50.09
159	100	0.1	0	0	0	0	0.009	0.011	0.024	100	0	0	0	0	46.522
160	100	0.1	0	0	0	0	0.014	0.012	0.035	100	0	0	0	0	41.686
160	100	0.2	0	0	0	0	0.008	0.006	0.011	100	0	0	0	0	49.978
160	100	0.4	0	0	0	0	0.029	0.033	0.062	100	0	0	0	0	40.179
160	100	0.1	0	0	0	0	0.036	0.048	0.087	100	0	0	0	0	40.198
160	99	0.6	0	0	0	0	0.007	0.02	0.029	100	0	0	0	0	40.175
160	100	0.3	0	0	0	0	0.02	0.016	0.027	99.9	0.1	0	0	0	47.313
160	100	0.3	0	0	0	0	0.015	0.012	0.017	99.9	0.1	0	0	0	47.307
160	98	2.2	0	0	0	0	0.053	0.056	0.167	100	0	0	0	0	29.123
161	100	0	0	0	0	0	0.014	0.011	0.017	100	0	0	0	0	46.018
161	100	0.3	0	0	0	0	0.017	0.009	0.024	99.8	0.2	0	0	0	41.944
161	100	0.3	0	0	0	0	0.025	0.016	0.028	99.8	0.2	0	0	0	41.934
161	100	0.3	0	0	0	0	0.017	0.009	0.024	99.8	0.2	0	0	0	41.944
161	100	0.3	0	0	0	0	0.011	0.011	0.021	99.8	0.2	0	0	0	41.94
161	100	0.3	0	0	0	0	0.006	0.009	0.01	100	0	0	0	0	54.479
161	100	0.2	0	0	0	0	0.005	0.007	0.012	100	0	0	0	0	54.483
162	92	7.7	0	0	0	0	0.065	0.016	0.085	100	0	0	0	0	73.182
162	99	1.5	0	0	0	0	0.011	0.01	0.027	100	0	0	0	0	73.166
163	100	0.1	0	0	0	0	0.01	0.013	0.026	100	0	0	0	0	43.783
163	100	0.1	0	0	0	0	0.009	0.012	0.019	100	0	0	0	0	43.776
164	100	0.1	0	0	0	0	0.015	0.012	0.033	99.9	0.1	0	0	0	35.055
164	100	0.1	0	0	0	0	0.043	0.031	0.062	99.9	0.1	0	0	0	35.052
164	100	0.1	0	0	0	0	0.015	0.012	0.033	99.9	0.1	0	0	0	35.055

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	(km)
164	100	0.2	0	0	0	0	0.037	0.022	0.038	98.4	1.6	0	0	0	61.025
164	100	0.2	0	0	0	0	0.037	0.022	0.038	98.4	1.6	0	0	0	61.025
165	100	0	0	0	0	0	0.015	0.012	0.019	99.8	0.2	0	0	0	43.826
166	100	0.1	0	0	0	0	0.03	0.025	0.046	100	0	0	0	0	34.223
166	100	0.1	0	0	0	0	0.026	0.022	0.036	100	0	0	0	0	34.223
166	100	0.1	0	0	0	0	0.051	0.036	0.054	100	0	0	0	0	36.526
166	100	0.1	0	0	0	0	0.053	0.03	0.065	100	0	0	0	0	36.525
167	100	0	0	0	0	0	0.019	0.018	0.029	99.9	0.1	0	0	0	37.482
167	100	0.1	0	0	0	0	0.018	0.017	0.028	99.9	0.1	0	0	0	37.481
167	100	0.1	0	0	0	0	0.027	0.049	0.059	99.9	0.1	0	0	0	37.485
167	100	0.1	0	0	0	0	0.025	0.011	0.029	100	0	0	0	0	71.228
168	100	0.1	0	0	0	0	0.017	0.01	0.022	99.9	0.1	0	0	0	10.396
168	100	0.2	0	0	0	0	0.011	0.023	0.027	100	0	0	0	0	8.372
169	99	0.6	0	0	0	0	0.018	0.022	0.021	100	0	0	0	0	14.678
169	100	0.1	0	0	0	0	0.024	0.016	0.034	99.7	0.3	0	0	0	5.94
170	100	0.1	0	0	0	0	0.016	0.017	0.026	100	0	0	0	0	5.776
170	100	0.1	0	0	0	0	0.036	0.025	0.048	99.7	0.3	0	0	0	6.656
171	100	0.1	0	0	0	0	0.023	0.016	0.035	99.8	0.2	0	0	0	8.119
171	100	0.1	0	0	0	0	0.011	0.019	0.029	100	0	0	0	0	7.471
171	100	0.1	0	0	0	0	0.007	0.009	0.021	100	0	0	0	0	6.711
172	100	0.2	0	0	0	0	0.021	0.016	0.029	100	0	0	0	0	35.826
172	100	0.1	0	0	0	0	0.016	0.02	0.042	99.4	0.6	0	0	0	49.884
173	100	0.1	0	0	0	0	0.026	0.015	0.025	100	0	0	0	0	52.299
173	100	0.2	0	0	0	0	0.03	0.039	0.071	100	0	0	0	0	87.736
173	100	0.1	0	0	0	0	0.007	0.012	0.018	100	0	0	0	0	14.087
173	100	0.1	0	0	0	0	0.02	0.016	0.035	99.6	0.4	0	0	0	23.288
174	100	0.1	0	0	0	0	0.018	0.016	0.032	99.8	0.2	0	0	0	7.58
174	99	0.8	0	0	0	0	0.024	0.023	0.042	100	0	0	0	0	7.531
176	100	0.3	0	0	0	0	0.021	0.016	0.033	100	0	0	0	0	40.586
176	99	1	0	0	0	0	0.011	0.013	0.021	99.7	0.3	0	0	0	23.1
177	100	0	0	0	0	0	0.025	0.019	0.034	99.8	0.2	0	0	0	14.479
177	100	0.1	0	0	0	0	0.018	0.016	0.027	99.8	0.2	0	0	0	14.48
177	100	0.1	0	0	0	0	0.011	0.019	0.031	100	0	0	0	0	17.115
178	99	1	0	0	0	0	0.012	0.011	0.015	99.7	0.3	0	0	0	25.256
178	100	0.1	0	0	0	0	0.005	0.008	0.019	100	0	0	0	0	21.204
178	100	0.1	0	0	0	0	0.007	0.012	0.03	100	0	0	0	0	11.087
178	100	0.3	0	0	0	0	0.005	0.01	0.02	100	0	0	0	0	5.933
178	100	0.3	0	0	0	0	0.008	0.009	0.022	100	0	0	0	0	18.827
178	100	0.3	0	0	0	0	0.007	0.02	0.023	100	0	0	0	0	8.646
179	100	0.1	0	0	0	0	0.023	0.022	0.035	99.9	0.1	0	0	0	18.316
179	100	0.5	0	0	0	0	0.014	0.006	0.031	100	0	0	0	0	6.387
179	100	0.1	0	0	0	0	0.019	0.014	0.016	100	0	0	0	0	8.194
180	100	0.1	0	0	0	0	0.015	0.016	0.031	99.9	0.1	0	0	0	19.543
180	100	0	0	0	0	0	0.045	0.043	0.095	100	0	0	0	0	14.55

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	(km)
180	99	0.6	0	0	0	0	0.032	0.037	0.093	100	0	0	0	0	15.52
181	98	2.2	0	0	0	0	0.034	0.022	0.091	100	0	0	0	0	9.608
181	100	0	0	0	0	0	0.02	0.02	0.03	99.9	0.1	0	0	0	15.546
181	100	0.2	0	0	0	0	0.011	0.02	0.02	100	0	0	0	0	7.191
182	100	0.1	0	0	0	0	0.009	0.021	0.02	99.8	0.2	0	0	0	23.255
182	100	0.1	0	0	0	0	0.013	0.011	0.022	100	0	0	0	0	18.595
183	100	0.1	0	0	0	0	0.03	0.016	0.028	99.7	0.3	0	0	0	17.809
183	100	0.1	0	0	0	0	0.008	0.006	0.023	100	0	0	0	0	50.483
183	100	0.1	0	0	0	0	0.01	0.021	0.025	100	0	0	0	0	56.948
184	99	1.3	0	0	0	0	0.006	0.013	0.023	100	0	0	0	0	51.918
184	100	0.2	0	0	0	0	0.021	0.012	0.038	100	0	0	0	0	60.084
185	100	0.3	0	0	0	0	0.041	0.033	0.087	99.7	0.3	0	0	0	22.825
185	100	0.1	0	0	0	0	0.012	0.011	0.027	100	0	0	0	0	24.07
186	100	0	0	0	0	0	0.087	0.063	0.1	99.8	0.2	0	0	0	59.372
186	100	0.1	0	0	0	0	0.026	0.027	0.056	100	0	0	0	0	39.124
187	99	1.3	0	0	0	0	0.078	0.041	0.071	100	0	0	0	0	22.394
188	100	0.2	0	0	0	0	0.019	0.012	0.026	100	0	0	0	0	53.515
190	100	0.1	0	0	0	0	0.018	0.014	0.028	100	0	0	0	0	10.003
191	100	0	0	0	0	0	0.016	0.017	0.031	99.9	0.1	0	0	0	19.559
191	100	0.1	0	0	0	0	0.003	0.013	0.01	100	0	0	0	0	8.438
191	100	0.5	0	0	0	0	0.016	0.035	0.104	100	0	0	0	0	26.862
191	100	0.3	0	0	0	0	0.049	0.071	0.192	99.3	0.7	0	0	0	28.909
191	100	0.3	0	0	0	0	0.007	0.005	0.011	100	0	0	0	0	19.159
192	100	0.1	0	0	0	0	0.043	0.04	0.065	99.8	0.2	0	0	0	19.064
192	100	0.1	0	0	0	0	0.01	0.012	0.028	100	0	0	0	0	7.589
193	100	0.1	0	0	0	0	0.01	0.012	0.024	100	0	0	0	0	19.295
193	100	0.1	0	0	0	0	0.032	0.023	0.036	100	0	0	0	0	23.791
194	93	6.5	0.4	0	0	0	0.058	0.042	0.067	99.9	0.1	0	0	0	68.284
194	91	9	0.4	0	0	0	0.048	0.03	0.055	100	0	0	0	0	44.464
195	100	0.1	0	0	0	0	0.045	0.042	0.064	100	0	0	0	0	48.419
195	100	0	0	0	0	0	0.01	0.013	0.024	99.6	0.4	0	0	0	11.199
195	100	0.1	0	0	0	0	0.005	0.01	0.021	100	0	0	0	0	9.75
195	100	0.4	0	0	0	0	0.005	0.003	0.011	100	0	0	0	0	8.084
195	100	0.2	0	0	0	0	0.007	0.004	0.016	100	0	0	0	0	8.67
195	100	0.5	0	0	0	0	0.006	0.018	0.032	100	0	0	0	0	7.76
196	100	0.1	0	0	0	0	0.018	0.021	0.036	100	0	0	0	0	8.267
196	100	0.2	0	0	0	0	0.037	0.016	0.03	99.8	0.2	0	0	0	13.335
197	91	9.1	0	0	0	0	0.024	0.024	0.024	99.9	0.1	0	0	0	42.294
197	100	0.2	0	0	0	0	0.021	0.042	0.044	100	0	0	0	0	56.503
197	100	0.2	0	0	0	0	0.011	0.045	0.057	100	0	0	0	0	70.112
198	95	4.8	0	0	0	0	0.009	0.012	0.02	100	0	0	0	0	56.67
198	99	0.8	0	0	0	0	0.032	0.04	0.087	98	2	0	0	0	118.12
199	100	0	0	0	0	0	0.01	0.008	0.016	99.8	0.2	0	0	0	60.503
199	100	0.1	0	0	0	0	0.025	0.036	0.045	100	0	0	0	0	45.096

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	(km)
199	100	0.4	0	0	0	0	0.012	0.03	0.047	100	0	0	0	0	42.874
200	0	4.3	81	15	0	0	0.063	0.207	0.253	0	0	100	0	0	83.962
200	100	0.3	0	0	0	0	0.006	0.01	0.011	100	0	0	0	0	43.95
200	100	0.3	0	0	0	0	0.004	0.006	0.017	100	0	0	0	0	67.375
201	100	0.1	0	0	0	0	0.009	0.015	0.04	100	0	0	0	0	50.02
201	100	0.4	0	0	0	0	0.017	0.02	0.04	100	0	0	0	0	15.677
202	100	0.1	0	0	0	0	0.03	0.012	0.03	100	0	0	0	0	32.128
203	0	0	62	33	5	0	0.12	0.161	0.167	0	0	100	0	0	149.806
203	100	0.4	0	0	0	0	0.003	0.006	0.021	100	0	0	0	0	118.971
204	100	0.2	0	0	0	0	0.016	0.025	0.033	100	0	0	0	0	117.881
204	100	0.2	0	0	0	0	0.028	0.015	0.028	100	0	0	0	0	28.485
205	100	0.1	0	0	0	0	0.014	0.012	0.026	99.7	0.3	0	0	0	27.501
205	100	0.3	0	0	0	0	0.026	0.025	0.041	100	0	0	0	0	12.839
206	100	0.1	0	0	0	0	0.023	0.021	0.04	99.6	0.4	0	0	0	15.69
206	100	0.1	0	0	0	0	0.032	0.012	0.027	100	0	0	0	0	19.439
207	27	54	18	0.7	0	0	0.401	0.136	0.336	99.7	0.3	0	0	0	14.486
207	100	0.1	0	0	0	0	0.015	0.016	0.023	100	0	0	0	0	19.585
208	100	0.1	0	0	0	0	0.015	0.011	0.022	99.7	0.3	0	0	0	66.175
208	100	0.1	0	0	0	0	0.025	0.024	0.036	100	0	0	0	0	56.052
209	100	0.1	0	0	0	0	0.02	0.024	0.027	99.8	0.2	0	0	0	56.031
209	100	0.1	0	0	0	0	0.065	0.023	0.095	100	0	0	0	0	47.904
210	100	0	0	0	0	0	0.017	0.018	0.028	99.8	0.2	0	0	0	50.107
210	100	0	0	0	0	0	0.02	0.018	0.033	100	0	0	0	0	30.911
211	100	0	0	0	0	0	0.018	0.018	0.033	99.8	0.2	0	0	0	46.836
211	100	0.1	0	0	0	0	0.016	0.014	0.026	100	0	0	0	0	9.492
212	100	0.1	0	0	0	0	0.015	0.008	0.03	100	0	0	0	0	15.946
212	100	0.1	0	0	0	0	0.015	0.014	0.023	100	0	0	0	0	15.216
213	100	0.1	0	0	0	0	0.015	0.011	0.032	100	0	0	0	0	15.968
213	100	0.3	0	0	0	0	0.06	0.05	0.072	99.6	0.4	0	0	0	49.701
213	100	0.1	0	0	0	0	0.009	0.008	0.016	100	0	0	0	0	69.924
213	100	0.1	0	0	0	0	0.007	0.021	0.029	100	0	0	0	0	64.521
213	100	0.1	0	0	0	0	0.005	0.01	0.022	100	0	0	0	0	70.455
213	100	0.3	0	0	0	0	0.004	0.02	0.02	100	0	0	0	0	67.857
213	100	0.4	0	0	0	0	0.004	0.004	0.012	100	0	0	0	0	62.296
214	100	0	0	0	0	0	0.018	0.017	0.039	99.8	0.2	0	0	0	64.884
214	98	1.8	0	0	0	0	0.067	0.043	0.078	100	0	0	0	0	26.319
214	98	1.8	0	0	0	0	0.014	0.023	0.027	100	0	0	0	0	50.305
215	100	0.1	0	0	0	0	0.031	0.026	0.044	100	0	0	0	0	17.614
215	100	0.3	0	0	0	0	0.05	0.058	0.065	100	0	0	0	0	10.561
215	93	7	0	0	0	0	0.018	0.031	0.071	100	0	0	0	0	52.345
216	100	0.1	0	0	0	0	0.012	0.012	0.028	100	0	0	0	0	21.749
216	100	0	0	0	0	0	0.012	0.013	0.03	100	0	0	0	0	17.344
217	100	0.3	0	0	0	0	0.056	0.036	0.047	97.7	2.3	0	0	0	14.634
217	100	0.5	0	0	0	0	0.003	0.011	0.006	100	0	0	0	0	22.457

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	(km)
219	100	0.1	0	0	0	0	0.021	0.01	0.046	100	0	0	0	0	36.771
220	100	0	0	0	0	0	0.026	0.023	0.04	99.7	0.3	0	0	0	50.567
220	100	0.1	0	0	0	0	0.048	0.048	0.068	100	0	0	0	0	49.872
221	100	0.1	0	0	0	0	0.012	0.008	0.019	99.6	0.4	0	0	0	50.11
221	100	0.1	0	0	0	0	0.011	0.023	0.027	100	0	0	0	0	49.552
222	100	0	0	0	0	0	0.015	0.018	0.018	99.6	0.4	0	0	0	49.129
222	100	0	0	0	0	0	0.017	0.012	0.02	100	0	0	0	0	47.548
222	100	0.1	0	0	0	0	0.005	0.01	0.019	100	0	0	0	0	44.404
223	100	0	0	0	0	0	0.013	0.024	0.025	99.7	0.3	0	0	0	49.649
223	98	2.1	0	0	0	0	0.018	0.012	0.02	100	0	0	0	0	49.162
224	87	13	0.2	0	0	0	0.145	0.093	0.41	97.7	2.3	0	0	0	70.563
224	100	0.1	0	0	0	0	0.052	0.026	0.066	100	0	0	0	0	50.531
225	93	7.4	0	0	0	0	0.023	0.026	0.04	100	0	0	0	0	39.578
225	100	0.1	0	0	0	0	0.077	0.021	0.074	100	0	0	0	0	37.393
226	100	0.1	0	0	0	0	0.015	0.016	0.028	99.6	0.4	0	0	0	35.759
226	100	0.1	0	0	0	0	0.018	0.046	0.119	100	0	0	0	0	36.094
227	100	0	0	0	0	0	0.011	0.017	0.026	99.6	0.4	0	0	0	32.937
227	100	0	0	0	0	0	0.052	0.031	0.05	100	0	0	0	0	29.941
228	100	0.1	0	0	0	0	0.016	0.016	0.023	99.6	0.4	0	0	0	25.843
228	100	0.1	0	0	0	0	0.044	0.022	0.031	100	0	0	0	0	16.744
229	100	0	0	0	0	0	0.028	0.033	0.057	99.6	0.4	0	0	0	21.509
229	100	0	0	0	0	0	0.049	0.028	0.051	100	0	0	0	0	24.997
230	100	0	0	0	0	0	0.044	0.046	0.078	99.6	0.4	0	0	0	23.471
230	100	0.4	0	0	0	0	0.012	0.016	0.019	100	0	0	0	0	43.292
231	100	0.1	0	0	0	0	0.024	0.018	0.027	99.3	0.7	0	0	0	24.034
231	100	0.1	0	0	0	0	0.024	0.016	0.037	100	0	0	0	0	29.33
232	100	0.1	0	0	0	0	0.057	0.052	0.083	100	0	0	0	0	45.938
232	100	0.1	0	0	0	0	0.008	0.012	0.014	100	0	0	0	0	55.408
232	100	0.1	0	0	0	0	0.056	0.044	0.06	100	0	0	0	0	48.094
232	100	0.4	0	0	0	0	0.008	0.006	0.028	100	0	0	0	0	44.766
233	100	0	0	0	0	0	0.018	0.013	0.031	100	0	0	0	0	41.199
233	100	0.3	0	0	0	0	0.009	0.017	0.015	100	0	0	0	0	31.377
233	100	0.1	0	0	0	0	0.016	0.018	0.05	100	0	0	0	0	23.356
233	100	0.3	0	0	0	0	0.006	0.007	0.029	100	0	0	0	0	27.251
234	100	0.1	0	0	0	0	0.05	0.038	0.062	100	0	0	0	0	24.915
234	100	0.1	0	0	0	0	0.017	0.023	0.03	100	0	0	0	0	8.452
234	98	2.2	0	0	0	0	0.032	0.019	0.04	99.8	0.2	0	0	0	12.408
234	100	0.1	0	0	0	0	0.019	0.01	0.033	100	0	0	0	0	17.415
234	100	0.1	0	0	0	0	0.011	0.012	0.025	100	0	0	0	0	15.371
234	100	0.2	0	0	0	0	0.023	0.071	0.106	100	0	0	0	0	17.444
235	100	0.1	0	0	0	0	0.023	0.018	0.057	99.4	0.6	0	0	0	19.419
235	100	0	0	0	0	0	0.031	0.023	0.052	100	0	0	0	0	23.551
235	100	0.1	0	0	0	0	0.011	0.025	0.031	100	0	0	0	0	44.693
235	100	0.2	0	0	0	0	0.014	0.022	0.027	100	0	0	0	0	34.979

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	(km)
236	100	0.1	0	0	0	0	0.013	0.012	0.02	98.8	1.2	0	0	0	35.412
236	100	0.1	0	0	0	0	0.022	0.008	0.024	100	0	0	0	0	34.068
236	100	0.1	0	0	0	0	0.015	0.009	0.028	100	0	0	0	0	26.068
237	100	0.1	0	0	0	0	0.033	0.025	0.025	99.3	0.7	0	0	0	27.818
237	100	0.1	0	0	0	0	0.025	0.028	0.043	100	0	0	0	0	36.898
237	100	0.1	0	0	0	0	0.011	0.021	0.017	100	0	0	0	0	34.645
238	100	0.3	0	0	0	0	0.009	0.007	0.017	100	0	0	0	0	39.424
238	100	0.2	0	0	0	0	0.003	0.007	0.014	100	0	0	0	0	33.59

R/V Mt. Augustine

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS			Position Standard Deviation Percentages (%)					Average
							Values(meters)								Baseline
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10 m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00 m	(km)
140	99	1	0	0	0	0	0.01	0.027	0.043	100	0	0	0	0	56.448
140	100	0	0	0	0	0	0.008	0.008	0.014	100	0	0	0	0	54.954
141	99	1	0	0	0	0	0.012	0.015	0.057	99.8	0.1	0.1	0	0	54.412
142	100	0	0	0	0	0	0.017	0.013	0.04	100	0	0	0	0	19.658
143	100	0	0	0	0	0	0.012	0.013	0.017	100	0	0	0	0	20.224
143	100	0	0	0	0	0	0.012	0.021	0.031	100	0	0	0	0	7.133
144	100	0	0	0	0	0	0.016	0.014	0.038	100	0	0	0	0	8.376
146	100	0	0	0	0	0	0.007	0.011	0.022	100	0	0	0	0	6.631
147	99	1	0	0	0	0	0.03	0.011	0.05	100	0	0	0	0	4.367
147	100	0	0	0	0	0	0.013	0.007	0.023	100	0	0	0	0	7.796
148	99	1	0	0	0	0	0.057	0.1	0.215	100	0	0	0	0	54.309
148	99	1	0	0	0	0	0.057	0.099	0.213	100	0	0	0	0	54.309
149	100	0	0	0	0	0	0.014	0.011	0.017	100	0	0	0	0	10.423
158	100	0	0	0	0	0	0.018	0.04	0.072	97	3	0	0	0	51.428
159	100	0	0	0	0	0	0.02	0.009	0.032	100	0	0	0	0	44.727
160	100	0	0	0	0	0	0.01	0.011	0.029	100	0	0	0	0	42.265
163	100	0	0	0	0	0	0.023	0.013	0.032	100	0	0	0	0	38.862
164	99	1	0	0	0	0	0.012	0.008	0.026	100	0	0	0	0	47.774
164	100	0	0	0	0	0	0.052	0.033	0.069	98.6	1.4	0	0	0	58.232
165	100	0	0	0	0	0	0.006	0.009	0.013	100	0	0	0	0	43.087
169	100	1	0	0	0	0	0.009	0.012	0.022	100	0	0	0	0	8.303
172	94	1	0	1	3	1	0.319	0.281	0.53	94.8	0.2	0.8	4.1	0.1	53.376
173	97	3	0	0	0	0	0.027	0.036	0.043	100	0	0	0	0	52.178
173	100	0	0	0	0	0	0.017	0.011	0.022	100	0	0	0	0	15.601
174	99	1	0	0	0	0	0.006	0.015	0.029	100	0	0	0	0	4.236
176	98	2	0	0	0	0	0.018	0.013	0.028	100	0	0	0	0	17.873
177	100	0	0	0	0	0	0.009	0.009	0.031	100	0	0	0	0	12.559
177	100	1	0	0	0	0	0.013	0.012	0.03	100	0	0	0	0	17.115
178	100	0	0	0	0	0	0.005	0.016	0.023	100	0	0	0	0	17.902

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS Values(meters)			Position Standard Deviation Percentages (%)					Average Baseline (km)
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10 m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00 m	
178	100	0	0	0	0	0	0.008	0.006	0.021	100	0	0	0	0	9.798
179	100	0	0	0	0	0	0.005	0.01	0.02	100	0	0	0	0	9.528
179	100	0	0	0	0	0	0.013	0.009	0.013	100	0	0	0	0	9.772
180	100	0	0	0	0	0	0.012	0.019	0.065	100	0	0	0	0	7.565
180	100	0	0	0	0	0	0.011	0.031	0.033	100	0	0	0	0	6.34
181	100	0	0	0	0	0	0.01	0.014	0.021	100	0	0	0	0	6.134
181	100	0	0	0	0	0	0.011	0.006	0.024	100	0	0	0	0	5.795
184	100	0	0	0	0	0	0.014	0.008	0.023	100	0	0	0	0	58.785
188	100	0	0	0	0	0	0.019	0.013	0.046	100	0	0	0	0	53.338
190	100	0	0	0	0	0	0.034	0.019	0.05	100	0	0	0	0	6.905
191	100	0	0	0	0	0	0.005	0.013	0.013	100	0	0	0	0	8.524
191	100	0	0	0	0	0	0.028	0.026	0.034	99.8	0.2	0	0	0	10.778
192	100	0	0	0	0	0	0.005	0.01	0.015	100	0	0	0	0	12.719
192	100	0	0	0	0	0	0.012	0.006	0.028	100	0	0	0	0	7.45
195	100	0	0	0	0	0	0.011	0.007	0.019	100	0	0	0	0	6.747
196	100	0	0	0	0	0	0.006	0.01	0.011	100	0	0	0	0	12.241
196	98	2	0	0	0	0	0.023	0.019	0.04	100	0	0	0	0	10.963
197	100	0	0	0	0	0	0.009	0.015	0.031	100	0	0	0	0	9.246
198	100	0	0	0	0	0	0.045	0.071	0.112	96.2	3.8	0	0	0	129.131
198	99	1	0	0	0	0	0.017	0.023	0.063	100	0	0	0	0	60.729
200	99	1	0	0	0	0	0.029	0.026	0.024	100	0	0	0	0	51.493
205	100	0	0	0	0	0	0.01	0.012	0.031	100	0	0	0	0	10.495
206	100	0	0	0	0	0	0.01	0.008	0.014	100	0	0	0	0	8.03
206	100	0	0	0	0	0	0.011	0.007	0.017	100	0	0	0	0	15.99
207	100	0	0	0	0	0	0.003	0.008	0.015	100	0	0	0	0	7.797
207	100	0	0	0	0	0	0.045	0.078	0.083	100	0	0	0	0	9.063
211	100	0	0	0	0	0	0.003	0.008	0.019	100	0	0	0	0	9.991
212	100	0	0	0	0	0	0.003	0.007	0.015	100	0	0	0	0	19.656
212	100	0	0	0	0	0	0.01	0.01	0.022	100	0	0	0	0	19.088
228	100	0	0	0	0	0	0.025	0.023	0.053	100	0	0	0	0	20.18
229	100	0	0	0	0	0	0.01	0.011	0.056	100	0	0	0	0	18.11

R/V Mt Mitchell

Julian Day	Quality Percentages (%)						Fwd/Rev Separation RMS Values(meters)			Position Standard Deviation Percentages (%)					Average Baseline (km)
	Q1	Q2	Q3	Q4	Q5	Q6	East	North	Height	<0.10 m	0.10-0.30m	0.30-1.00m	1.00-5.00m	>5.00m	
170	97	3	0	0	0	0	0.021	0.031	0.039	100	0	0	0	0	83.78
170	99	1	0	0	0	0	0.017	0.023	0.043	100	0	0	0	0	87.416
171	98	3	0	0	0	0	0.02	0.014	0.027	100	0	0	0	0	74.92
171	97	2	1	0	0	0	0.051	0.043	0.141	89.5	10.5	0	0	0	88.316
172	99	1	0	0	0	0	0.035	0.029	0.06	100	0	0	0	0	57.668
172	99	1	0	0	0	0	0.019	0.021	0.048	100	0	0	0	0	55.312