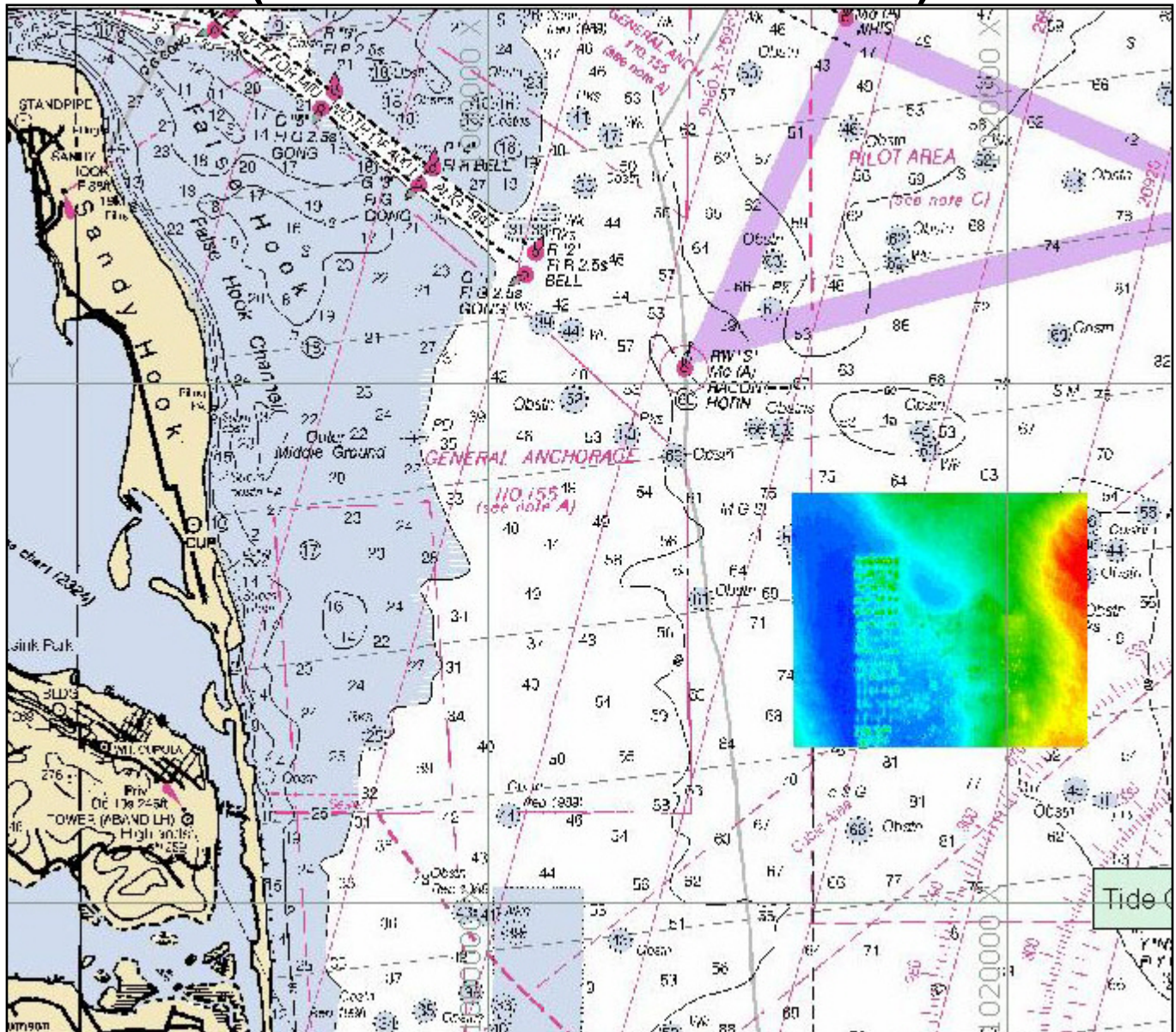


# H.A.R.S. – PRA #1 (Historic Area Remediation Site)



## 2009 Multibeam Bathymetry

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## 1.0 Introduction

As part of Rogers Surveying's Indefinite Delivery Contract with The United States Army Corps of Engineers. Rogers Surveying was tasked with surveying the HARS (Historic Area Remediation Site). The HARS, which was re-designated as a remediation site in September 1977 was formerly known as the Mud Dump Site (MDS), and was used for the deposit of sediments dredged from the New York / New Jersey Harbor Estuary. The remediation consists of placing a one-meter "cap" layer of uncontaminated dredged material on top of the existing surface sediments within the nine-Priority Remediation Areas (PRA's) of the HARS.

## 2.0 Objective

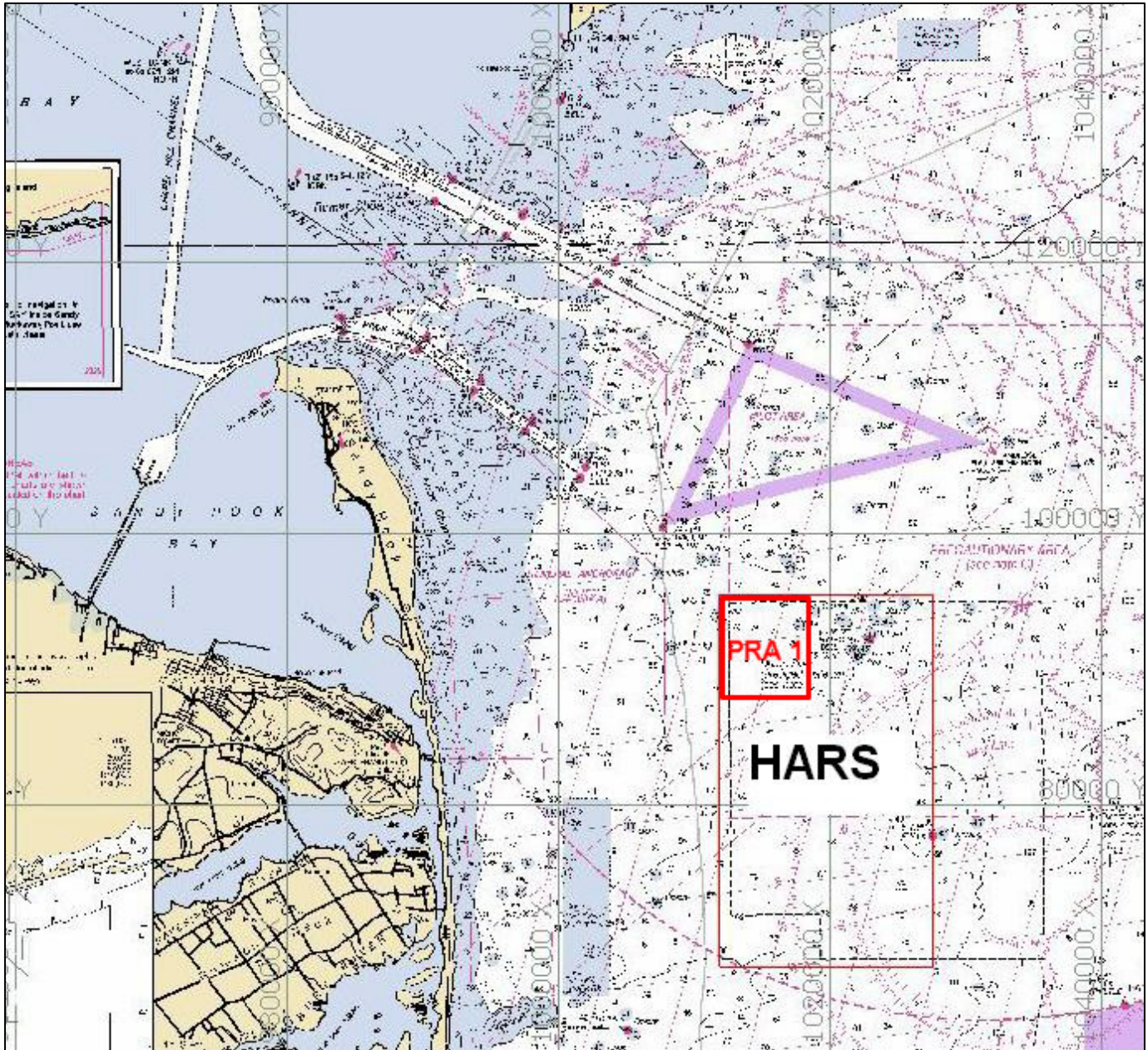
The primary objective of this task order is to obtain current high-accuracy multibeam bathymetry of PRA1, to be used in the monitoring and planning of dredge placement. The site limits being bounded by North latitude of  $40^{\circ} 25.757'$ , a South latitude of  $40^{\circ} 24.162'$ , and East longitude of  $73^{\circ} 51.645'$ , a West longitude of  $73^{\circ} 54.075'$ . The total survey coverage area being approximately 4 square miles. (Figure 3.0-2). The HARS area is shown in Figure 2.0-1. Rogers Surveying was given a scope of work and proceeded to perform survey operations on 5/26/09 (Table 2.0-1).

## 3.0 Procedure

The survey data was collected utilizing multibeam technology, and collected in accordance with The U.S. Army Corps of Engineers Manual 1110-2-1003. All survey data was collected with the survey vessel "Red Rogers" (Table 3.0-1). The "Red Rogers" is a 36' long catamaran with a beam of 12' that has berthing for 2. Survey operations were run during daylight working hours, when fuel, weather and crew staffing permitted. The vessel is equipped with a *RESON* 8101 multibeam sonar. Vessel motion corrections are supplied by an *APPLANIX* 320 (POS/MV), Differential GPS corrections are supplied by a *TRIMBLE* Pro-Beacon receiver, and when available RTK corrections provided to the POS/MV with the addition of a USB cellular modem. Speed of sound profiles are recorded thru the water column with a *SEABIRD* SBE19 CTD profiler V2 (Table 3.0-1).

A seabed mounted water pressure gauge was installed at latitude N  $41^{\circ} 42' 23.6578''$  and longitude W  $75^{\circ} 08' 15.2015''$ . It was anchored in approximately 45' of water (Figures 3.0-1 and 3.0-2). Its position was marked with a 48" tall lighted buoy. The gauge was preset to record data for 60 seconds every 6 minutes. Water levels were also recorded at the Coast Guard station located at Sandy Hook, New Jersey. The Real Time Kinematic GPS, which augmented the POS/MV position also provided real time water levels. The GPS reference station used at the time of the survey was located in Lido Beach, New York and corrections were provided via a cellular Internet GPS network.

**Figure 2.0-1**  
Historic Area Restoration Site (HARS).



**Table 2.0-1**

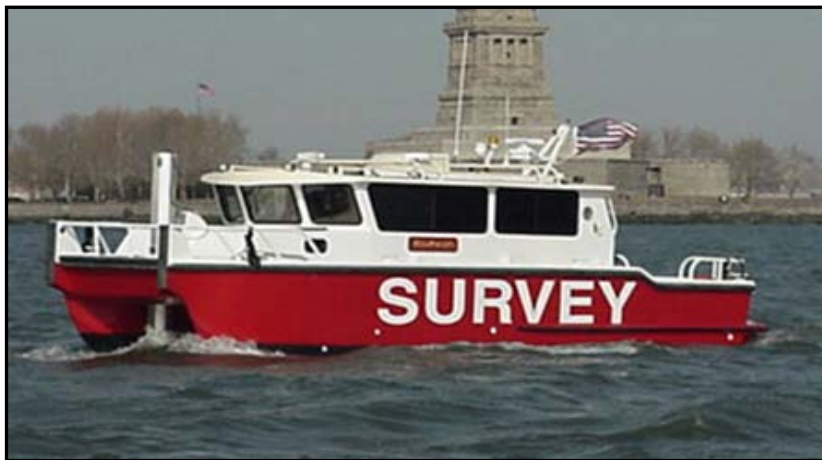
Summary of survey operations on board survey vessel Red Rogers for the 2009 multibeam survey at PRA# 1

DATE	Operations
05/26/09	Patch Test performed on survey vessel Red Rogers for multibeam system calibration.
06/01/09	Deployed survey buoy and submersible tide recorder, checked RTK network coverage on site.
06/01/09	Mobilization to HARS. Commenced multibeam survey of PRA# 1.
06/03/09	Continued daylight Survey from previous day.
06/04/09	Continued daylight Survey from 06/03/09. Multibeam survey of PRA# 1 complete.
06/09/09	Retrieved survey buoy and submersible tide recorder. Demobilize.

**Table 3.0-1**  
Equipment used during the 2009 multibeam survey at PRA# 1

<b>System</b>	<b>Model</b>	<b>*Accuracy</b>
Multibeam	Reson Seabat 8101 (150/210 deg) 240 kHz, beam width 1.5 degree along and across track, 101 horizontal beams.	4 cm Nadir, 5 cm 45 degrees, 1.25 range resolution.
<b>Position</b>		
Differential GPS	Trimble Pro Beacon	3-5 meters DGPS USCG, 3 meters DGPS WAAS
RTK GPS	Trimble R8 GNSS VRS Rover with Controller	1 cm + 1 ppm
Inertial Navigation System	TSS POS M/V 320 Motion (HPR) & Heading	Roll Pitch 0.02 (1 sigma DGPS, 2 sigma RTK) Heave 5cm or 5% 20 seconds or less Heading 0.02 (1 sigma) Position 0.5 - 2m (DGPS), 0.02 - 0.10 (RTK) Velocity 0.03 m/s horizontal
Data Acquisition and Navigation	Hypack 2008 Hysweep Survey Running on a Super Logic computer, with dual Aptec Raid removable disk drives .	
Sound Velocity	SeaBird SBE 19plusV2	
<b>Tide Gauges</b>		
Dockside Pressure Gauge	WL16 Water Level Logger (Deployed at Sandy Hook)	+/- 0.1% of full scale at constant temperature, +/- 0.2% over 35 deg (F) to 70 deg (F) Automatic barometric pressure compensation.
Submersible Pressure Gauge	Valeport Midas WLR (Deployed at HARS)	Range -5 to +35 deg (C). +/-0.01 deg (C)

<b>Survey Vessel</b>	
M/V Red Rogers	LOA= 36', Beam= 10', Draft= 2.5, Max Speed
Propulsion	Twin Volvo KAD 44P-C Turbo Diesel Engines with DPE Stern Drives
Power	Owen 6.5 kilowatt Generator with UPS & DC power supplies

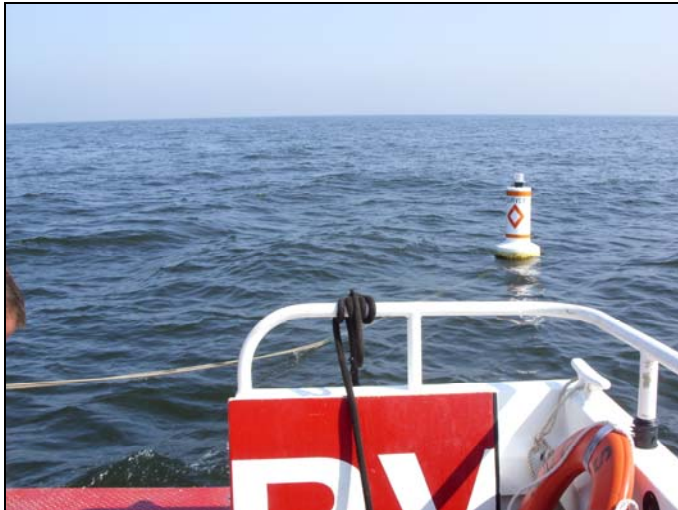


*R/V Red Roger*



**Figure 3.0-1**

Deployment of the Valeport Midas WLR Submersible Tide Gauge during the 2009 multibeam survey at PRA# 1.



Buoy Deployment

Submersible Tide Gauge Buoy

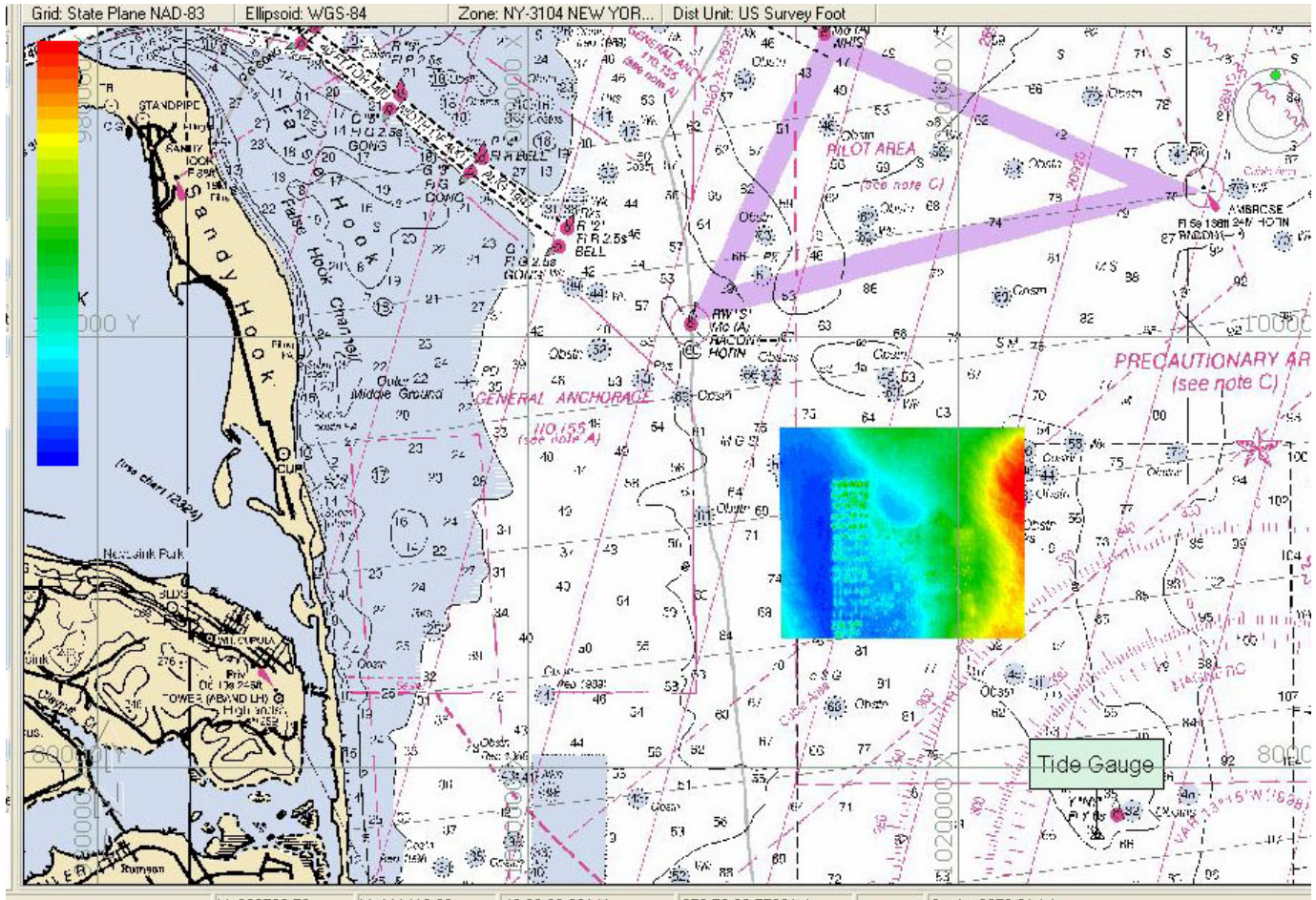
**Figure 3.1-1**

Sandy Hook Tidal Station information, during the 2009 multibeam survey at PRA# 1.

<b>Sandy Hook, NJ</b>		Station ID: 8531680
<b>Station Information</b>		
Latitude: 40° 28.0' N	Mean Range: 4.70 ft.	 <small>Click image for larger image.</small>
Longitude: 74° 0.6' W	Diurnal Range: 5.22 ft.	
Established: Jan 7 1910		
Present Installation: Sep 26 1989		
NOAA Chart #: 12327		
Time Meridian: 75		
<b>Minimum Water Level:</b> -4.71 ft. below <a href="#">MLLW</a> (02/02/1976)	<b>Maximum Water Level:</b> 4.86 ft. above <a href="#">MHHW</a> (09/12/1960)	
<b>Data Types Available:</b> Primary Water Level Backup Water Level Wind Air Temperature Water Temperature Barometric Pressure Barometric Pressure Conductivity	<b>Station and Bench Mark Drawing</b>  Click <a href="#">HERE</a> for Drawing (Not for navigational use)	<b>Station Location Chartlet</b>  Click <a href="#">HERE</a> for Map (Not for navigational use)

N.O.A.A. Station "Sandyhook"

**Figure 3.0-2**  
Final Multibeam coverage of PRA# 1 with submersible Tide Gauge location.



### 3.1 Data Acquisition

The survey vessel *Red Rogers* is permanently berthed in Elizabeth, New Jersey. The voyage from the vessels homeport to the HARS is approximately 1.5 hours. Prior to multibeam survey operations a float test was performed to confirm that the RTK GPS tide reading on the survey vessel agreed with the tide board at the dock at Sandy Hook, which had previously been referenced to National Geodetic Survey (NGS) disk KV0709 (Figure 3.1-1). This having been done the survey vessel transited to the HARS for commencement of multibeam data collection at the PRA# 1 site.

Once at the HARS the initial task was to lower the multibeam transducer head and perform a sound velocity profile (SVP). The information from the SVP was used to provide the Reson 8101 multibeam processor with a sound velocity surface value used for beam steering. In addition the sound velocity profile was used in the Hypack data acquisition and processing software and applied to the multibeam data.

Having performed and applied the SVP correction, multibeam data collection began. Survey lines were run in a general North-South direction with cross check lines (see Section 5.0) being run in an East-West direction.

Constant monitoring of the Reson 8101 screen and adjustment of range, transmit/ receive power settings were made if required to accurately map and encompass the swath width needed. The swath width was set to 60 deg. either side of nadir (center beam of multibeam) and lines were run to provide a 60% swath data coverage. In addition to monitoring the Reson 8101, it was also necessary to monitor the Hypack navigation software, which provided quality information on GPS and inertial navigation sensors, motion reference unit sensor and the multibeam data from the Reson 8101.

### 3.2 Sound Velocity Profiles

Sound velocity profiles were taken during the course of the survey using a Sea Bird SBE 19plus Version 2 CTD. Casts were obtained before, during and after each survey period. During survey operations casts were taken not less than three hours apart and at opposite ends of PRA#1 to account for any spatial changes. The SeaBird was last calibrated by the manufacturer on 05/25/07 and is periodically checked against our Odom Digibar Pro velocity profiler. A total of 13 SVP casts were taken over the course of the Multibeam survey (Table 3.2-0). Plots of all SVP casts are shown in Figures 3.2-1 to 3.2-13.

### 3.3 Survey Line Report

Multibeam survey lines were run in a North-South direction primarily to best facilitate vessel operation under wave and current conditions at the time of the survey. Table 3.3-1 and 3.3-2 lists survey line start and stop times with location and direction run

**Table 3.2-0**  
Sound Velocity Profiles (SVP's) taken during the 2009 multibeam survey at PRA# 1.

Date	Time	CTD File #	NAD83 NY LI (Feet)		Depth Feet MLW	Latitude		Longitude	
			Easting	Northing		N	W		
06/01/09	8:37	svp-060109-0837	1022990	85846	57	40.40221676	73.86090906		
06/01/09	10:49	svp-060109-1049	1022478	95862	58	40.42970981	73.86268743		
06/01/09	12:28	svp-060109-1228	1021817	85747	52	40.40194813	73.86511868		
06/01/09	14:47	svp-060109-1447	1020430	86167	59	40.40310803	73.87009615		
06/03/09	9:00	svp-060309-0900	1020134	85945	59	40.40250002	73.87116221		
06/03/09	11:13	svp-060309-1113	1019513	95936	64	40.42992428	73.87333889		
06/03/09	13:27	svp-060309-1327	1017967	85787	73	40.40207517	73.87894087		
06/03/09	15:25	svp-060309-1525	1016813	85903	77	40.40239752	73.88308489		
06/04/09	8:38	svp-060409-0838	1015944	95758	64	40.42945088	73.88615809		
06/04/09	10:45	svp-060409-1045	1014859	95564	68	40.42892082	73.89005823		
06/04/09	12:39	svp-060409-1230	1013489	85913	73	40.40243595	73.89501999		
06/04/09	14:44	svp-060409-1444	1012540	95879	75	40.42979291	73.89838673		
06/04/09	16:02	Svp-060409-1602	1011653	95562	76	40.42892653	73.90157154		

**Table 3.3-1**  
Multibeam Survey Lines run during the 2009 multibeam survey at PRA# 1.

Line	Date	Time	Latitude	Longitude	Direction
002_0849	6/1/09	8:49	N40-24 09.3543	W73-51 38.5731	North
000_0906	6/1/09	9:06	N40-25 46.0709	W73-51 39.8074	South
002_0922	6/1/09	9:22	N40-24 09.5384	W73-51 41.2690	North
000_0939	6/1/09	9:39	N40-24 45.9305	W73-51 41.6859	South
002_0955	6/1/09	9:55	N40-24 09.1807	W73-51 43.8794	North
000_1014	6/1/09	10:14	N40-25 46.0761	W73-51 44.0910	South
002_1027	6/1/09	10:27	N40-24 09.1251	W73-51 46.7822	North
000_1058	6/1/09	10:58	N40-25 45.5769	W73-51 46.4815	South
002_1113	6/1/09	11:13	N40-24 08.7251	W73-51 49.7692	North
000_1133	6/1/09	11:33	N40-25 46.3309	W73-51 49.2688	South
002_1148	6/1/09	11:48	N40-24 08.7438	W73-51 52.7569	North
000_1207	6/1/09	12:07	N40-25 44.3735	W73-51 52.8540	East (Cross-Line)
002_1212	6/1/09	12:12	N40-25 45.9472	W73-51 52.4388	South
000_1229	6/1/09	12:29	N40-24 08.6312	W73-51 55.7998	North
002_1246	6/1/09	12:46	N40-25 46.4603	W73-51 56.2725	South
000_1303	6/1/09	13:03	N40-24 09.0585	W73-52 00.3279	North
002_1320	6/1/09	13:20	N40-25 46.3915	W73-51 59.5369	South
000_1337	6/1/09	13:37	N40-24 08.9267	W73-52 04.1969	North
002_1353	6/1/09	13:53	N40-25 47.1474	W73-52 04.0357	South
000_1411	6/1/09	14:11	N40-24 09.2515	W73-52 08.1879	North
002_1426	6/1/09	14:26	N40-25 46.0871	W73-52 08.6332	South
000_1447	6/1/09	14:47	N40-24 08.7475	W73-52 12.1804	North
000_1503	6/1/09	15:03	N40-25 45.2203	W73-52 13.0400	East (Cross-Line)
000_0909	6/3/09	9:09	N40-24 09.3574	W73-52 14.4508	North
002_0927	6/3/09	9:27	N40-25 46.4712	W73-52 15.3723	South
000_0934	6/3/09	9:34	N40-24 08.9809	W73-52 17.2535	North
002_1003	6/3/09	10:03	N40-25 46.4204	W73-52 17.9719	South
000_1019	6/3/09	10:19	N40-24 09.0408	W73-52 22.3253	North
002_1036	6/3/09	10:36	N40-25 46.5328	W73-52 22.3979	South
000_1053	6/3/09	10:53	N40-24 08.6663	W73-52 26.9369	North
002_1118	6/3/09	11:18	N40-25 46.4823	W73-52 25.3489	South
000_1135	6/3/09	11:35	N40-24 08.7250	W73-52 31.0865	North
002_1152	6/3/09	11:52	N40-25 46.5942	W73-52 29.4939	South
000_1209	6/3/09	12:09	N40-24 11.6787	W73-52 35.2449	East (Cross-Line)
002_1217	6/3/09	12:17	N40-24 08.8254	W73-52 35.4537	North
000_1234	6/3/09	12:34	N40-25 46.3576	W73-52 24.0259	South
002_1240	6/3/09	12:40	N40-21 08.4226	W73-52 33.6099	South
000_1250	6/3/09	12:50	N40-24 08.7051	W73-52 40.2665	North
000_1300	6/3/09	13:00	N40-25 02.1091	W73-52 36.4243	North
000_1302	6/3/09	13:02	N40-25 01.9082	W73-52 35.5626	North
000_1310	6/3/09	13:10	N40-25 46.0194	W73-52 38.5225	South
000_1332	6/3/09	13:32	N40-24 09.191	W73-52 45.0235	North
000_1349	6/3/09	13:49	N40-25 46.0194	W73-52 43.0326	South
000_1405	6/3/09	14:05	N40-24 08.8814	W73-52 49.7376	North
000_1421	6/3/09	14:21	N40-25 45.7643	W73-52 47.3531	South
000_1437	6/3/09	14:37	N40-24 09.1844	W73-52 53.9168	North
000_1457	6/3/09	14:57	N40-25 46.2515	W73-52 52.1092	South
000_1516	6/3/09	15:16	N40-24 11.0714	W73-52 59.4214	East (Cross-Line)
000_1530	6/3/09	15:30	N40-24 09.4893	W73-53 00.0101	North

**Table 3.3-2**  
Multibeam Survey Lines run during the 2009 multibeam survey at PRA# 1.

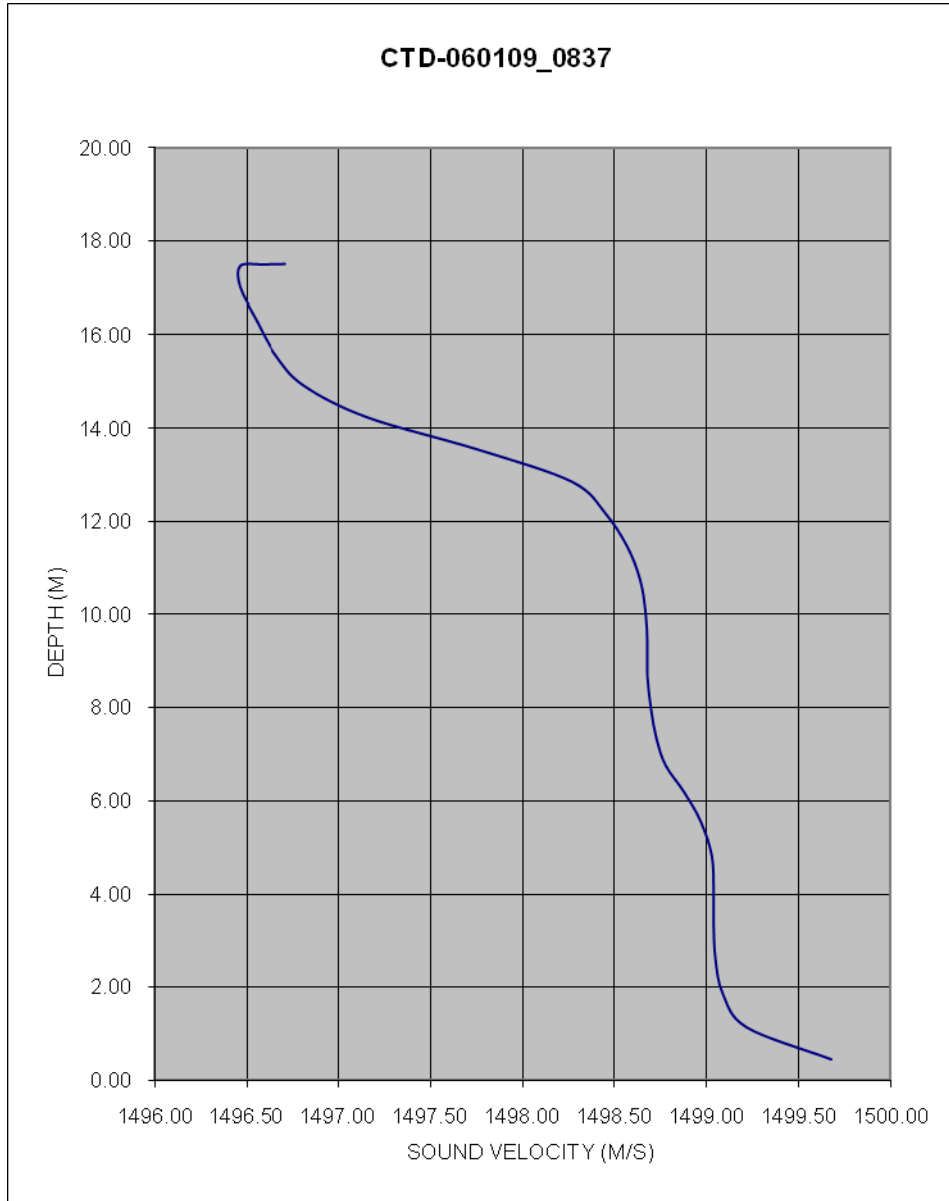
Line	Date	Time	Latitude	Longitude	Direction
000_1547	6/3/09	15:47	N40-25 46.2932	W73-52 56.5748	South
000_1607	6/3/09	16:07	N40-24 08.9563	W73-53 04.5423	North
000_1625	6/3/09	16:25	N40-25 46.7427	W73-53 00.8941	South
000_1644	6/3/09	16:44	N40-24 08.7816	W73-53 08.9958	North
000_1701	6/3/09	17:01	N40-25 46.5253	W73-53 05.9912	South
000_1717	6/3/09	17:17	N40-24 08.936	W73-53 14.1128	North
000_1739	6/3/09	17:39	N40-25 44.2296	W73-53 10.121	East (Cross-Line)
000_0909	6/3/09	9:09	N40-24 09.3574	W73-52 14.4508	North
002_0927	6/3/09	9:27	N40-25 46.4712	W73-52 15.3723	South
000_0934	6/3/09	9:34	N40-24 08.9809	W73-52 17.2535	North
002_1003	6/3/09	10:03	N40-25 46.4204	W73-52 17.9719	South
000_1019	6/3/09	10:19	N40-24 09.0408	W73-52 22.3253	North
002_1036	6/3/09	10:36	N40-25 46.5328	W73-52 22.3979	South
000_1053	6/3/09	10:53	N40-24 08.6663	W73-52 26.9369	North
002_1118	6/3/09	11:18	N40-25 46.4823	W73-52 25.3489	South
000_1135	6/3/09	11:35	N40-24 08.725	W73-52 31.0865	North
002_1152	6/3/09	11:52	N40-25 46.5942	W73-52 29.4939	South
000_1209	6/3/09	12:09	N40-24 11.6787	W73-52 35.2449	East (Cross-Line)
002_1217	6/3/09	12:17	N40-24 08.8254	W73-52 35.4537	North
000_1234	6/3/09	12:34	N40-25 46.3576	W73-52 24.0259	South
002_1240	6/3/09	12:40	N40-21 08.4226	W73-52 33.6099	South
000_1250	6/3/09	12:50	N40-24 08.7051	W73-52 40.2665	North
000_1300	6/3/09	13:00	N40-25 02.1091	W73-52 36.4243	North
000_1302	6/3/09	13:02	N40-25 01.9082	W73-52 35.5626	North
000_1310	6/3/09	13:10	N40-25 46.0194	W73-52 38.5225	South
000_1332	6/3/09	13:32	N40-24 09.191	W73-52 45.0235	North
000_1349	6/3/09	13:49	N40-25 46.0194	W73-52 43.0326	South
000_1405	6/3/09	14:05	N40-24 08.8814	W73-52 49.7376	North
000_1421	6/3/09	14:21	N40-25 45.7643	W73-52 47.3531	South
000_1437	6/3/09	14:37	N40-24 09.1844	W73-52 53.9168	North
000_1457	6/3/09	14:57	N40-25 46.2515	W73-52 52.1092	South
000_1516	6/3/09	15:16	N40-24 11.0714	W73-52 59.4214	East (Cross-Line)
000_1530	6/3/09	15:30	N40-24 09.4893	W73-53 00.0101	North
000_1547	6/3/09	15:47	N40-25 46.2932	W73-52 56.5748	South
000_1607	6/3/09	16:07	N40-24 08.9563	W73-53 04.5423	North
000_1625	6/3/09	16:25	N40-25 46.7427	W73-53 00.8941	South
000_1644	6/3/09	16:44	N40-24 08.7816	W73-53 08.9958	North
000_1701	6/3/09	17:01	N40-25 46.5253	W73-53 05.9912	South
000_1717	6/3/09	17:17	N40-24 08.936	W73-53 14.1128	North
000_1739	6/4/09	17:39	N40-25 44.2296	W73-53 10.121	East (Cross-Line)

**Figure 3.2-1**  
 SVP 060109-0837 taken during the 2009 multibeam survey at PRA# 1.

**CTD PROFILE # 060109-0837**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI</u>	<u>(Feet)</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/01/09	8:37	1022990	85846	57	40.40221676	73.86090906

1499.68 0.44  
 1499.22 1.13  
 1499.09 1.85  
 1499.05 2.59  
 1499.04 3.34  
 1499.04 4.08  
 1499.03 4.82  
 1498.97 5.55  
 1498.88 6.18  
 1498.78 6.75  
 1498.73 7.32  
 1498.70 7.96  
 1498.68 8.67  
 1498.68 9.37  
 1498.67 10.05  
 1498.64 10.75  
 1498.57 11.46  
 1498.45 12.18  
 1498.27 12.85  
 1497.76 13.54  
 1497.16 14.23  
 1496.81 14.92  
 1496.65 15.61  
 1496.55 16.31  
 1496.46 17.01  
 1496.46 17.46  
 1496.58 17.49  
 1496.71 17.50

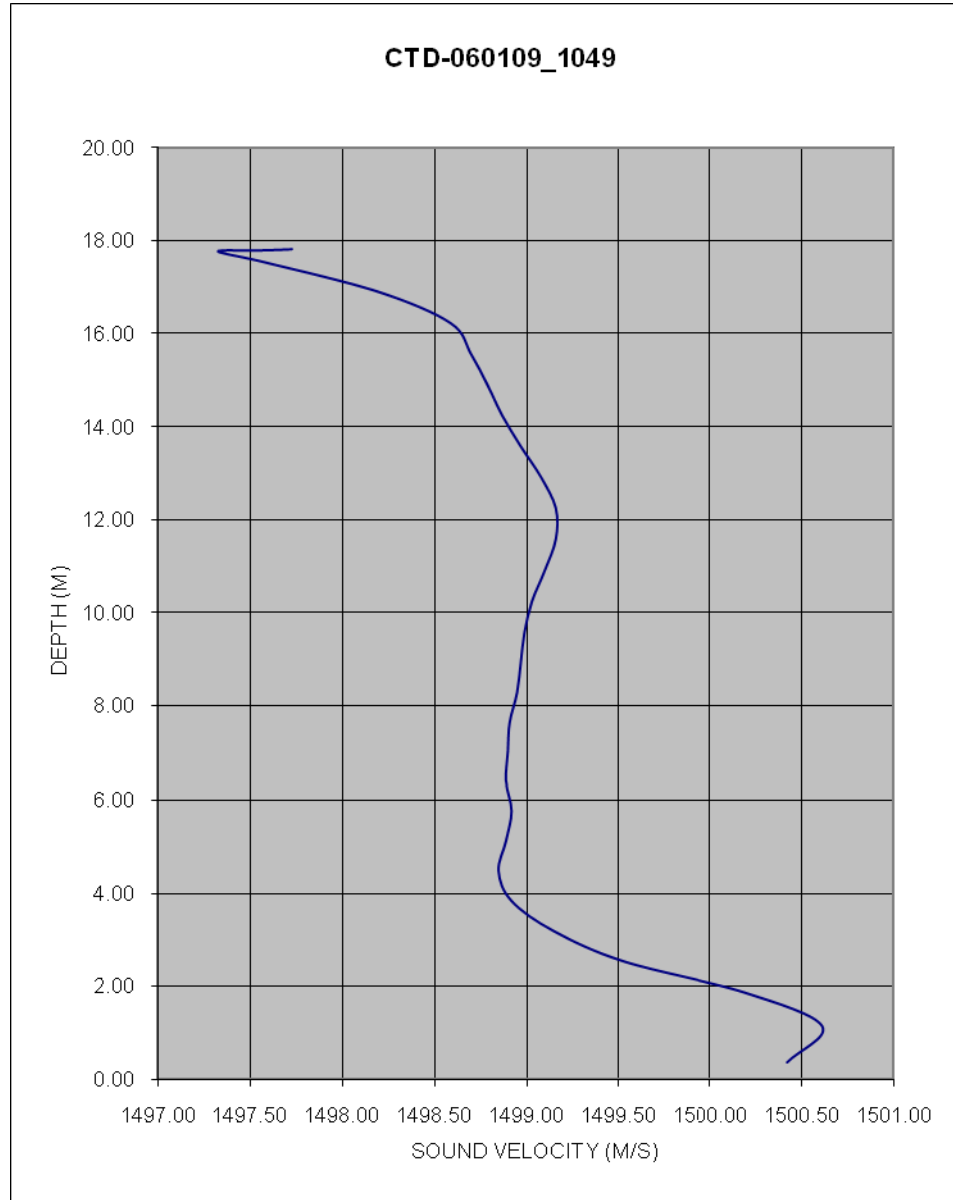


**Figure 3.2-2**  
 SVP 060109-1049 taken during the 2009 multibeam survey at PRA# 1

**CTD PROFILE # 060109-1049**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI</u>	<u>(Feet)</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/01/09	10:49	1022478	95862	58	40.42970981	73.86268743

1500.42 0.37  
 1500.61 1.15  
 1500.19 1.87  
 1499.53 2.54  
 1499.15 3.19  
 1498.92 3.84  
 1498.85 4.48  
 1498.89 5.13  
 1498.92 5.77  
 1498.89 6.40  
 1498.90 7.03  
 1498.91 7.65  
 1498.95 8.29  
 1498.97 8.93  
 1498.99 9.58  
 1499.03 10.24  
 1499.10 10.91  
 1499.16 11.59  
 1499.16 12.25  
 1499.08 12.92  
 1498.97 13.58  
 1498.87 14.24  
 1498.79 14.90  
 1498.70 15.57  
 1498.59 16.23  
 1498.20 16.90  
 1497.59 17.53  
 1497.33 17.77  
 1497.54 17.79  
 1497.70 17.81  
 1497.73 17.82



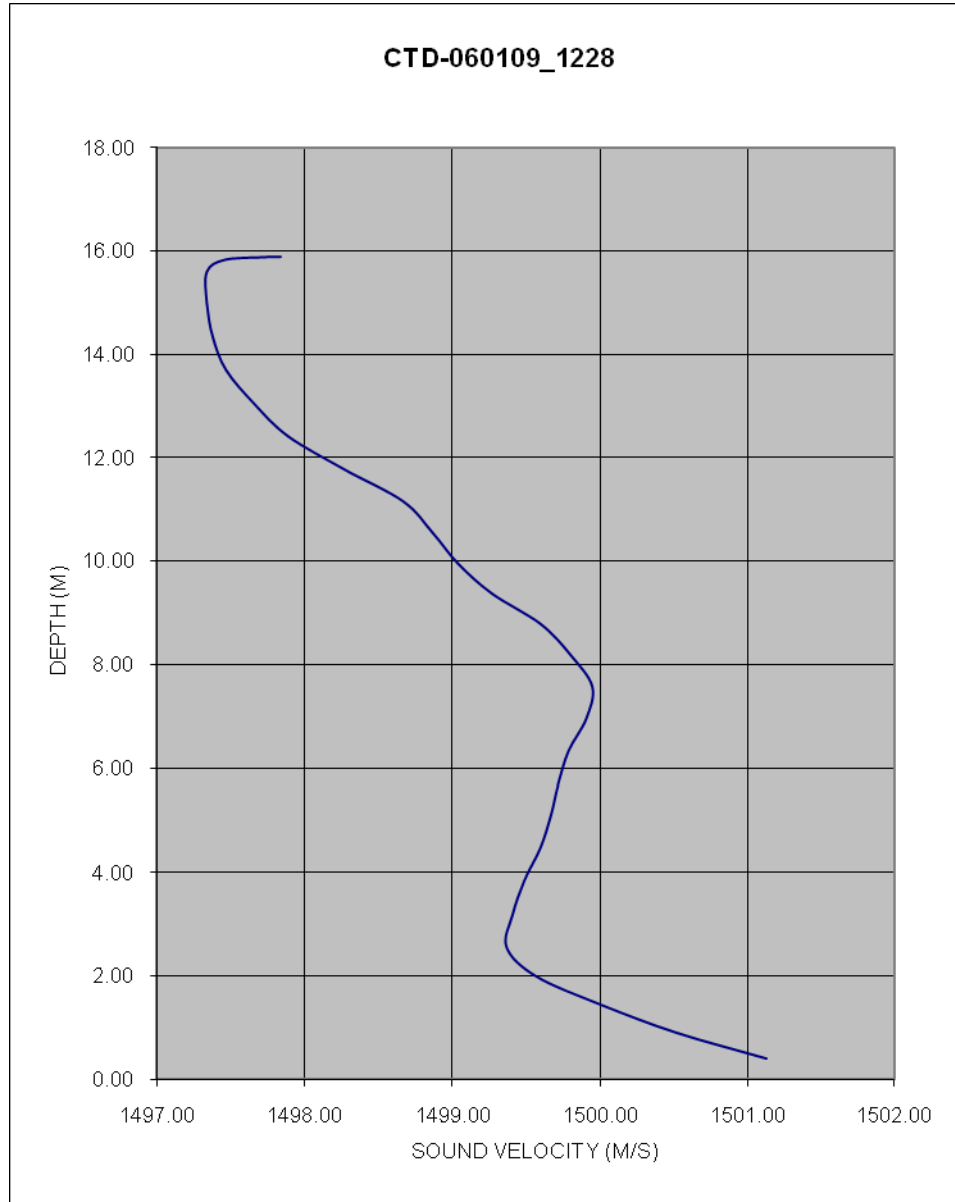


**Figure 3.2-3**  
 SVP 060109-1228 taken during the 2009 multibeam survey at PRA# 1

**CTD PROFILE # 060109-1228**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI</u>	<u>(Feet)</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/01/09	12:28	1021817	85747	52	40.40194813	73.86511868

1501.13 0.40  
 1500.52 0.90  
 1500.01 1.44  
 1499.57 1.99  
 1499.37 2.55  
 1499.41 3.18  
 1499.49 3.84  
 1499.60 4.48  
 1499.67 5.10  
 1499.72 5.70  
 1499.79 6.33  
 1499.91 6.95  
 1499.95 7.57  
 1499.80 8.19  
 1499.60 8.78  
 1499.27 9.37  
 1499.04 9.95  
 1498.87 10.54  
 1498.67 11.15  
 1498.27 11.77  
 1497.89 12.41  
 1497.66 13.04  
 1497.47 13.69  
 1497.38 14.33  
 1497.34 14.98  
 1497.34 15.59  
 1497.46 15.82  
 1497.71 15.87  
 1497.84 15.88

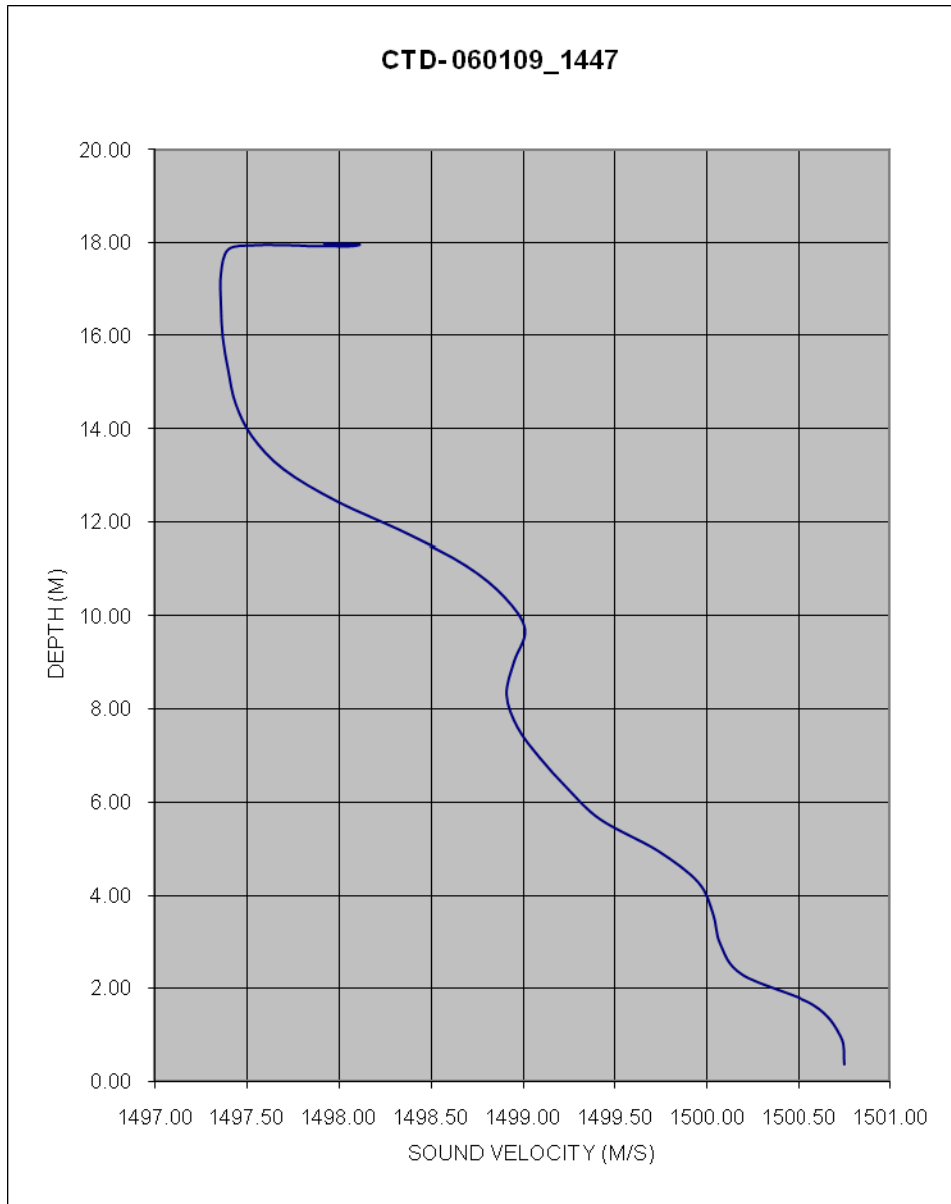


**Figure 3.2-4**  
SVP 060109-1447 taken during the 2009 multibeam survey at PRA# 1.

**CTD PROFILE # 060109-1447**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI (Feet)</u>		<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/01/09	14:47	1020430	86167	59	40.40310803	73.87009615

1500.75 0.35  
 1500.73 0.95  
 1500.58 1.63  
 1500.19 2.28  
 1500.07 2.94  
 1500.03 3.60  
 1499.95 4.27  
 1499.73 4.95  
 1499.42 5.62  
 1499.24 6.29  
 1499.09 6.95  
 1498.97 7.60  
 1498.91 8.30  
 1498.95 9.01  
 1499.01 9.71  
 1498.90 10.40  
 1498.69 11.08  
 1498.37 11.75  
 1497.99 12.44  
 1497.70 13.13  
 1497.53 13.83  
 1497.44 14.54  
 1497.40 15.25  
 1497.37 15.96  
 1497.36 16.66  
 1497.36 17.34  
 1497.40 17.86  
 1497.54 17.95  
 1497.74 17.95  
 1497.86 17.93  
 1497.96 17.93  
 1498.07 17.93  
 1498.11 17.97  
 1497.96 17.98  
 1497.92 17.99  
 1497.89 18.00  
 1497.90 18.01

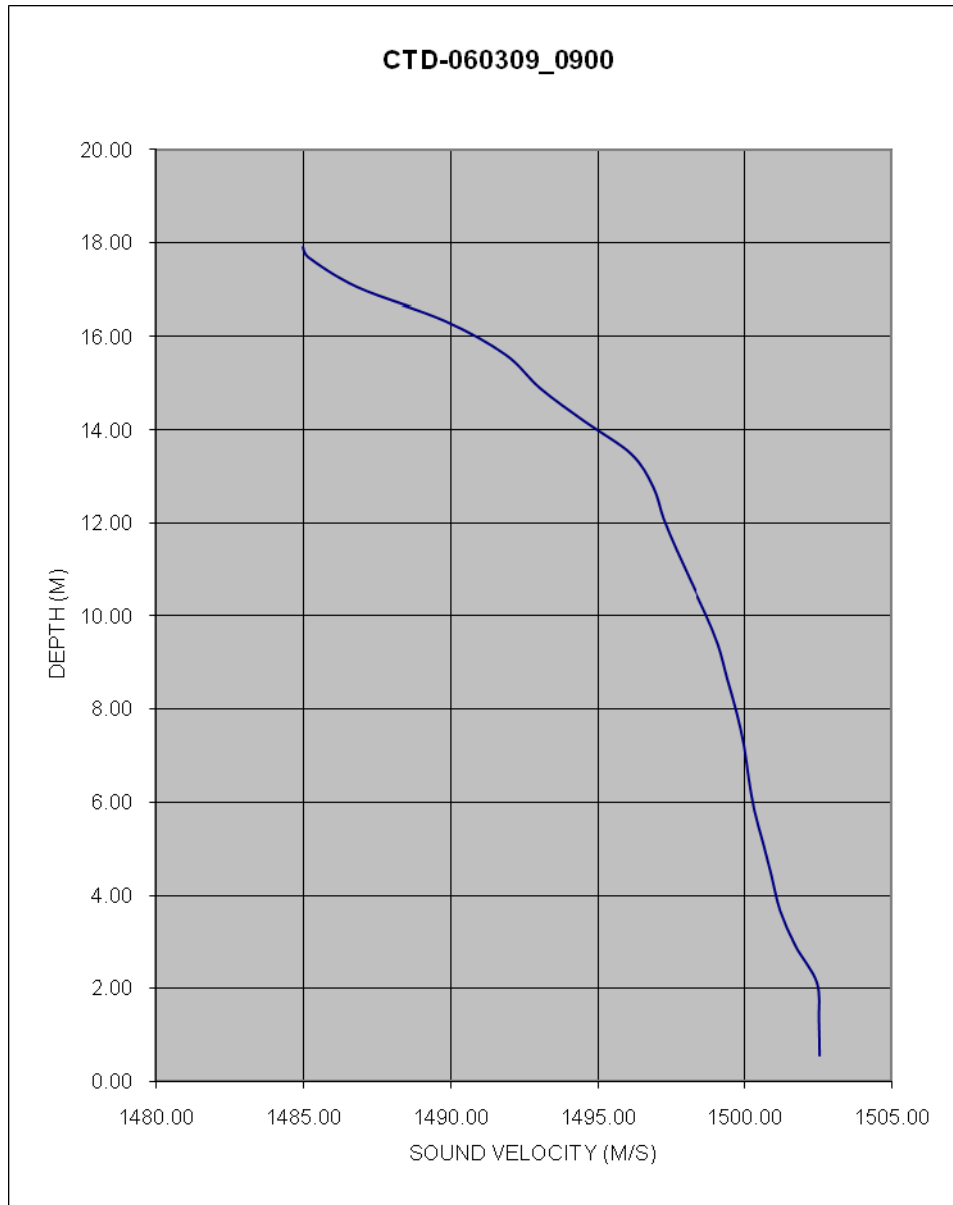


**Figure 3.2-5**  
 SVP 060309-0900 taken during the 2009 multibeam survey at PRA# 1.

**CTD PROFILE # 060309-0900**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI</u>	<u>(Feet)</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/03/09	9:00	1020134	85945	59	40.40250002	73.87116221

1502.57 0.55  
 1502.55 1.33  
 1502.48 2.12  
 1501.75 2.91  
 1501.23 3.67  
 1500.94 4.42  
 1500.65 5.13  
 1500.36 5.82  
 1500.17 6.50  
 1500.01 7.21  
 1499.75 7.95  
 1499.43 8.67  
 1499.12 9.39  
 1498.68 10.07  
 1498.18 10.74  
 1497.69 11.42  
 1497.24 12.10  
 1496.88 12.79  
 1496.14 13.49  
 1494.56 14.19  
 1493.06 14.90  
 1491.87 15.63  
 1489.82 16.35  
 1486.87 17.05  
 1485.18 17.70  
 1485.01 17.91

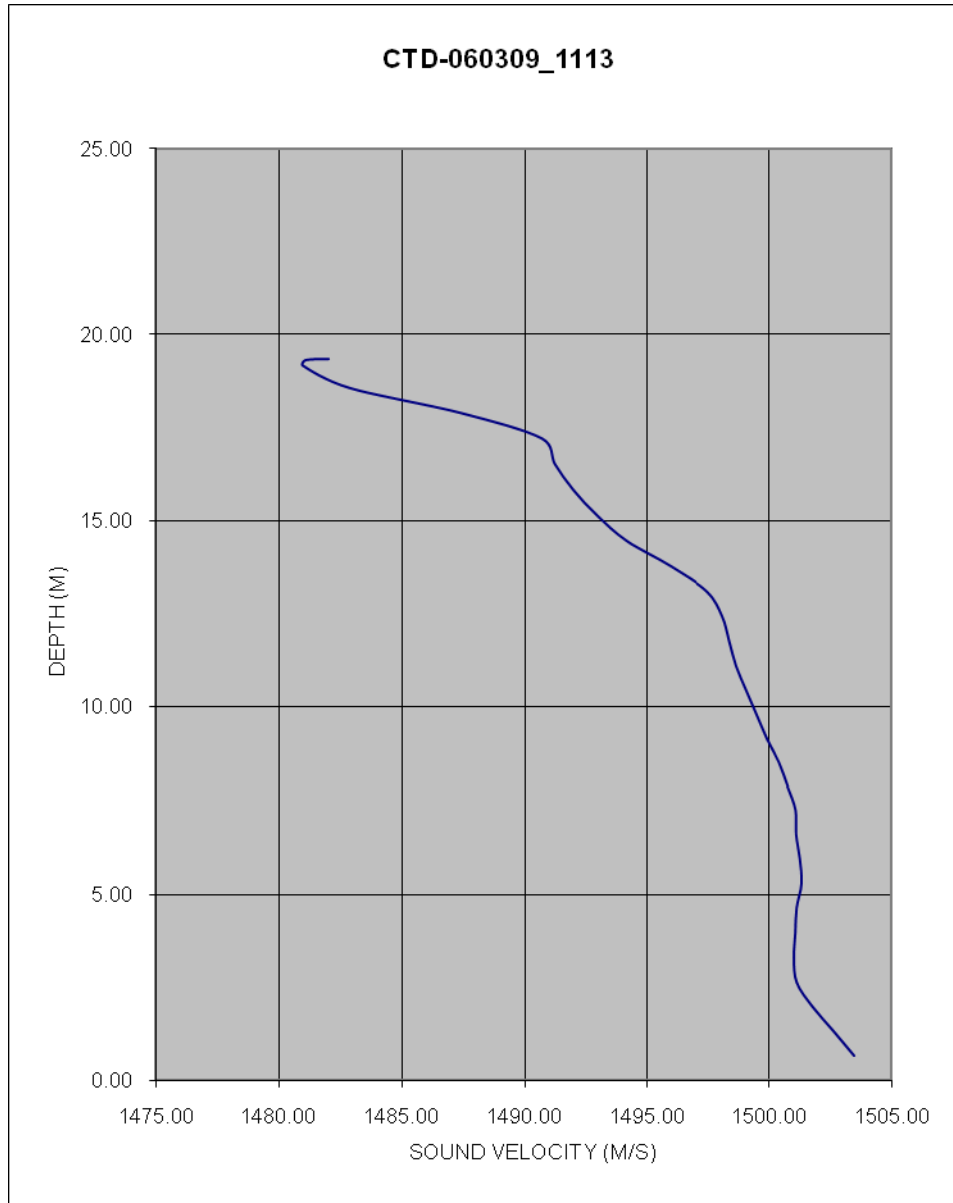


**Figure 3.2-6**  
 SVP 060309-1113 taken during the 2009 multibeam survey at PRA# 1.

**CTD PROFILE # 060309-1113**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI</u>	<u>(Feet)</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/03/09	11:13	1019513	95936	64	40.42992428	73.87333889

1503.46 0.65  
 1502.60 1.33  
 1501.78 1.96  
 1501.13 2.61  
 1501.01 3.28  
 1501.07 3.96  
 1501.12 4.62  
 1501.32 5.29  
 1501.25 5.95  
 1501.10 6.61  
 1501.08 7.25  
 1500.76 7.87  
 1500.40 8.51  
 1499.91 9.15  
 1499.49 9.80  
 1499.06 10.46  
 1498.66 11.10  
 1498.38 11.77  
 1498.09 12.44  
 1497.47 13.10  
 1495.98 13.78  
 1494.18 14.46  
 1492.96 15.15  
 1491.99 15.84  
 1491.24 16.54  
 1490.72 17.22  
 1487.46 17.90  
 1482.91 18.58  
 1481.01 19.18  
 1481.12 19.33  
 1482.05 19.36

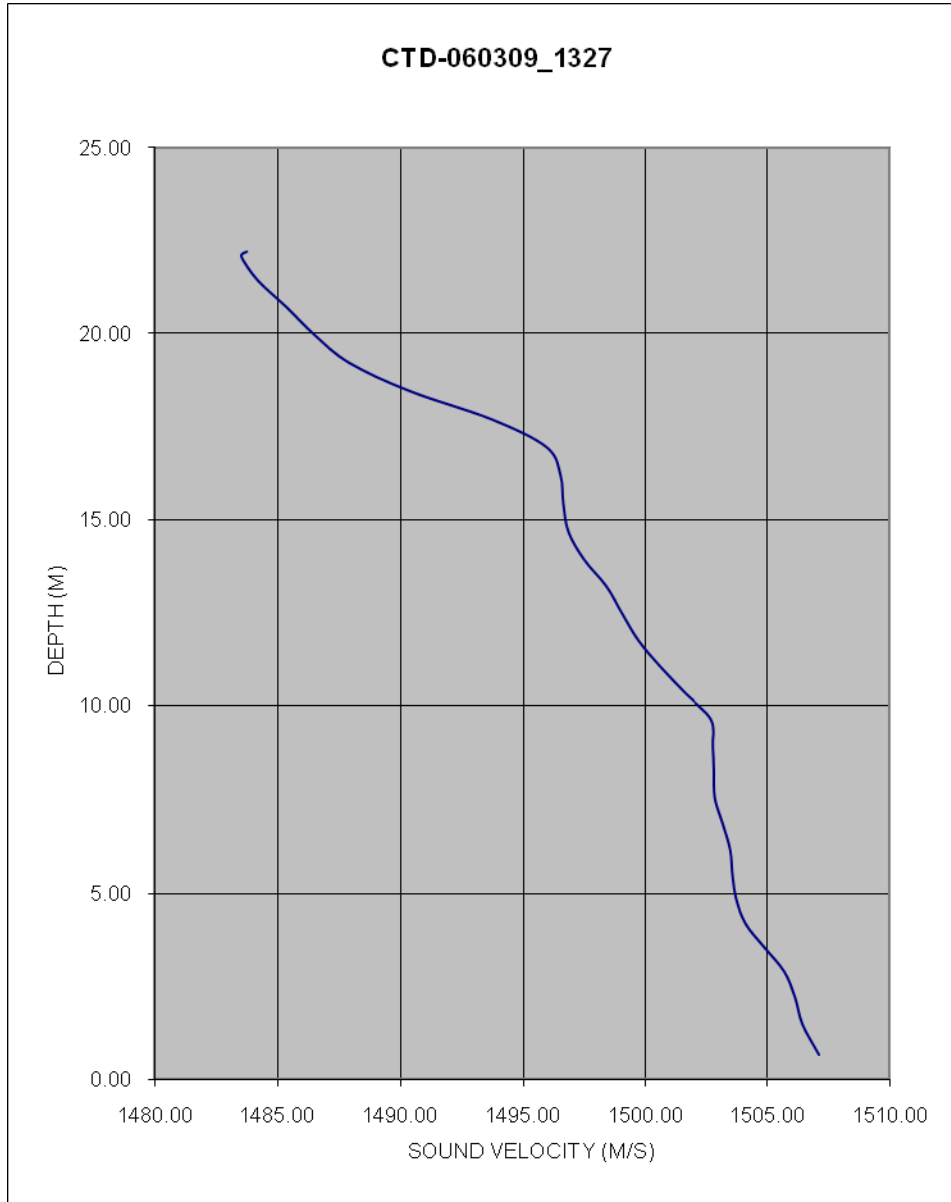


**Figure 3.2-7**  
 SVP 060309-1327 taken during the 2009 multibeam survey at PRA# 1

**CTD PROFILE # 060309-1327**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI (Feet)</u>		<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/03/09	13:27	1017967	85787	73	40.40207517	73.87894087

1507.11 0.65  
 1506.44 1.46  
 1506.13 2.20  
 1505.69 2.89  
 1504.88 3.54  
 1504.12 4.17  
 1503.75 4.81  
 1503.59 5.46  
 1503.50 6.14  
 1503.20 6.84  
 1502.87 7.54  
 1502.83 8.23  
 1502.79 8.92  
 1502.71 9.62  
 1501.65 10.32  
 1500.64 11.02  
 1499.72 11.74  
 1499.04 12.48  
 1498.40 13.21  
 1497.49 13.93  
 1496.86 14.67  
 1496.65 15.43  
 1496.54 16.18  
 1495.98 16.94  
 1493.75 17.69  
 1490.41 18.45  
 1487.94 19.21  
 1486.53 19.96  
 1485.40 20.70  
 1484.21 21.43  
 1483.55 22.07  
 1483.77 22.20

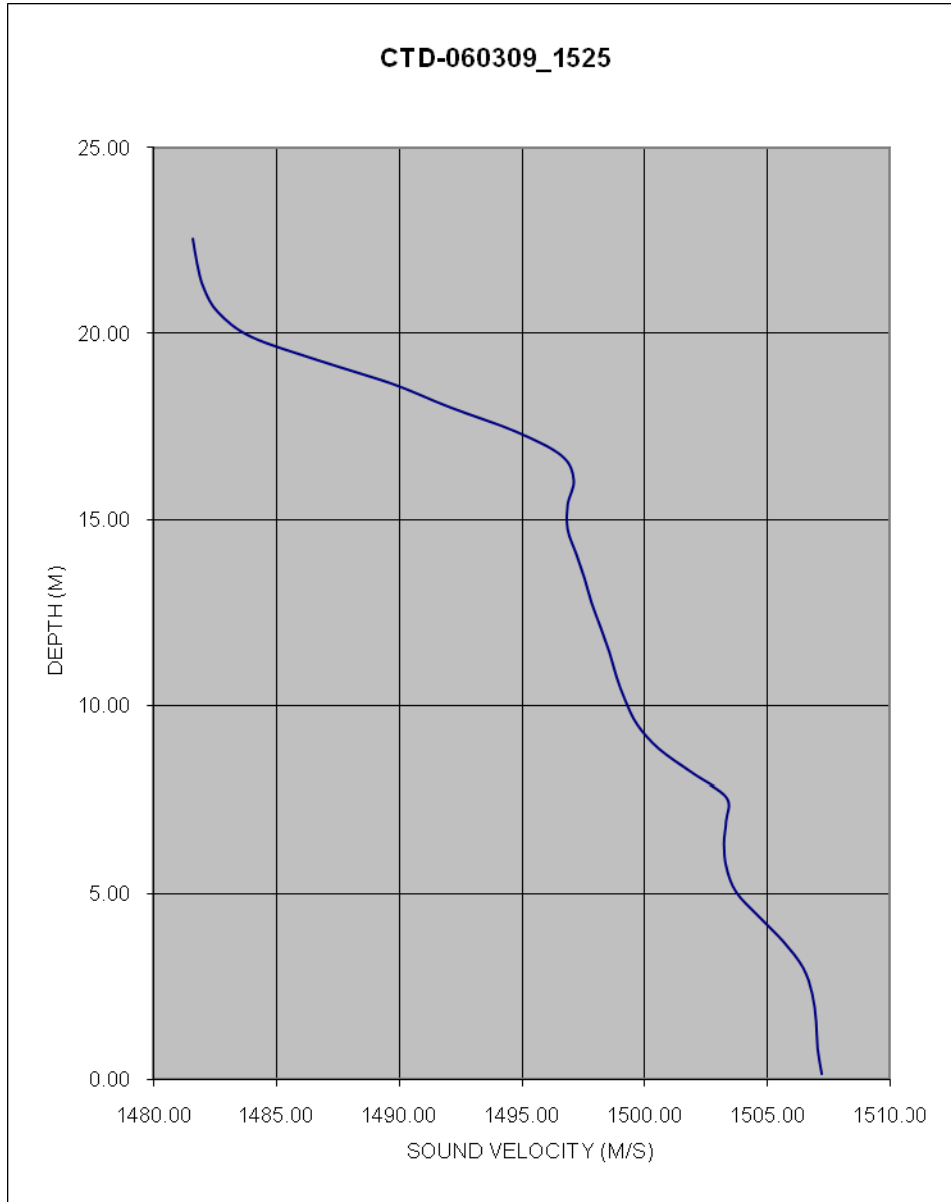


**Figure 3.2-8**  
 SVP 060309-1525 taken during the 2009 multibeam survey at PRA# 1

**CTD PROFILE # 060309-1525**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI (Feet)</u>		<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/03/09	15:25	1016813	85903	77	40.40239752	73.88308489

1507.24 0.14  
 1507.07 0.82  
 1507.01 1.55  
 1506.85 2.29  
 1506.48 2.99  
 1505.68 3.69  
 1504.68 4.36  
 1503.75 5.02  
 1503.35 5.68  
 1503.25 6.31  
 1503.34 6.94  
 1503.35 7.56  
 1501.97 8.19  
 1500.59 8.84  
 1499.71 9.49  
 1499.22 10.14  
 1498.86 10.78  
 1498.57 11.44  
 1498.22 12.09  
 1497.85 12.75  
 1497.56 13.41  
 1497.22 14.07  
 1496.87 14.73  
 1496.87 15.39  
 1497.12 16.06  
 1496.62 16.71  
 1494.74 17.36  
 1492.10 18.00  
 1489.70 18.64  
 1486.69 19.27  
 1483.96 19.90  
 1482.62 20.55  
 1482.03 21.20  
 1481.75 21.87  
 1481.58 22.53  
 1481.57 23.12  
 1481.99 23.28



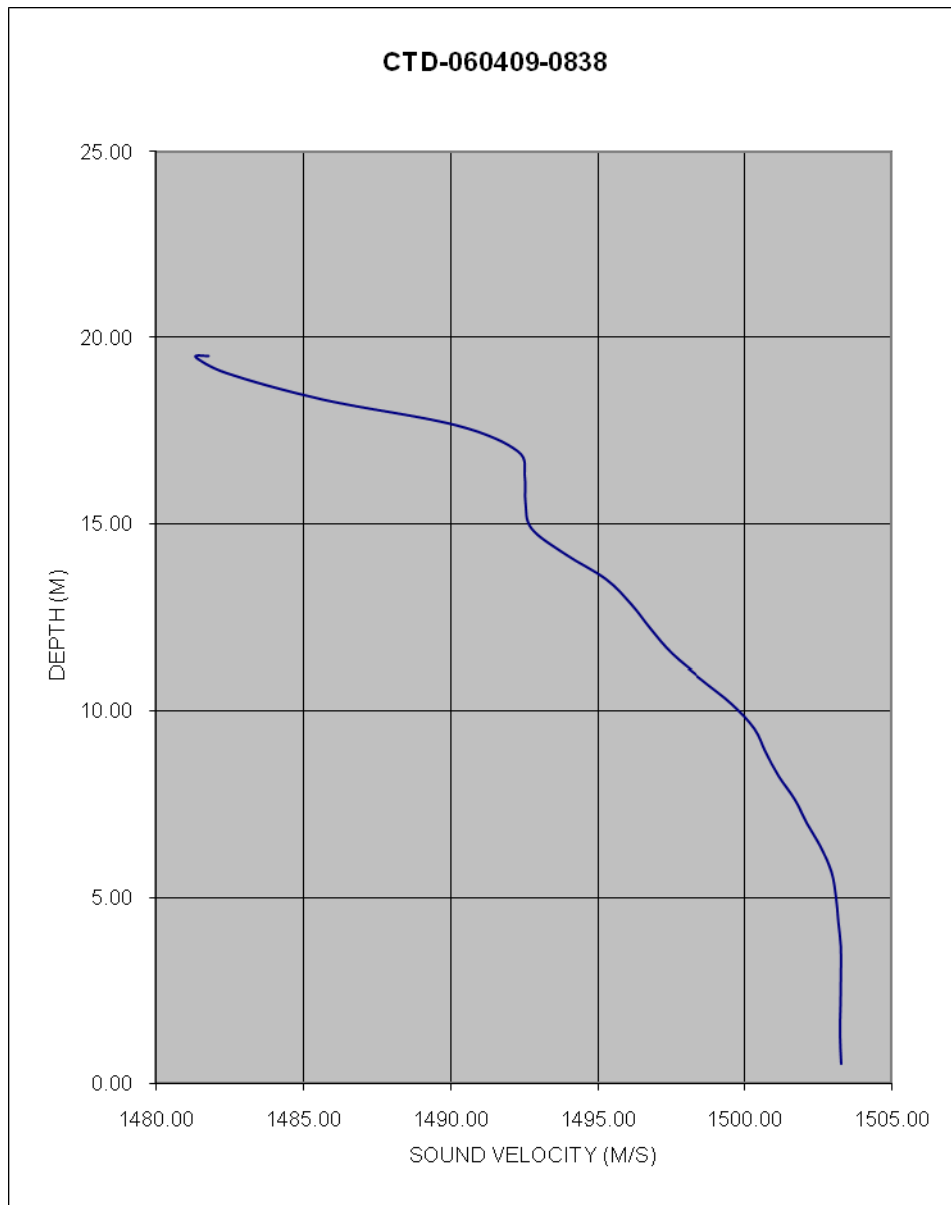
1482.63 23.33

**Figure 3.2-9**  
SVP 060409-0838 taken during the 2009 multibeam survey at PRA# 1.

**CTD PROFILE # 060409-0838**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI (Feet)</u>		<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/04/09	8:38	1015944	95758	64	40.42945088	73.88615809

1503.31 0.53  
 1503.27 1.34  
 1503.29 2.15  
 1503.30 2.92  
 1503.30 3.67  
 1503.21 4.36  
 1503.13 5.04  
 1502.98 5.69  
 1502.62 6.35  
 1502.15 6.99  
 1501.74 7.63  
 1501.19 8.26  
 1500.75 8.90  
 1500.36 9.54  
 1499.59 10.20  
 1498.55 10.86  
 1497.54 11.52  
 1496.81 12.18  
 1496.15 12.84  
 1495.29 13.52  
 1493.91 14.19  
 1492.76 14.88  
 1492.55 15.58  
 1492.53 16.27  
 1492.29 16.96  
 1490.20 17.66  
 1485.67 18.35  
 1482.41 19.06  
 1481.36 19.49  
 1481.79 19.52

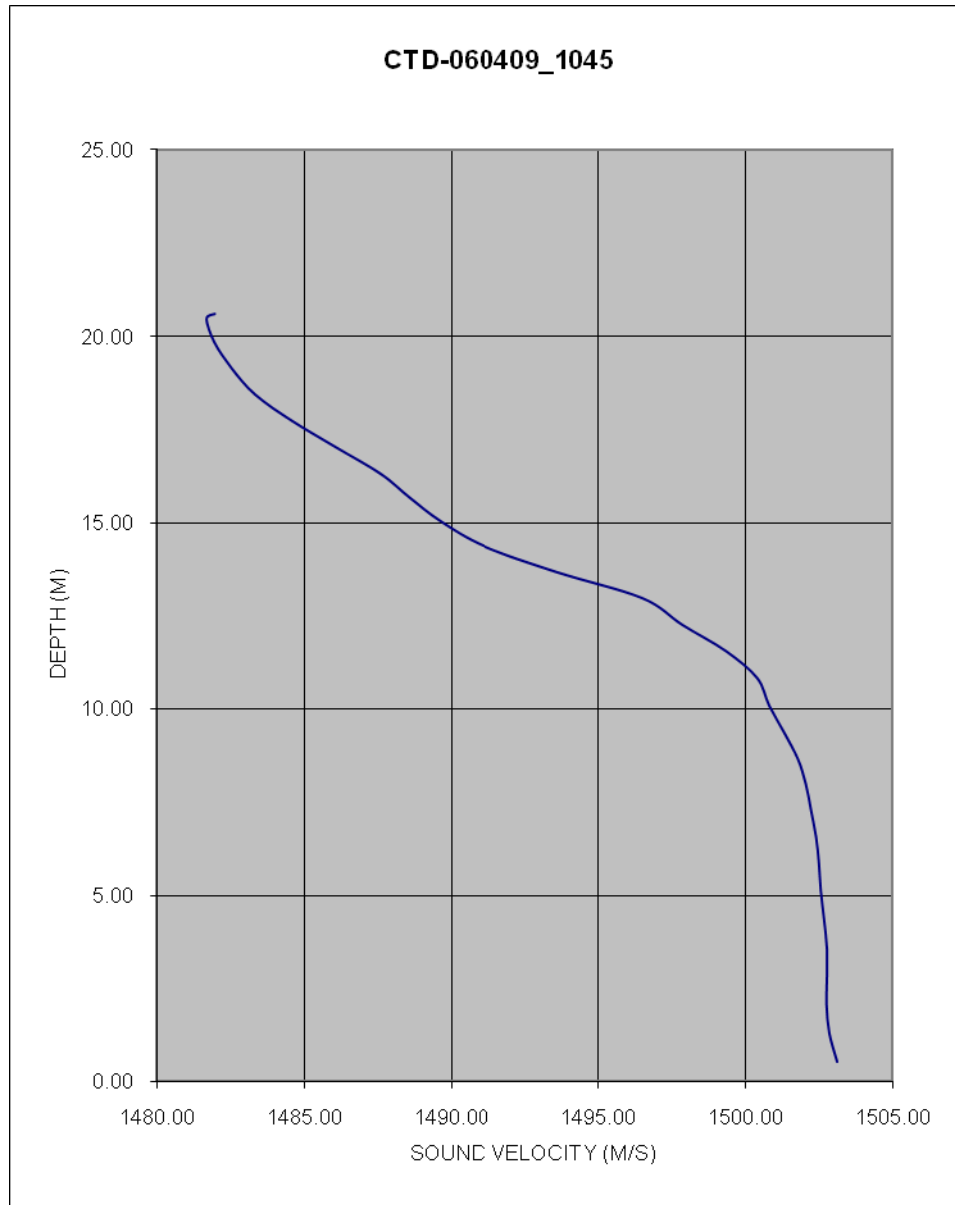


**Figure 3.2-10**  
 SVP 060409-1045 taken during the 2009 multibeam survey at PRA# 1

**CTD PROFILE # 060409-1045**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI (Feet)</u>		<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/04/09	10:45	1014859	95564	68	40.42892082	73.89005823

1503.13 0.52  
 1502.86 1.30  
 1502.77 2.04  
 1502.78 2.80  
 1502.78 3.57  
 1502.68 4.37  
 1502.57 5.13  
 1502.51 5.85  
 1502.41 6.57  
 1502.24 7.29  
 1502.06 8.00  
 1501.79 8.67  
 1501.33 9.37  
 1500.82 10.10  
 1500.41 10.84  
 1499.36 11.56  
 1497.87 12.27  
 1496.50 12.99  
 1493.59 13.69  
 1491.13 14.38  
 1489.63 15.05  
 1488.57 15.69  
 1487.58 16.33  
 1486.05 17.05  
 1484.56 17.76  
 1483.32 18.46  
 1482.52 19.17  
 1481.94 19.86  
 1481.67 20.49  
 1481.95 20.63



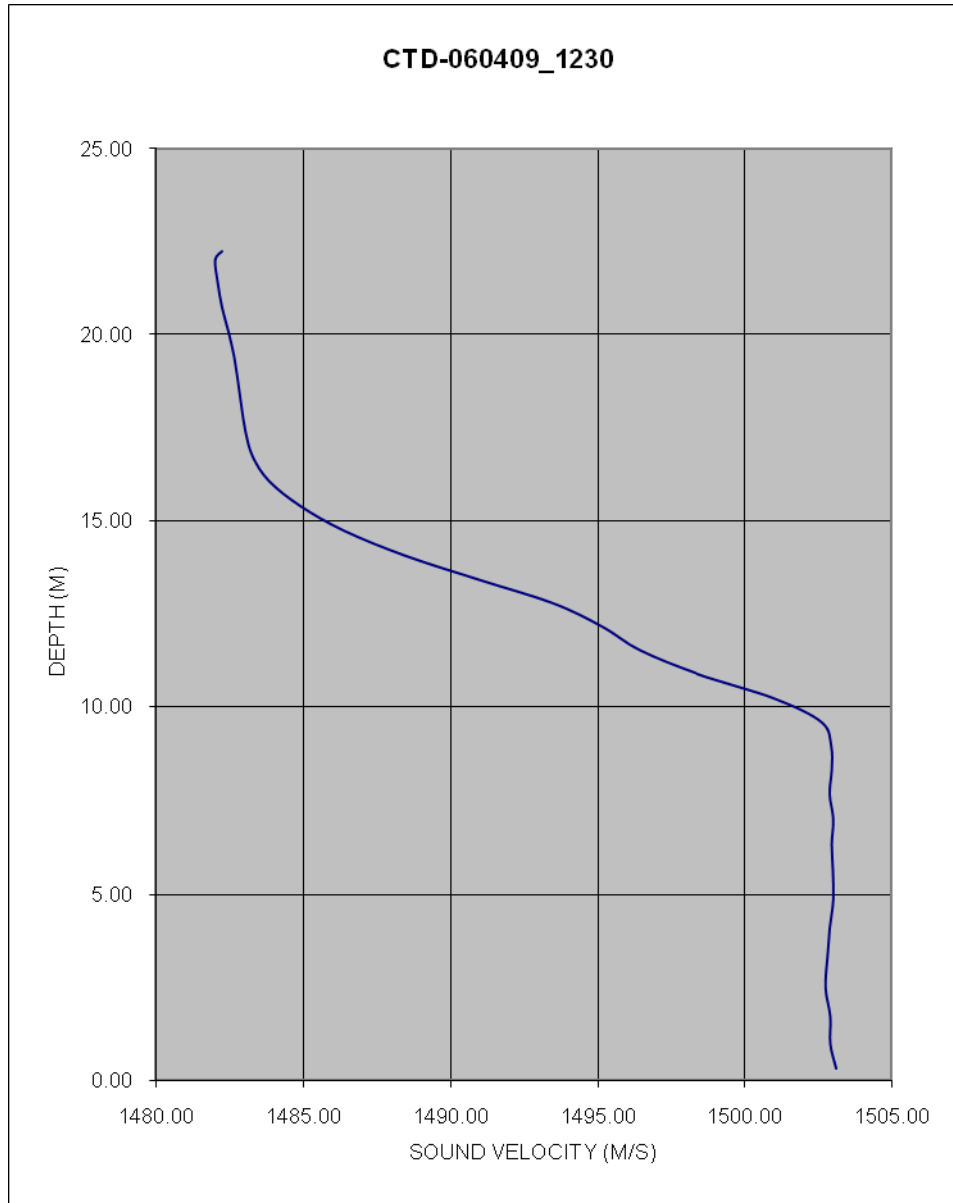


**Figure 3.2-11**  
 SVP 060409-1230 taken during the 2009 multibeam survey at PRA# 1

**CTD PROFILE # 060409-1230**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI</u>	<u>(Feet)</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/04/09	12:39	1013489	85913	73	40.40243595	73.89501999

1503.12 0.32  
 1502.92 0.98  
 1502.92 1.71  
 1502.76 2.48  
 1502.82 3.28  
 1502.90 4.08  
 1503.02 4.86  
 1503.01 5.62  
 1502.97 6.34  
 1503.02 7.02  
 1502.90 7.68  
 1502.97 8.32  
 1502.95 8.95  
 1502.62 9.59  
 1501.00 10.23  
 1498.41 10.88  
 1496.43 11.52  
 1495.13 12.16  
 1493.48 12.78  
 1490.98 13.41  
 1488.50 14.05  
 1486.42 14.72  
 1484.92 15.39  
 1483.86 16.06  
 1483.30 16.72  
 1483.06 17.38  
 1482.92 18.06  
 1482.80 18.74  
 1482.67 19.41  
 1482.48 20.07  
 1482.26 20.73  
 1482.12 21.37  
 1482.03 22.00  
 1482.26 22.23

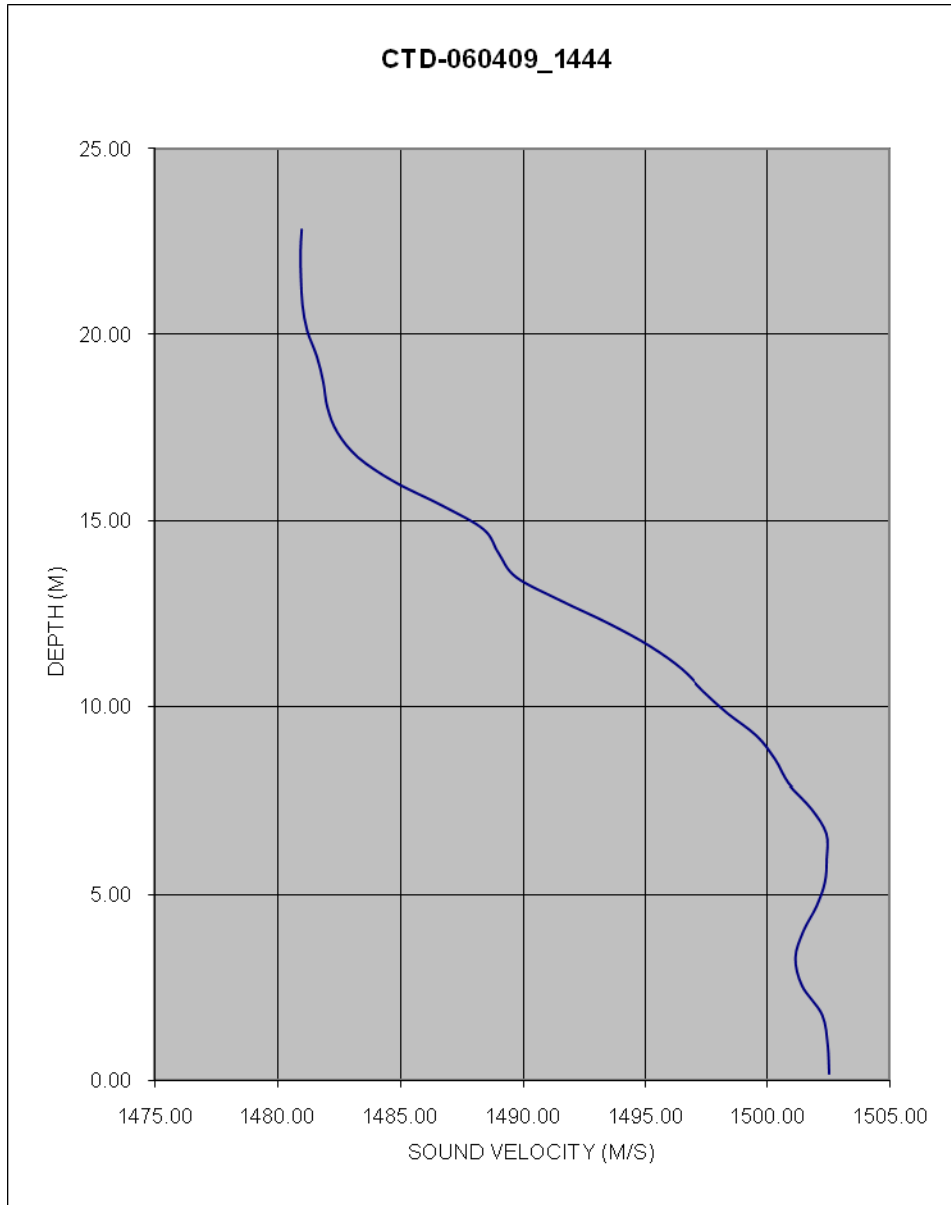


**Figure 3.2-12**  
 SVP 060409-1444 taken during the 2009 multibeam survey at PRA# 1

**CTD PROFILE # 060409-1444**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI</u>	<u>(Feet)</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/04/09	14:44	1012540	95879	75	40.42979291	73.89838673

1502.56 0.18  
 1502.50 0.94  
 1502.27 1.76  
 1501.45 2.54  
 1501.18 3.29  
 1501.50 4.00  
 1502.04 4.67  
 1502.38 5.31  
 1502.46 5.96  
 1502.44 6.63  
 1501.83 7.29  
 1500.90 7.95  
 1500.35 8.59  
 1499.59 9.22  
 1498.41 9.82  
 1497.41 10.41  
 1496.50 11.01  
 1495.20 11.62  
 1493.52 12.23  
 1491.54 12.85  
 1489.72 13.48  
 1489.01 14.12  
 1488.40 14.76  
 1486.73 15.39  
 1484.75 16.04  
 1483.28 16.69  
 1482.43 17.36  
 1482.02 18.03  
 1481.85 18.71  
 1481.59 19.40  
 1481.19 20.10  
 1481.00 20.80  
 1480.94 21.50  
 1480.92 22.19  
 1480.97 22.81  
 1481.30 22.97

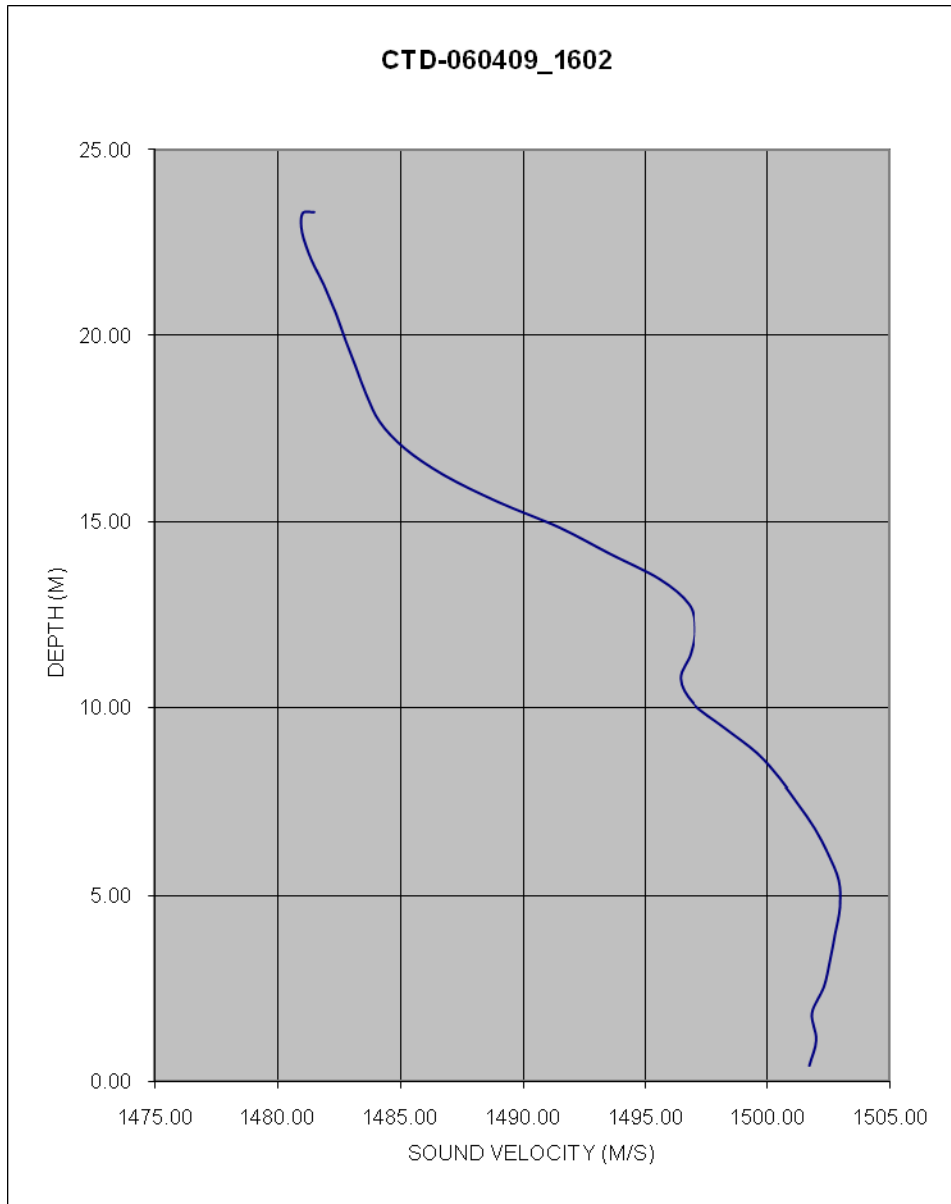


**Figure 3.2-13**  
 SVP 060409-1602 taken during the 2009 multibeam survey at PRA# 1

**CTD PROFILE # 060409-1602**

<u>Date</u>	<u>Time</u>	<u>NAD83 NY LI</u>	<u>(Feet)</u>	<u>Depth</u>	<u>Latitude</u>	<u>Longitude</u>
-	-	<u>Easting</u>	<u>Northing</u>	<u>Feet MLW</u>	<u>N</u>	<u>W</u>
06/04/09	16:02	1011653	95562	76	40.42892653	73.90157154

1501.70 0.43  
 1501.98 1.12  
 1501.81 1.84  
 1502.29 2.54  
 1502.54 3.24  
 1502.75 3.97  
 1502.95 4.69  
 1502.90 5.40  
 1502.47 6.11  
 1501.93 6.79  
 1501.23 7.46  
 1500.49 8.12  
 1499.57 8.79  
 1498.25 9.46  
 1496.93 10.13  
 1496.42 10.79  
 1496.83 11.45  
 1497.00 12.11  
 1496.76 12.78  
 1495.55 13.46  
 1493.52 14.14  
 1491.48 14.84  
 1488.94 15.54  
 1486.77 16.25  
 1485.17 16.97  
 1484.16 17.68  
 1483.61 18.41  
 1483.19 19.14  
 1482.77 19.86  
 1482.37 20.60  
 1481.90 21.33  
 1481.37 22.04  
 1481.00 22.76  
 1481.01 23.27  
 1481.49 23.31



## 4.0 Tidal Corrections

For the 2009 bathymetry survey the “Valeport Midas WLR” submersible tide gauge was deployed prior to collection of multibeam data at PRA# 1 site. This gauge which measures pressure was located on the sea floor attached to an anchor with an additional attachment to a surface lighted buoy (see Figure 3.0-2).

For the 2009 bathymetry survey it was also decided to utilize the Real Time Kinematic GPS (RTK) option of the POS/MV on board the survey vessel to provide real time water level elevations. This system was referenced to NAVD88 during data collection. Unfortunately due to drops in the cellular network providing the RTK corrections the RTK data set is not as complete as expected. This coupled with the fact that the Base Station providing the corrections was on the limit of the range for which required accuracies are needed.

As with previous surveys at the HARS site, tide data from NOAA’s reference tide station at Sandy Hook was downloaded from N.O.A.A.’s web site. Historic range and time correctors (used since 2006) of 0.94 and -30 minutes were used to correct the Sandy Hook NOAA tide data for the PRA#1 survey area. This corrected tide data was then referenced to MLW as per the USACOE SOW, (0’ MLW is 1.73’ below 0’ NGVD29 and 2.84’ below NAVD88).

## 4.0 Cross-Track Analysis

Cross-track analysis was performed to provide a quality check on the accuracy of the multibeam data. Cross-track lines are run perpendicular to the main direction of survey lines to produce areas of overlapping data that can be analyzed and errors quantified to provide an indication of the overall quality of data.

For the 2009 survey the main body of survey lines were run in a North-South direction and for every ten (10) main body lines a cross-track line was run in an East-West direction. This yielded a total of seven (7) cross-track lines, which were then analyzed utilizing the Beam Angle Test module within the Hypack Processing software. The Beam Angle Test compares multibeam check lines to a reference surface and estimates the depth accuracy of the multibeam system at different angle limits. The estimated accuracy can be used to determine if the multibeam system meets survey specifications. In this case the reference surface used was the final 10x10 xyz of the processed main body multibeam data. Results from this analysis are seen in Section 4.1.

## 4.1 Cross-Track Analysis Results

Table 4.1-1 show the results from the Hypack Beam Analysis for each crossing. The analysis software generates; Max Outlier, Mean Difference, Standard Deviation and 95% Confidence for the beam angle limits specified. All but one of the crossings show that the 95% confidence is less than 0.7', while crossing 0603-1516 is 0.98'. The mean difference for all crossings is less than 0.19', while the standard deviation for all crossings is less than 0.50'. The maximum outlier is 5.06. Figures 4.1-1 to 4.1-2 show screen captures of the summary plots for the errors at +/- 60 deg. for each crossing.

**Table 4.1-1**  
Summary of Beam Analysis Results for all crossings during HARS 2009 survey

Crossing	Beam Angle	Max. Outlier	Mean Diff.	Std Dev.	95%	Crossing	Beam Angle	Max. Outlier	Mean Diff.	Std Dev.	95%	Crossing	Beam Angle	Max. Outlier	Mean Diff.	Std Dev.	95%
0601-1207	+/-20	0.66	0.03	0.17	0.34	0601-1503	+/-20	3.48	-0.15	0.26	0.51	0603-1209	+/-20	2.49	0.10	0.31	0.60
	+/-25	0.66	0.05	0.18	0.35		+/-25	3.45	-0.14	0.25	0.49		+/-25	2.43	0.10	0.24	0.47
	+/-30	0.79	0.05	0.16	0.31		+/-30	1.71	-0.13	0.26	0.51		+/-30	2.23	0.10	0.25	0.48
	+/-35	0.79	0.04	0.16	0.31		+/-35	4.39	-0.11	0.24	0.47		+/-35	2.66	0.11	0.24	0.48
	+/-40	0.69	0.05	0.17	0.33		+/-40	5.06	-0.11	0.26	0.51		+/-40	3.37	0.12	0.24	0.46
	+/-45	0.69	0.07	0.17	0.34		+/-45	5.06	-0.09	0.27	0.53		+/-45	3.37	0.14	0.33	0.65
	+/-50	0.69	0.05	0.17	0.33		+/-50	5.06	-0.06	0.26	0.51		+/-50	3.37	0.15	0.28	0.55
	+/-55	0.69	0.07	0.17	0.34		+/-55	5.06	-0.04	0.30	0.59		+/-55	3.51	0.16	0.27	0.53
	+/-60	0.66	0.12	0.18	0.36		+/-60	4.30	0.05	0.36	0.70		+/-60	3.51	0.19	0.36	0.70

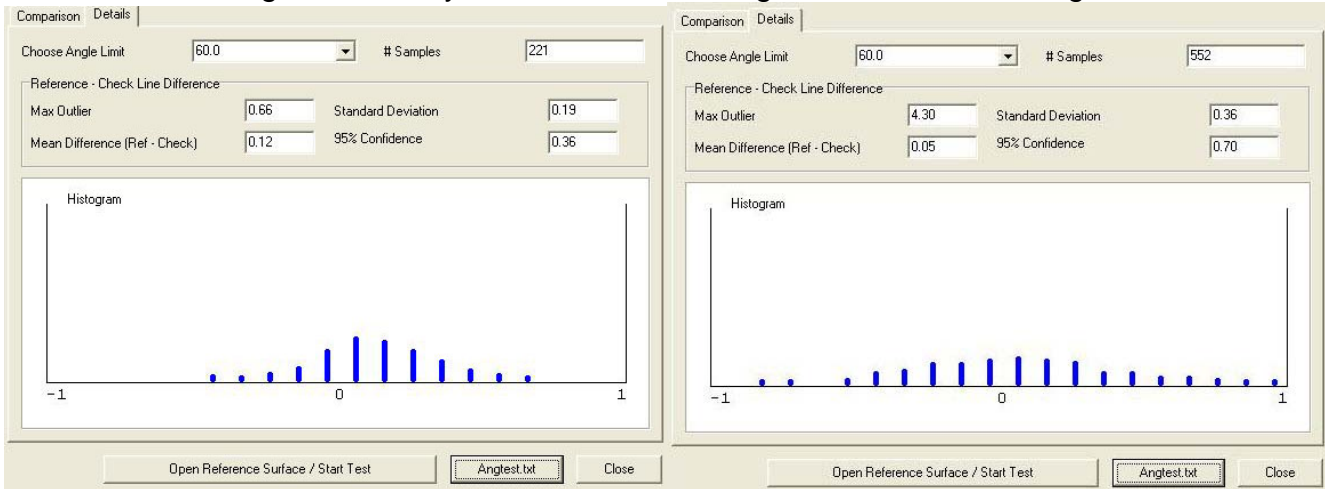
0603-1516	+/-20	4.72	-0.01	0.50	0.98	0603-1739	+/-20	1.11	0.00	0.23	0.45	0604-1204	+/-20	1.55	-0.07	0.22	0.44
	+/-25	4.16	0.00	0.38	0.74		+/-25	1.57	0.01	0.23	0.44		+/-25	1.55	-0.07	0.22	0.42
	+/-30	3.71	0.01	0.42	0.83		+/-30	1.57	-0.01	0.20	0.40		+/-30	1.93	-0.05	0.19	0.38
	+/-35	4.10	0.02	0.44	0.86		+/-35	1.57	0.02	0.19	0.37		+/-35	1.93	-0.06	0.20	0.39
	+/-40	4.10	0.01	0.50	0.99		+/-40	1.32	0.05	0.23	0.44		+/-40	1.80	-0.04	0.20	0.40
	+/-45	3.81	-0.01	0.43	0.84		+/-45	1.32	0.05	0.20	0.40		+/-45	1.80	0.00	0.22	0.43
	+/-50	4.00	0.00	0.35	0.69		+/-50	1.61	0.10	0.22	0.44		+/-50	1.81	0.02	0.21	0.42
	+/-55	4.00	0.07	0.36	0.71		+/-55	2.17	0.14	0.27	0.52		+/-55	1.81	0.00	0.24	0.47
	+/-60	3.97	0.03	0.40	0.78		+/-60	2.17	0.15	0.26	0.50		+/-60	2.33	0.02	0.25	0.49

0604-1556	+/-20	1.18	0.16	0.21	0.41
	+/-25	0.99	0.14	0.22	0.43
	+/-30	0.99	0.13	0.21	0.41
	+/-35	0.92	0.12	0.20	0.39
	+/-40	0.92	0.13	0.20	0.40
	+/-45	1.12	0.10	0.22	0.42
	+/-50	0.92	0.05	0.21	0.41
	+/-55	0.99	-0.06	0.24	0.46
	+/-60	0.99	-0.15	0.29	0.58

Beam Angle	Max. Outlier	Mean Diff.	Std Dev.	95%
+/-20	4.72	0.01	0.27	0.53
+/-25	4.16	0.01	0.25	0.48
+/-30	3.71	0.01	0.24	0.47
+/-35	4.39	0.02	0.24	0.47
+/-40	5.06	0.03	0.26	0.50
+/-45	5.06	0.04	0.26	0.52
+/-50	5.06	0.04	0.24	0.48
+/-55	5.06	0.05	0.27	0.52
+/-60	4.30	0.06	0.30	0.59

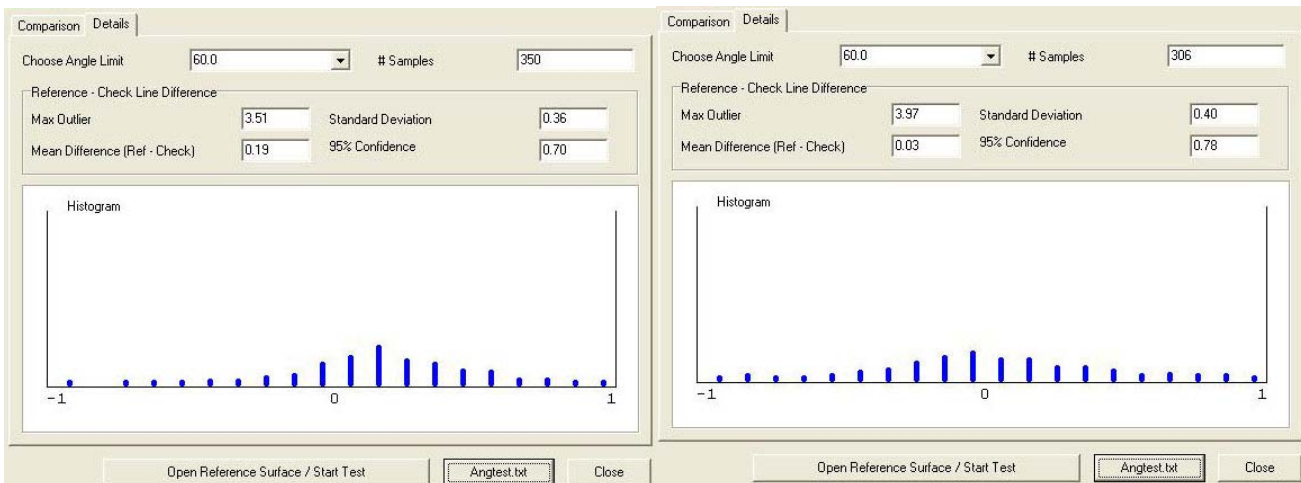
**Figure 4.1-1**

Plots of +/- 60 Deg. Beam Analysis Results for crossings 06/01 to 06/03 during HARS 2009 survey



Crossing 0601-1207

Crossing 0601-1503

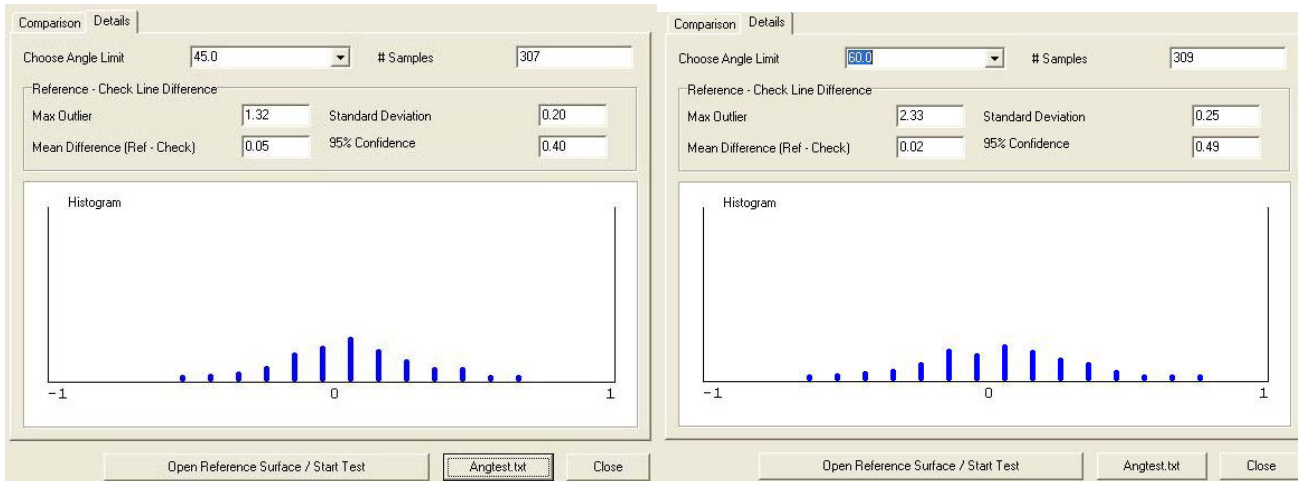


Crossing 0603-1209

Crossing 0603-1516

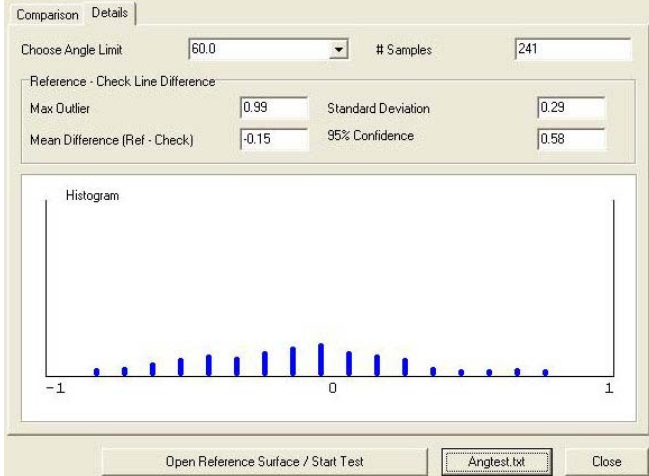
**Figure 4.1-2**

Plots of +/- 60 Deg. Beam Analysis Results for crossings 06/03 to 06/04 during HARS 2009 survey



**Crossing 0603-1739**

**Crossing 0604-1204**



**Crossing 0604-1556**