S-J977-KR-CC

NOAA FORM 76-35A
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

DATA ACQUISITION AND PROCESSING REPORT

Type of Survey: Hydrographic Single Beam & 100% Sidescan

Project Number: S-J977-KR-CC

Time Frame: Beginning May, 2006

LOCALITY

State: Mississippi

General Locality: Mississippi Sound

2007

CHIEF OF PARTY
Joseph Burke

LIBRARY & ARCHIVES

DATE: June 2007 Revision 1

NOAA FORM 77-28 (11-72)

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

PROJECT NUMBER: S-J977_KR-CC

HYDROGRAPHIC TITLE SHEET
Data Acquisition and Processing Report

Revision 1

FIELD NUMBER: Sheet B

State: Mississippi

General Locality: Mississippi Sound

Locality: Clermont Harbor to Grand Bay

Scale: 1:40,000 Date of Survey: Beginning May, 2006

Instructions Dated: September, 2006 Project Number: S-J977-KR-CC

Vessels: *Arlen, Beach Surveyor, High Roller, Hydro Surveyor, Inland Surveyor*

Chief of Party: Joe Burke, Scott Croft

Surveyed by: C & C Technologies

Soundings taken by echosounder, hand lead line, or pole: Odom Hydrotrac echosounder

Graphic record scaled by: N/A

Graphic record checked by: N/A

Protracted by: N/A Automated plot by: HP 1055 Plotter

Verification by: C&C Technologies Personnel

Soundings in: Feet: X Fathoms: ___ Meters: ___ at MLW: ___ MLLW: X

Remarks: Single Beam Debris Mapping Surveys
Data collection in meters, referenced to MLLW, later converted into feet
100% side scan sonar coverage
CST time
Grab samples
Tidal Zones and Correctors from NOS, CO-OPS

TABLE OF CONTENTS

A. EQUIPMENT

The major operational systems used to acquire hydrographic data include the Odom 200 kHz Hydrotrac single beam echosounder, GeoAcoustics side scan sonar systems, and Imaganex shark side scan sonars. PCs were used to collect onboard all vessels, as well as process all data at our Lafayette, LA office.

A.1 SURVEY VESSELS

Five separate survey vessels were used for data collection during this survey, the *Arlen*, *Beach Surveyor*, *High Roller*, *Hydro Surveyor*, and the *Inland Surveyor*.

The *Arlen* worked in the shallower sections of H11617 (sheet B), H11619 (sheet D), and H11638 (sheet F). The dates of survey for the *Arlen* are as follows:

Survey	Dates
H11617	Oct. 19 – Jan. 19
H11619	May 15 – Oct. 10
H11638	Jan. 24 – Feb. 3

The *Beach Surveyor* worked in the middle section of H11617 (sheet B). The dates of survey for the *Beach Surveyor* are as follows:

Survey	Dates
H11617	Nov. 10 – Dec. 6

The *High Roller* collected all of H11616 (sheet A), as well as large sections of H11617 (sheet B), H11618, (sheet C), H11619 (sheet D), and H11620 (sheet E). The dates of survey for the High Roller are as follows:

Survey	Dates
H11616	Dec. 14 – Feb. 7
H11617	Nov. 17 – Dec. 6
H11618	Oct. 14 – Nov. 14
H11619	Sept. 29 – Oct. 25
H11620	Feb. 8 – Feb. 27

The Hydro Surveyor worked in H11617 (sheet B), H11620 (sheet E), and H11638 (sheet F), as well as collecting investigation lines in all of the survey areas. The dates of survey for the Hydro Surveyor are as follows:

Survey	Dates
H11617	July 23 – Mar. 5
H11620	Feb. 26 – Feb. 27
H11638	Feb. 14 – Feb. 20

The *Inland Surveyor* worked in the eastern section of H11618 (sheet C). The dates of survey for the *Inland Surveyor* are as follows:

Survey	Dates
H11618	Oct. 14 – Nov. 14

Vessel diagrams and specifications are included in Appendix A. The diagrams show all offsets from the vessel center reference point to the antennas and to all survey equipment. The details of the vessels include registration numbers, capacity, and equipment.

A.2 SINGLE BEAM SONAR OPERATIONS

A hull mounted 200 kHz Hydrotrac single beam echosounder was installed on board all five survey vessels. Data from the Hydrotrac was continuously recorded and monitored in real-time. If any data displayed navigation or motion correction problems, that line was rerun.

A.3 SIDE SCAN SONAR OPERATIONS

The Imagenex Shark side scan sonar was in used in shallow water survey on board the *Arlen*. The side scan sonar was towed from the bow of the boat, such that the transducers were positioned directly beneath the GPS antennae.

A GeoAcoustics side scan sonar system was used to collect survey data on board the *Beach Surveyor*, *High Roller*, *Hydro Surveyor*, and the *Inland Surveyor*. On board the *Beach Surveyor*, *High Roller*, *Hydro Surveyor*, the towfish was towed from the bow of the vessel resulting in a negligible layback, with the exception of the *High Roller*, which has a –2.5 meter layback from the GPS antennae. The *Inland Surveyor* had both a towed and bow mounted configuration.

Depending upon the local conditions, survey operations were conducted at speeds averaging between 3 and 5.5 knots. The side scan sonars were operated at various range scales, with line spacing set between 30 and 65 meters depending upon the depth of the water. Confidence checks were performed a minimum of once a day.

Imagenex side scan collection software was used when collecting data with the Shark. Side Scan Sonar Chesapeake Technologies SonarWiz.MAP software was used when collecting with the GeoAcustics. SonarWiz.MAP was also used for the processing and target selection of the all side scan sonar data.

B. QUALITY CONTROL

B.1 SINGLE BEAM

Single beam data was monitored real time at all times during data collection. In addition, data was reviewed in Caris within 24 hours of its collection. If it was determined that any data quality issues were present, all lines affected would be noted and rerun.

B.2 SIDE SCAN

B.2.1 REVIEW PROCESS

All data was reviewed at least twice in the field. The side scan operator reviewed all data during collection and noted in the survey logs any significant features or surface/water column effects. Within hours of collection the data was reviewed for a second time by a geoscientist.

B.2.2 CONTACT SELECTION

As each line was reviewed sonar contacts were tagged and recorded. All contacts with shadows, or appeared to potentially be marine debris, were recorded. Numerous crab traps were seen in the data. In order to separate working crab traps from debris, the time a crab trap was seen and its range from nadir was logged by the side scan operator. All other existing infrastructure, such as aids to navigation and piers were noted in the logs, and only marked in the instance that they represented hurricane debris.

B.2.3 PROOF OF COVERAGE

As the geoscientist reviewed the data a mosaic was produced. Any gaps in coverage were noted, logged in the rerun log, and brought to the attention of the party chief.

For the coverage map requirement of the interim and final deliverables we submitted side scan sonar mosaics. These mosaics were generated in the field and served as another quality control tool. The mosaics were not only used for coverage but could be used to correlate contacts seen on adjacent lines. The mosaic images were also overlain with the nautical charts, sonar contact plot and bathymetry data to give a full picture of the survey area.

C. CORRECTIONS TO ECHO SOUNDINGS

C.1 INSTRUMENT CORRECTIONS

No instrument corrections were necessary.

C.2 VESSEL CONFIGURATION CORRECTIONS

Prior to survey operations, offsets to the antennas and other survey equipment were measured on board each survey vessel. Offsets were measured from the Central Reference Point (CRP) to all relevant points on the survey vessel (bow, stern, antennas, transducers, etc.) using traditional survey techniques incorporating plumb bobs, tape measures, and digital levels. On board the *High Roller* and the *Inland Surveyor*, the CRP was established as an arbitrary point along the central along track axis of the boat. On board the *Arlen*, *Beach Surveyor*, and *Hydro Surveyor*, the GPS antennae were used as the reference point.

The results of the vessel surveys are shown in diagram form in Appendix A.

C.3 STATIC AND DYNAMIC DRAFT CORRECTIONS

Frequent lead line comparisons to the measured single beam depth were used to verify, or correct as needed, the draft of all five survey vessels. Draft corrections were applied during collection of the data. The original lead line draft corrections, as well as any subsequent changes to the draft offset, are recorded in the boats survey logs. A Caris vessel file is provided for each survey vessel within the Caris project submitted in conjunction with this report. All vessel files contain a waterline of 0.0m, with the exception of the Beach and Hydro Surveyors. Due to errors applying draft corrections at the time of collection, the following waterline heights were applied in Caris:

Vessel	Date	Waterline Height
Beach Surveyor	Oct. 27, 2006 (2006-300)	0.2m
Hydro Surveyor	March 9, 2007 (2007-068)	0.15m (Applied only until 14:30 of this day)

C.4 VESSEL MOTION CORRECTIONS

TSS 335B motion compensators were utilized on board the *High Roller* and *Inland Surveyor*. TSS 320 heave compensators were used on board the *Beach Surveyor* and *Hydro Surveyor*. The *Arlen* did not have any motion correction applied to its single beam data.

C.5 SOUND VELOCITY CORRECTIONS

Sound velocity was measured and applied on a daily basis on board the *High Roller* and *Inland Surveyor* using Seabird SBE-19 CTD profiler serial number 1174. A sound velocity correction of 1500 m/s was applied to data collected on board all other vessels.

C.6 TIDE AND WATER LEVEL CORRECTIONS

Tidal correction data was downloaded from the NOAA website. NOAA CO-OPS supplied tidal zoning for the entire survey area. Three tidal gauges were used, gauge 8747437 at Bay Waveland Yacht Club, gauge 8745557 at Gulfport Harbor, and gauge 8741533 at the Pascagoula NOAA Lab.

No tidal zoning was provided for Bay St. Louis, in the Northern half of H11617. C&C Technologies created a new tidal zone, named CGM600, in order to correct for tidal offsets in Bay St. Louis. A time corrector of zero and range correction of one were applied in this zone. This zone was incorporated into a new .zdf file, named J977KR2007CC_CORP_rev, which can be found in the Caris project submitted in conjunction with the separate project reports.

Least depths in Biloxi Back Bay (H11638) were corrected using the Gulfport Harbor tidal gauge, with zero time or range corrections. It is the opinion of C&C Technologies that the application of this tidal corrector results in erroneous least depths of submerged features, and that these depths can not be considered reliable for navigation purposes.

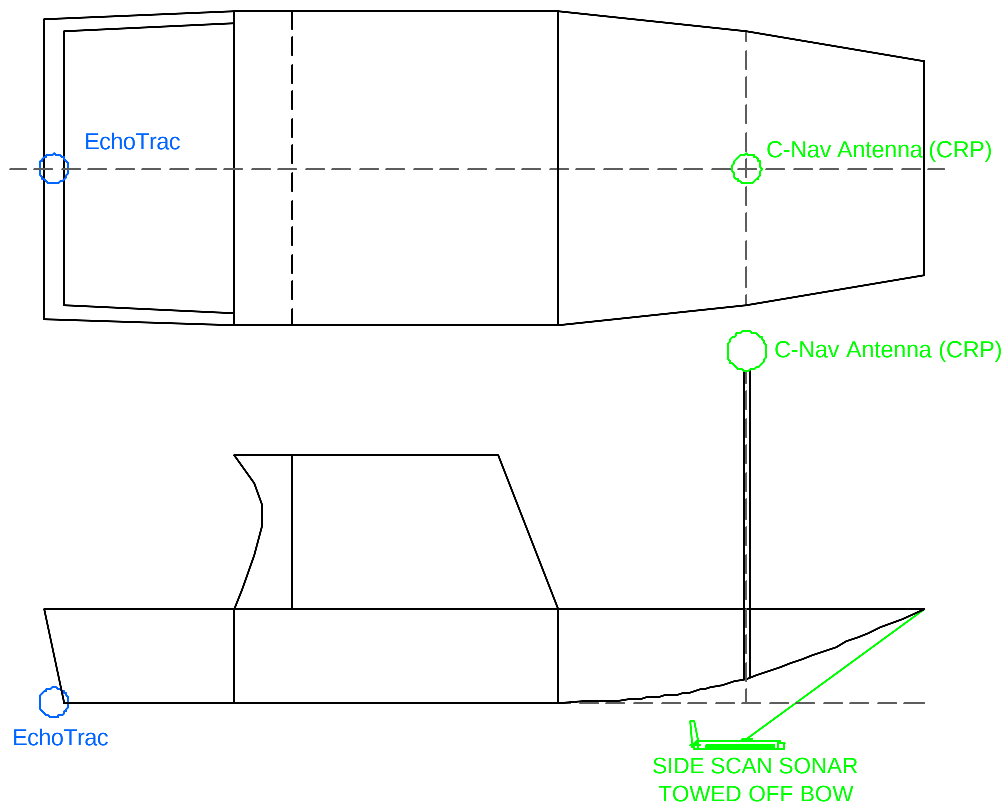
APPENDIX A - VESSEL DESCRIPTIONS

The *Arlen* is a 20-foot survey vessel. The vessel is 7 feet wide and has an approximate draft of 1.5 feet. The CNAV antennae were used as the central reference point for this vessel. A cleat on the forward deck of the boat was used as the side scan tow point. The relevant offsets are presented in the following table where X is positive forward, Y is positive starboard, and Z is positive down.

A Caris Hips vessel file with all of the correct offsets needed for importing single beam data collected by the *Arlen* has been included in the Caris projects submitted in conjunction with the separate surveys reports. All TPE values applied are also included in the vessels file.

	Hydrotrac Head	Side Scan Sonar Towpoint	CNAV Antennae
X Offset	-4.78 m	1.20 m	0.00 m
Y Offset	0.00 m	0.00 m	0.00 m
Z Offset	2.29 m	2.29 m	0.00 m

Arlen
Vessel Offset Diagram



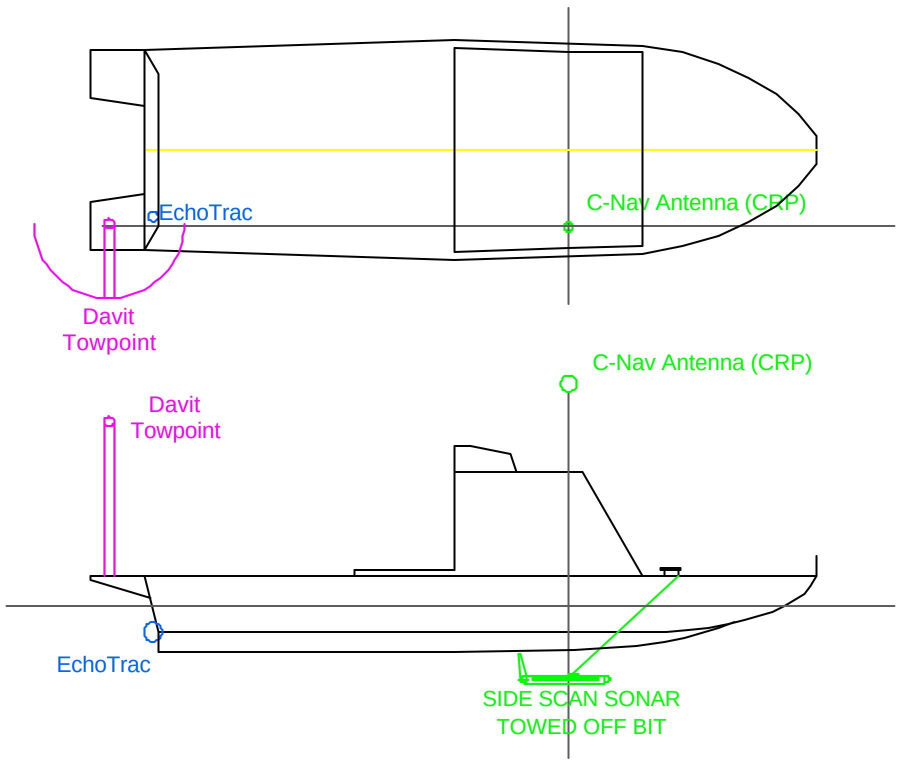
POINT	Forward +	Starboard +	Down +
C-Nav	0.00 m	0.00 m	0.00 m
EchoTrac	-4.78 m	0.00 m	2.29 m
Tow Point	1.20 m	0.00 m	1.63 m

The *Beach Surveyor* is a 25-foot survey vessel. The vessel is 7.6 feet wide and has an approximate draft of 1.5 feet. A central reference point (CRP) was established from which offsets to all equipment were measured. The relevant offsets are presented in the following table where X is positive forward, Y is positive starboard, and Z is positive down.

A Caris Hips vessel file with all of the correct offsets needed for importing single beam data collected by the *Beach Surveyor* has been included in the Caris projects submitted in conjunction with the separate surveys reports. All TPE values applied are also included in the vessels file.

	Hydrotrac Head	Side Scan Sonar Towpoint	CNAV Antennae
X Offset	-4.78 m	1.20 m	0.00 m
Y Offset	0.00 m	0.00 m	0.00 m
Z Offset	2.29 m	2.29 m	-2.38 m

R/V Beach Surveyor
Vessel Offset Diagram

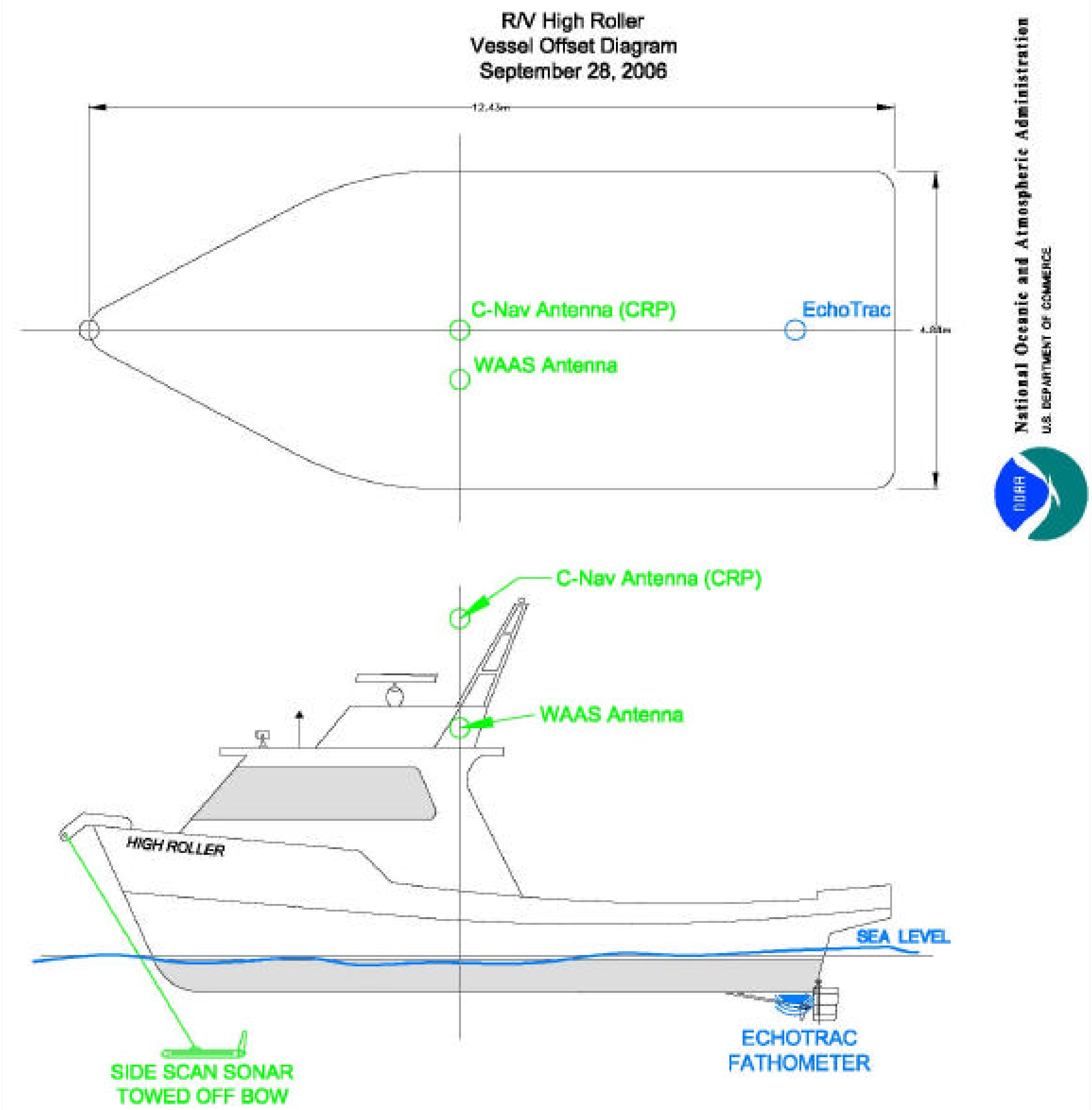


POINT	Forward +	Starboard +	Down +
C-Nav	0.00m	0.00m	-2.38m
EchoTrac	-4.44m	-0.11m	0.28m
Tow Point	1.17m	0.27m	-0.42m

The *High Roller*, a 41-foot Lafitte skiff, was used for hydrographic operations in Sheet A. The vessel is 16 feet wide and has an approximate draft of 2.6 feet. The CNAV antennae were used as the central reference point for this vessel. A cleat on the forward deck of the boat was used as the side scan tow point. The relevant offsets are presented in the following table where X is positive forward, Y is positive starboard, and Z is positive down.

A Caris Hips vessel file with all of the correct offsets needed for importing single beam data collected by the *High Roller* has been included in the Caris projects submitted in conjunction with the separate surveys reports. All TPE values applied are also included in the vessels file.

	Hydrotrac Head	Side Scan Sonar Towpoint	CNAV Antennae
X Offset	-5.18 m	5.72 m	0.00 m
Y Offset	0.00 m	0.00 m	0.00 m
Z Offset	0.67 m	3.34 m	-5.18 m



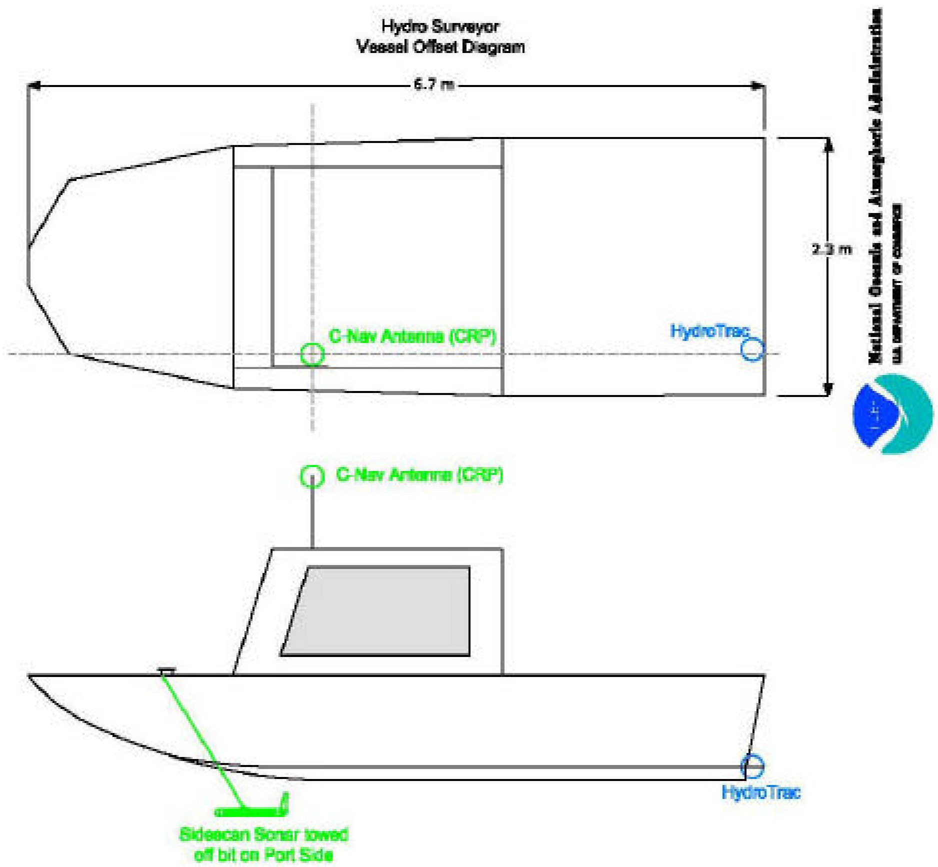
Offsets from CRP
(Water Level under C-Nav)

POINT	Forward (+)	Starboard (+)	Down (+)
C-Nav	0.00m	0.00m	−5.18m
WAAS	0.00m	−0.76m	−3.50m
EchoTrac	−5.18m	0.00m	0.67m
Bow (Sonar Tow)	5.72m	0.00m	

The *Hydro Surveyor* is a 22-foot survey vessel. The vessel is 7.5 feet wide, and has a draft of approximately 1.2 feet. The CNAV antennae were used as the central reference point for this vessel. A cleat on the forward deck of the boat was used as the side scan tow point. The relevant offsets are presented in the following table where X is positive forward, Y is positive starboard, and Z is positive down.

A Caris Hips vessel file with all of the correct offsets needed for importing single beam data collected by the *Hydro Surveyor* has been included in the Caris projects submitted in conjunction with the separate surveys reports. All TPE values applied are also included in the vessels file.

	Hydrotrac Head	Side Scan Sonar Towpoint	CNAV Antennae
X Offset	-4.00 m	1.37 m	0 m
Y Offset	0.00 m	0.00 m	0 m
Z Offset	2.61 m	1.78 m	0 m



Offsets from CRP

POINT	Forward (+)	Starboard (+)	Down (+)
C-Nav	0.00 m	0.00 m	0.00 m
EchoTrac	-4 m	0.00 m	2.6 m
Sonar Tow	1.4 m	1.8 m	1.8 m

The *Inland Surveyor* is a 26-foot survey vessel. The vessel is 9.6 feet wide and has an approximate draft of 1.5 feet. A central reference point (CRP) from which offsets to all equipment were measured was established at the waterline below the primary CNAV GPS. In an effort to minimize motion errors, the transducer was moved from the bow of the boat to its stern on October 20, 2006. The relevant offsets are presented in the following table where X is positive forward, Y is positive starboard, and Z is positive down.

A Caris Hips vessel file with all of the correct offsets needed for importing single beam data collected by the *Inland Surveyor* has been included in the Caris projects submitted in conjunction with the separate surveys reports. All TPE values applied are also included in the vessels file.

	Hydrotrac Head Pre Oct. 20	Hydrotrac Head Post Oct. 20	Side Scan Sonar Towpoint	CNAV DGPS Antennae
X Offset	0 m	-7.75 m	5.72 m	0 m
Y Offset	0 m	0.055 m	0m	0 m
Z Offset	Variable	Variable	N/A	

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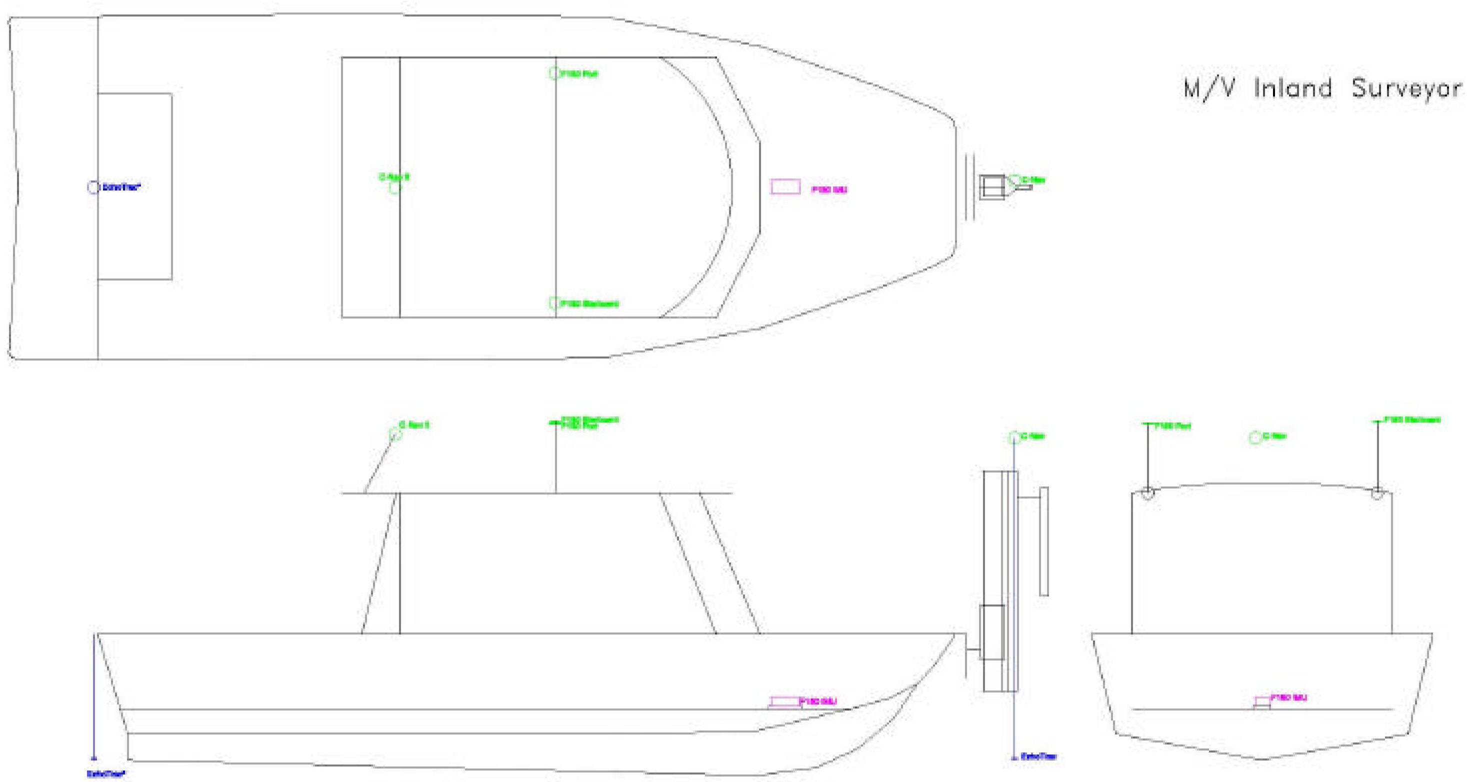
SURVEY SERVICES



POINT	Forward +	Starboard +	Down +
C-Nav	0.00m	0.00m	
C-Nav 2	-5.18m	0.00m	
EchoTrac	0.00m	0.00m	Variable
EchoTrac*	-7.75m	0.055m	Variable

*EchoTrac moved to stern on Oct 20, 2006.
CRP is at water level under Primary C-Nav on Bow Ram.

C&C Technologies
SURVEY SERVICES

National Oceanic and Atmospheric Administration
U.S. DEPARTMENT OF COMMERCE

APPENDIX B – EQUIPMENT DESCRIPTIONS

ODOM HYDROTRAC ECHOSOUNDER

The HYDROTRAC echo sounder by ODOM Hydrographic Systems, Inc. can collect analog paper records as well as digitized depth information for output to a data logger. Digital depth data can be logged directly to the navigation computer along with date, time, and position for later post processing and mapping. The system includes a recording unit with built in digitizer and transceiver, and a side mountable transducer. The unit utilizes a combination of dynamic gating and velocity fit to track the true bottom through advanced microprocessor technology, solving the normal problems associated with conventional depth sounders. For example, if the "fixed gate" mode is activated, signal digitizing can be restricted to a user-defined range, rejecting unwanted returns during bar-check calibrations.

The acoustic pulse is generated with the Model OHS 200/9 transducer, which operates at single frequency of 200 kHz with a beam width of 9°. This system is very much similar to ODOM ECHOTRAC SF3200, except that ECHOTRAC has capabilities of operating on dual frequencies of 24 and 200 kHz. The shipboard transceiver automatically adjusts power output in proportion to the return signal yielding a clear, unambiguous record in shallow as well as deep water. The self-adjusting power varies from 1 to 225 watts at 200 kHz. Return signals are optimized by Time Varied Gain (TVG) and Automatic Gain Control.

A thermal paper recording is printed in real-time where automated scale changes prevent the bottom from "running" off the chart. Scale widths are selectable in meters, 2 to 1,000, or feet, 10 to 3,000; however, routine operating scales are 10 to 100 feet. Key system parameters, i.e. velocity of sound, draft, and time, are input from the recorder's front panel. A tide correction may be introduced without altering the analog record in any way. A line is added to the chart to indicate where the bottom would be if corrected for water level.

Recording resolutions of the HYDROTRAC, ranging from 8 mm to 4 meters dependent upon the selected scale width, permit detailed assessments of local water depths. Reference to a tidal datum permits the evaluation of navigable waterways, subsidence and scour features around seafloor based structures, and pre/post dredging or construction water bottom conditions.

Specifications:

Frequency	200 kHz
Output Power	500 Watts
Power Requirement	11-28 VDC
	110/220 VAC (Optional)
Ports	RS 232

GEOACOUSTICS SIDE SCAN SONAR

The GeoAcoustics Side Scan Sonar System is an industry standard high-resolution search and survey instrument designed both object location and the study of sea floor geology. The GeoAcoustics Side Scan Sonar System employs a surface based Model SS981 Transceiver and Model 159 Tow Vehicle with two Model 196D Transducers and a Model SS982 Sub-surface Electronic bottle. A real time data acquisition and processing system can be used to provide high-resolution graphics, digital data storage, and imaging processing. The system offers frequency operation modes of low frequency (114 kHz) and a high frequency (410 kHz).

The GeoAcoustics dual frequency Side Scan Sonar system is a multiplexed system. All power, control signals and received sonar signals as well as optional data telemetry are multiplexed onto a standard armored single coaxial cable, which also act as the tow-cable. This simplified tow-cable configuration virtually eliminates cross talk between channels.

The Deck Unit is used to control and condition the signals from the tow-fish. With the addition of a thermal paper recorder the data can be printed out in real time.

The compact subsea electronic pressure vessel (GeoAcoustics Model No. SS982) contains side scan sonar transmitter and receiver modules. It can be fit onto the standard GeoAcoustic 159 side scan tow-fish or on a standard profiler tow-fish when used as part of a combined side scan and profiler system. The port and starboard side scan transducer units are fitted on either side of the tow-fish. Each tow-fish contains two arrays operating at either 114 kHz or 410 kHz. These side scan transducers convert electronic energy to acoustic signals of high intensity. These acoustic signals travel through the water at approximately 1500 ms-1 until they reach the seabed, where some of the energy is returned back to the transducers. This acoustic return energy is converted by the same transducer to a much lower voltage electronic signal which is accepted by the receiver electronics and processed using time varied gain (TVG) and then converted to separate frequencies and transmitted back to the surface unit.

Specifications:

Transceiver – Model SS981:

General

Power requirements	110/240 VAC switchable, 40-60 Hz, 50 W, optional 24 VDC.
Size	43.2 cm W x 45.7 cm D x 18.7 cm H.
Weight	16 kg.
Temperature Storage:	-20 to 75 °C Operating: -5 to 50 °C.
Humidity	10% to 95% RH, non-condensing.
Mounting	The unit is suitable for either bench or rack mounting.

Operating Specification

Power output to tow vehicle 150 VDC ±3 VDC, 100 mA average, 320 mA peak.

Key burst out 455 kHz, pulse width selectable 16 Vpp, PRR determined by key source.

Key input Positive CMOS or TTL, 10 kW input impedance.

Receivers

Modulation frequency Port 135 kHz, Starboard 65 kHz.
Bandwidth 15 kHz.

Sensitivity 6 mV rms input produces 800 mV rms output with a 20 dB signal-to-noise ratio (all gain maximum).

Input impedance 5 k W .
Output impedance 600 W on all outputs.

Dynamic range Gain: adjustable over 60 dB range. TVG: -20 to +20 dB maximum AGC: -34 dB maximum.

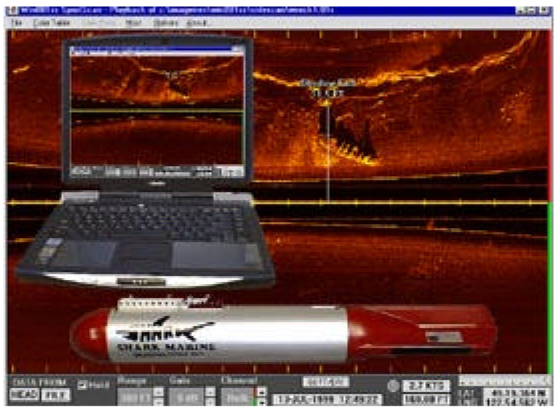
Output Selectable signal envelope or amplitude modulated 12 kHz.
TVG delay 3.3 ms minimum, 330 ms maximum.

Event mark 5 Vpp, 12 kHz, front panel push button or BNC input requiring CMOS or TTL level pulse. Produces visual mark on recording media.

Key out	0.6 ms CMOS/TTL compatible.
Modes	100 kHz and 500 kHz operation. Raw signal and processed signal.

Imagenex Side Scan Sonar

Product Specifications



SportScan Side-scan Sonar

Never before have so many high-end features in a high resolution digital Side-Scan Sonar been offered at such an affordable price. This system, designed by one of the worlds leaders in high-resolution sonar imaging rivals systems costing many times the price. The quality, detail and ease of use of this Side-Scan Sonar truly has to be seen to be appreciated. This side-scan sonar is available in single Frequency (330 kHz), and dual frequency (330 and 800 kHz), The small size of this system provides the utmost in portability.

Specifications:

Towfish Construction:	Molded Polyurethane and anodized aluminum	
Ballast:	Standard diver belt weights (available at dive stores)	
Balance:	By moving the tow yoke to a balance point.	
Transducers:	Single Frequency: 2x330 kHz -Beam 1.8x60	Dual Frequency: 2x330kHz -Beam 1.8x60 2x800 kHz - Beam .7 x 30
Range:	15,30,60,90,120 metre (50,100,200,300,400 feet)	
Towfish Depth:	30 metre (100 feet) Maximum	
Power:	12 Volts DC at 500 mA	
Communication:	RS-232C serial interface	
Software:	Included for Windows 95/98/ME/XP/2000	
Dimensions:	11.4 cm (4.5") diameter X 83.3 cm (32.8") long	

Cable:	7mm (.3") diameter x 22.8m (75ft) standard 60 m (200ft) optional. 45 kg (1000) lb break strength
Weight:	Towfish: 4.5 kg (10 lb.) without weights Standard Cable: 1.7 kg (3.8lb.)
Computer:	Pentium 100MHz or better (not included)
Display Colours:	Colour, Grayscale, Reverse Grey, Yellow/Brown

TSS 335B Compensator

The TSS 335 is a stand-alone sensor providing accurate real-time measurement of heave, roll and pitch. Designed originally to compensate soundings and profiling, it has found many other applications: compensation for fansweep sounders, vertical reference for positioning systems, flight deck motion indication, input for compensated winches and cranes, analysis of vessel/platform motion and deck movement, indication to subsea vehicles and correction for GPS antenna movement.

Additional features allow the TSS 335 sensors to: calculate motion data in remote positions (keel, stern, bridge etc), provide delayed data and a quality control facility, present heave-roll-pitch data on a simple computer generated graphical display and measure roll-pitch mount angles. The TSS 335 incorporates its own processing capabilities. However, the addition of angular accelerometers gives improved performance in the presence of large horizontal accelerations. This makes it suitable for small vessel and rough water operations. It is enabled to be utilized across a wide range of applications.

TSS 335B HEAVE COMPENSATOR - SPECIFICATIONS	
Size	160 x 370 mm
Weight	8.0 kg
Finish	HAM
Real-Time Operation	Yes
I / F with any Echosounder	Yes
Internal Digitizer	Yes
BCD Input / Output	Yes
IEEE-488 (GP-IB)	Yes
Analogue Output	Yes
Trigger Input / Output	Yes
Digital 20mA l.Current Loop	Optional
Heave Output	Yes
Roll and Pitch Outputs	Yes
Surge and Sway Outputs	Yes
Small Boat Compatible (< 10m)	Yes

Horizontal Acceleration Immunity		Yes
Heave:	**Range** **Period** **Accuracy**	± 10 m 1-20 sec 5% / 5 cm
Roll/Pitch:	**Range** **Dynamic Accuracy** **Static Repeatability**	± 30° 0.15° 0.01°
Day Rate		21 / sec

SEABIRD SEACAT 19 CTD PROFILER

The Seacat SBE 19-01 Profiler, from Sea-Bird Electronics, Inc., measures electrical conductivity and temperature versus pressure (depth) in marine environments to depths up to 6,800 meters (22,309 feet). The maximum sampling rate is 2 scans per second. Self-powered and self-contained, the SBE 19 features proven Sea-Bird conductivity and temperature sensors and a precision semiconductor strain-gauge pressure transducer. A 64-kilobyte solid-state memory allows 1.5 hours of recording (6 hours with optional 256-kilobyte memory) while sampling at two scans per second. Set-up, checkout, and data extraction are performed without opening the housing. Simultaneous real time monitoring is possible using the Seacat Profiler's two wire RS-232C transmit capability. Sea-Bird's powerful Seasoft CTD software derives salinity, density, sound velocity, and other ocean parameters from stored CTD (conductivity, temperature, depth) and may be used for data analysis, plotting and archival. Small external sensors may be powered and their frequency or voltage outputs acquired by the SBE 19.

Seacat Profiler options include 1) aluminum housings for use to 3,400 or 6,800 meters; 2) 256 kilobyte memory; 3) an extra bulkhead connector for auxiliary inputs; 4) SBE 5 submersible pump for pumped conductivity; 5) an opto-isolated junction box for supplying power and interconnecting Seacat Profiler and a companion computer which is necessary when using the Profiler in real-time mode.

Use of conductivity, temperature, and depth measurement for determination of sound velocity is appealing because these instruments are simpler and more rugged and because resolution, accuracy, and stability lead to better precision than can be obtained with direct sound velocity measuring devices. Three equations are widely used for deriving sound velocity from CTD data (Wilson, 1959; Del Grosso, 1972; Millero and Chen, 1977). Absolute sound velocities derived from these equations differ on the order of .5 meter/second for various combinations of water temperature, salinity, and pressure. The work of Millero and Chen is the most modern and builds upon and attempts to incorporate the work of the earlier investigators. Millero and Chen's 1977 equation is used in the Sea-Bird Seasoft software, and is the one which is endorsed by the Unesco/SCOR/ICES/IASPO Joint Panel on Oceanographic Tables and Standards which comprises the internationally recognized authority for measurements of ocean parameters.

C-NAV DIFFERENTIAL GPS

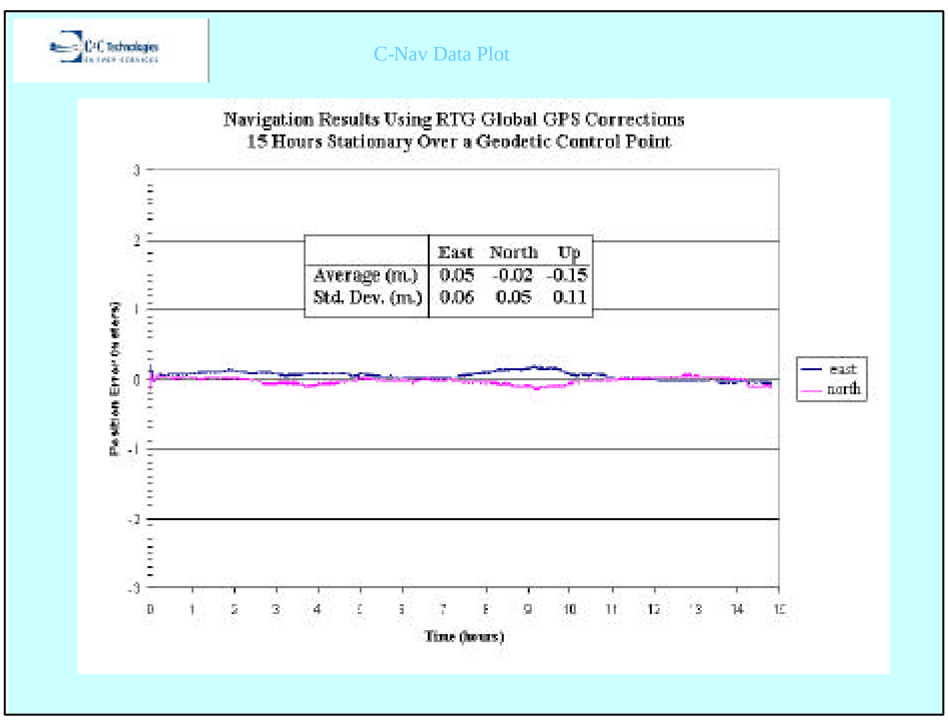
C-Nav is a globally corrected differential GPS system owned and operated by C & C Technologies, Inc. The C-Nav GPS Receiver combines a dual-frequency, geodetic grade, GPS Receiver with an integrated L-BAND communication RF detector and decoder all linked by an internal microprocessor. C-Nav uses monitoring stations strategically located around the globe to provide worldwide accuracies in the order of 0.10cm (1 sigma)*.

The technique, developed by the Jet Propulsion Lab for the National Aeronautics Space Administration, uses a global network of reference stations to track the entire constellation of GPS satellites. The raw GPS observations are transmitted via the Internet back to the Network Control Center where the GPS constellation satellite orbital corrections and clock-offset values are calculated and modeled in real-time. These corrections are universally valid and can be applied to GPS measurements from any location on earth.

The multi-function antenna assembly is capable of receiving the L1 and L2 GPS frequencies as well as the Inmarsat L-BAND receive frequency band. The gain pattern of this antenna is designed to be relatively constant even at lower elevations. This allows for an efficient link budget when the unit is operated at higher latitudes where the elevation of the geo-stationary communication satellite is low and close to the horizon. Atmospheric delays are eliminated from local measurements by comparing the L1 and L2 frequencies in the internal GPS receiver.

The C-Nav GPS System provides an output of RTCM (Type 1) pseudorange differential correction messages via a second RS232 interface. Raw GPS observation information can be collected from the C-Nav GPS Receiver system for recording and analysis. The raw GPS observation information can be converted to RINEX ASCII data (observation and navigation) file format as and when required.

The C-Nav GPS Receiver requires at least four (4) usable GPS satellites to compute a three dimensional (3D) solution. The C-Nav GPS Receiver will yield an autonomous horizontal position accuracy of 2 to 5 meters (1 sigma), depending on the GPS satellite geometry configuration and tracking (DOP index values).



Receiver Specifications:

Features

- Real-time sub meter accuracy
- Single integrated package – simple installation
- Rugged, waterproof housing
- Wide-range (10-40VDC) power supply
- RTCM and NMEA {GGA, GSA, RMC, VTG, ZDA) outputs
- Patented multipath mitigation significantly reduces noise
- Geodetic quality dual frequency GPS virtually eliminates ionospheric effects

Performance

- L-band receiver frequency
- Automatically selected 1525 to 1560 MHz
- GcGPS Accuracy:
  Position (H): <10cm
  Position (V): <30cm
  {1–sigma and HDOP = 1}
  Velocity <0.02m/s
- Time to first fix: Cold Start: 90 sec(typical)
- Reacquisition
  Coast for 30 sec with GPS lock <2sec
  L-band loss with less than 30 sec with GPS lock <30 sec

Physical/Environmental

- Size: 9.8 in (H) x 7.2 in (D) (24.8 x 18.7 cm)
- Weight: 5.5 lbs (2.4 kg)
- Power: Input voltages: 10-40 VDC
  Consumption: <10W average power
  1.2 A max @12 VDC
- I/O Connector 8 pin waterproof connector
- Temperature: Operating: -20°C to +70°C
  Storage: -40°C to 85°C
- Humidity: 100% non-condensing

Display Unit Specifications:

Features

- 4 x 20 character LCD screen
- 12 key membrane button input pad
- Rugged, stainless steel housing
- Wide-range (20-40VDC) power supply
- RTCM and NMEA and raw data outputs

Physical/Environmental

- Size: 9.6 in (L) x 6.7 in (W) x 3.3 in (H) (24.4 x 17.0 x 3.3 cm)
- Weight: 3.8 lbs (1.75 kg)
- Power: Input voltages: 12-40 VDC
  Consumption: <1W average power
  100 mA max @28 VDC typical
- I/O Connectors: 3 db-9, 1 cat-5 and 1 8 pin waterproof connector
- Temperature: Operating: -20°C to +70°C
  Storage: -40°C to 85°C
- Humidity: 100% non-condensing

APPENDIX C – CALIBRATION RECORDS

LETTER OF APPROVAL

Data Acquisition and Processing Report

S-J977-KR-CC

This report is respectfully submitted.

Field operations contributing to the accomplishment of this survey were conducted under my direct supervision between the dates of May 2006 – March 2007 with frequent personal checks of progress and adequacy. This report has been closely reviewed and is considered complete and adequate as per the Statement of Work.

Joseph Burke

Chief of Party

C&C Technologies

June 2007