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SITE INSPECTION WORK PLAN AND MUNITIONS AND EXPLOSIVES OF CONCERN QUALITY ASSURANCE PROJECT PLAN FOR UNEXPLODED ORDNANCE SITE UXO 3 MUNITIONS LOADING PIERS NWS YORKTOWN VA

12/1/2013

CH2M HILL

MEC-QAPP Worksheet #1—Title and Approval Page

Final

Site Inspection Work Plan and Munitions and Explosives of Concern Quality Assurance Project Plan UXO-0003 Munitions Loading Piers

Naval Weapons Station Yorktown
Yorktown, Virginia

Contract Task Order WE03

December 2013

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN Program 8012
Contract N62470-11-D-8012

Prepared by

CH2MHILL

Virginia Beach, Virginia

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Approval Signatures

12/3/13

Jim Gravette
United States Navy Remedial Project Manager

12/8/13

Moshood Oduwole
USEPA Remedial Project Manager

12/09/2013

Wade Smith
VDEQ Remedial Project Manager

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Executive Summary

This Site Inspection (SI) Work Plan and Munitions and Explosives of Concern (MEC) Uniform Federal Policy (UFP) – Quality Assurance Project Plan (QAPP), herein referred to as the MEC-QAPP, has been prepared in support of SI field activities at Site Unexploded Ordnance (UXO)-0003 (UXO 3) Munitions Loading Piers, Naval Weapons Station (WPNSTA) Yorktown, in Yorktown, Virginia. It outlines the approach and procedures for conducting the SI to support the determination of whether there has been a release of MEC to the underwater environment at the site. The SI is not intended as a full-scale study of the nature and extent of contamination or explosives hazards; rather, it is being conducted to assess whether there is a potential presence of MEC at the site. The activities conducted through this investigation do not address munitions constituents (MC). If MEC is found to be present in the investigation areas, subsequent investigations, including MC sampling, may be necessary to assess the nature and extent of impacts to the environment.

UXO 3 consists of the current and former piers and pier areas along the shoreline of the York River, comprising approximately 289 acres of water. The areas of concern at UXO 3 include former Pier R-1 (operational from 1920 to the 1970s), which also included Structure R-2 (a small boat landing) and Pier R-3 (operational from 1941 to the present) berthing areas and associated sediment, where munitions-handling activities have historically occurred. The currently operational Pier R-3 includes approximately 6,400 linear feet of standing concrete pier. Adjacent to Pier R-3, remnants of the former wooden pier (Pier R-1) remain beneath the water surface. Structure R-2 is depicted in historical drawings as a small boat landing that was attached to the trestle area of Pier R-1.

This SI is being conducted as a follow-up to the 2013 Preliminary Assessment (PA) (CH2M HILL, 2013). Although documentation of a release of MEC was not identified during the PA, the potential exists for MEC to be present at UXO 3 as a result of undocumented releases during historical loading operations. Active pier sites used for munitions-related activities are typically not investigated until munitions activities have ceased or unless the site is suspected of causing contamination at other areas. Therefore, as recommended by the PA, SI activities at Pier R-3 will be deferred until munitions loading operations in this area have ceased. The PA recommended that an SI be performed for former Pier R-1 to further evaluate the potential presence or suggested absence of MEC in that portion of UXO 3. There is little information available regarding the history of Structure R-2, and no documentation of munitions handling at Structure R-2 was identified during the PA. However, recent anecdotal evidence indicates that small arms and small munitions may have been loaded in this area. Therefore, although it was not included in the PA, this area will be included in the Pier R-1 SI investigation activities as a conservative measure.

This MEC-QAPP provides the approach for conducting a two-phased SI investigation around Pier R-1 and Structure R-2. The Phase I investigation will consist of collecting acoustic (side-scan and multibeam [bathymetric] sonar) and digital geophysical mapping (DGM) survey data in the area adjacent to Pier R-1 and Structure R-2. The Phase II investigation will consist of conducting anomaly inspections to determine whether the sources of select geophysical anomalies around Pier R-1 and Structure R-2 are MEC[1]. Side-scan sonar is intended to image discrete targets proud of (that is, sitting on top of or protruding from) the riverbed sediment surface and provide the location of potential underwater navigational obstructions that may affect future investigations. The bathymetric survey is intended to further characterize riverbed topography and features for navigating DGM equipment as specified in this MEC-QAPP. DGM is intended to identify geophysical anomalies in the vicinity of Pier R-1 and Structure R-2 that may be indicative of potential MEC. The need for Phase II is anticipated but not certain, and its details (if needed) would be based on the data collected during Phase I. Therefore, the concept of the Phase II investigation activities is presented herein, and if it is confirmed that Phase II is warranted, an addendum to this MEC-QAPP will be provided to detail the selected anomaly inspection technology and the number and locations of

[1] For the purpose of consistency with previous documents, the term MEC is used throughout this document but its use primarily refers to discarded military munitions, which is the sub-category of MEC of direct interest at the site.

geophysical anomalies requiring inspection (to be identified in conjunction with project stakeholders during subsequent scoping and planning stages). Data from this investigation will be used to assess the potential presence of MEC at the site and to identify areas of the site where MEC is not likely present (areas that may be free of geophysical anomalies).

This MEC-QAPP is intended to serve as the primary work-planning document for the SI. It serves as a guideline for the field activities and data quality assessment. Applicable standard operating procedures (SOPs) are included in **Appendix A**. This MEC-QAPP was developed in accordance with the following guidance documents:

- *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS* (USEPA, 2002)
- *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)* (USEPA, 2005)
- *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)

This document consists of worksheets based on the UFP Sampling and Analysis Plan format designed specifically for chemical sampling. Worksheets deemed not applicable to this MEC-QAPP format have either been modified to meet the intent of the worksheet with respect to MEC, or excluded. Figures are included at the end of worksheets, where applicable.

Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic is conducting this SI in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act investigation process. This site has been identified under the Department of the Navy (Navy) Munitions Response Program (MRP). The United States Environmental Protection Agency (USEPA) is the lead regulatory agency and the Virginia Department of Environmental Quality (VDEQ) is the support regulatory agency. This MEC-QAPP will help make sure that data collected or compiled are scientifically sound, of known and documented quality, and suitable for their intended uses. The SI activities are being performed under NAVFAC Contract Number N62470-11-D-8012, Contract Task Order WE03.

MEC-QAPP Worksheets

Appendixes

* SOP will be provided by the subcontractor upon award

Tables

Figures

Abbreviations and Acronyms

3-R	Recognize, Retreat, Report
AM	Activity Manager
AQM	Activity Quality Manager
CA	corrective action
CLEAN	Comprehensive Long-term Environmental Action—Navy
cm	centimeter
CONUS	Continental United States
CSM	conceptual site model
DFOW	definable feature of work
DGM	digital geophysical mapping
EM	electromagnetic
EOD	Explosive Ordnance Disposal
ESS	Explosives Safety Submission
ESS-DR	Explosives Safety Submission Determination Request
FEAD	Facility Engineering and Acquisition Division
FP	Follow-up Phase
FTL	Field Team Leader
GIS	geographic information system
GPS	global positioning system
H&S	health and safety
HSO	Health and Safety Officer
IP	Initial Phase
MC	munitions constituents
MEC	munitions and explosives of concern
MLW	mean low water
MPC	measurement performance criteria
MR	Munitions Response
MRP	Munitions Response Program
MRSIMS	Munitions Response Site Information Management System
NAD	North American Datum
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
PA	Preliminary Assessment
PAL	project action limit
PDF	portable document format
PDL	Project Delivery Lead
PM	Project Manager
POC	point of contact
PP	Preparatory Phase
PQO	project quality objective
QA	quality assurance

QAPP	Quality Assurance Project Plan
QC	quality control
ROV	remotely operated vehicle
RPM	Remedial Project Manager
RTC	Response to Comments
SI	Site Inspection
SOP	standard operating procedure
SSC	Site Safety Coordinator
STC	Senior Technical Consultant
SUXOS	Senior Unexploded Ordnance Supervisor
TBD	to be determined
TIFF	tagged image file format
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
UXO	unexploded ordnance
UXO-0003	Site Unexploded Ordnance 3
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VDEQ	Virginia Department of Environmental Quality
WPNSTA	Naval Weapons Station

MEC-QAPP Worksheet #2—QAPP Identifying Information

Site Name/Number: Site Unexploded Ordnance (UXO)-0003 (UXO 3) Munitions Loading Pier, Pier R-1 and Structure R-2

Operable Unit: Not Applicable

Contractor Name: CH2M HILL

Contract Number: N62470-11-D-8012, Contract Task Order WE03

Contract Title: Comprehensive Long-term Environmental Action—Navy (CLEAN) 8012

1. **This Quality Assurance Project Plan (QAPP) was prepared in accordance with the requirements of the following documents:**
   - *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS* (USEPA, 2002)
   - *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)* (USEPA, 2005)
   - *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006)
2. **Identify regulatory program:**
   - Comprehensive Environmental Response, Compensation, and Liability Act of 1980
3. **This is a project-specific QAPP for:**
   - Site Inspection (SI) activities for the former Pier R-1 and Structure R-2 area of UXO 3 at Naval Weapons Station (WPNSTA) Yorktown.
     - Phase I Investigation – Site Survey (includes acoustic [side-scan sonar and bathymetric] and digital geophysical mapping [DGM] surveys).
     - Phase II Investigation - Inspection of select geophysical anomalies, if warranted.
4. **List dates of scoping sessions that were held:**

Scoping Session	Date
Partnering Team Meeting – May 2013	05/21/13
Partnering Team Meeting – August 2013	08/08/13

5. **List dates and titles of any QAPP documents written for previous site work that are relevant to the current investigation.**

Title	Author/Date
None	

MEC-QAPP Worksheet #2—QAPP Identifying Information (continued)

6. List organizational partners (stakeholders) and connection with lead organization:

- State Regulatory Agency: Virginia Department of Environmental Quality (VDEQ)
- Federal Regulatory Agency: United States Environmental Protection Agency (USEPA)
- Lead organization: Department of the Navy (Navy)

7. If any required QAPP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted QAPP elements and provide an explanation for their exclusion as follows:

The worksheets that are not applicable to the Munitions and Explosives of Concern (MEC) format of the Uniform Federal Policy (UFP) for QAPPs are as follows: **Worksheets #15, #19, #20, #23-28,** #**30**, and #**36**. These worksheets have been excluded because they pertain to environmental samples that are collected from a site and sent to an analytical laboratory, which is not part of the SI scope of work. Worksheets that were not applicable to this MEC UFP-QAPP (MEC-QAPP) are listed as "excluded" in the following table and are not included in the document. Where appropriate, an explanation for exclusion of a worksheet has been included. Additionally, if it is anticipated that a worksheet will require updating to complete Phase II activities, if warranted, an explanation has also been included in the comment column.

UFP-QAPP Worksheet #	Required Information	Included or Excluded	Comment
A. Project Management			
Documentation			
1	Title and Approval Page	Included	
2	Table of Contents QAPP Identifying Information	Included	
3	Distribution List	Included	Will be updated in QAPP Addendum, as appropriate, to identify Phase II project personnel
4	Project Personnel Sign-Off Sheet	Included	Will be updated in QAPP Addendum, as appropriate, to identify Phase II project personnel
Project Organization			
5	Project Organizational Chart	Included	Will be updated in QAPP Addendum, as appropriate, to identify Phase II project personnel
6	Communication Pathways	Included	Will be updated in QAPP Addendum, as appropriate, to identify Phase II project personnel
7	Personnel Responsibilities Table	Included	Will be updated in QAPP Addendum, as appropriate, to identify Phase II project personnel
8	Special Personnel Training Requirements Table	Included	
Project Planning/Problem Definition			
9	Project Scoping Session Participants Sheet	Included	Additional scoping sessions will be included in the QAPP Addendum as needed
10	Conceptual Site Model (CSM)	Included	
11	Project Quality Objectives (PQOs)/Systematic Planning Process Statements	Included	Will be updated in QAPP Addendum
12-1a	Measurement Performance Criteria (MPC) Table – Phase I	Included	
12-1b	MPC Table – Phase II	Included	Will be updated in QAPP Addendum

MEC-QAPP Worksheet #2—QAPP Identifying Information (continued)

UFP-QAPP Worksheet #	Required Information	Included or Excluded	Comment
12-2a	Definable Features of Work (DFOW) – Phase I	Included	
12-2b	DFOW – Phase II	Included	Will be updated in QAPP Addendum
13	Sources of Secondary Use Data and Information Secondary Use of Data Criteria and Limitations Table	Included	
14a	Summary of Project Tasks– Phase I	Included	
14b	Summary of Project Tasks– Phase II	Included	Will be updated in QAPP Addendum
15	Reference Limits and Evaluation Table	Excluded	Laboratory-related; no samples will be collected for this investigation
16	Project Schedule/Timeline Table	Included	Will be updated as needed in QAPP Addendum
B. Measurement Data Acquisition			
Sampling Tasks			
17a	Sampling Design and Rationale – Phase I	Included	
17b	Sampling Design and Rationale – Phase II	Included	Will be updated in QAPP Addendum
18a	Sampling Locations and Methods/Standard Operating Procedures (SOPs) Requirements Table – Phase I	Included	
18b	Sampling Locations and Methods/SOPs Requirements Table – Phase II	Included	Will be updated in QAPP Addendum
19	Analytical Methods/SOP Requirements Table	Excluded	Laboratory-related; no samples will be collected for this investigation
20	Field Quality Control (QC) Sample Summary Table	Excluded	Laboratory-related; no samples will be collected for this investigation
21	Project Sampling SOP References Table Sampling SOPs	Included	Will be updated in QAPP Addendum to identify information relevant to Phase II
22a	Field Equipment Calibration, Maintenance, Testing, and Inspection Table– Phase I	Included	
22b	Field Equipment Calibration, Maintenance, Testing, and Inspection Table– Phase II	Included	Will be updated in QAPP Addendum
Analytical Tasks			
23	Analytical SOPs Analytical SOP References Table	Excluded	Laboratory-related; no samples will be collected for this investigation
24	Analytical Instrument Calibration Table	Excluded	Laboratory-related; no samples will be collected for this investigation
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Excluded	Laboratory-related; no samples will be collected for this investigation
Sample Collection			
26	Sample Handling System, Documentation Collection, Tracking, Archiving and Disposal Sample Handling Flow Diagram	Excluded	Laboratory-related; no samples will be collected for this investigation
27	Sample Custody Requirements, Procedures/SOPs Sample Container Identification Example Chain-of-Custody Form and Seal	Excluded	Laboratory-related; no samples will be collected for this investigation

MEC-QAPP Worksheet #2—QAPP Identifying Information (continued)

UFP-QAPP Worksheet #	Required Information	Included or Excluded	Comment
QC Samples			
28	QC Samples Table Screening/Confirmatory Analysis Decision Tree	Excluded	Laboratory-related; no samples will be collected for this investigation
Data Management Tasks			
29	Project Documents and Records Table	Included	
30	Analytical Services Table Analytical and Data Management SOPs	Excluded	Laboratory-related; no samples will be collected for this investigation
C. Assessment Oversight			
31	Planned Project Assessments Table Audit Checklists	Included	
32	Assessment Findings and Corrective Action (CA) Responses Table	Included	
33	Quality Assurance (QA) Management Reports Table	Included	
D. Data Review			
34a	Verification (Step I) Process Table– Phase I	Included	
34b	Verification (Step I) Process Table– Phase I-	Included	Will be updated in QAPP Addendum
35a	Validation (Steps IIa and IIb) Process Table– Phase I	Included	
35b	Validation (Steps IIa and IIb) Process Table– Phase II	Included	Will be updated in QAPP Addendum
36	Validation (Steps IIa and IIb) Summary Table	Excluded	Redundant information
37	Usability Assessment	Included	

MEC-QAPP Worksheet #3—Distribution List

Name of QAPP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Jim Gravette	Remedial Project Manager (RPM)	Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic	(757) 341-0477	james.gravette@navy.mil	(An administrative record number will be assigned when the final document is being prepared.)
Wade Smith	Project Manager (PM)	VDEQ	(804) 698-4125	wade.smith@deq.virginia.gov	
Moshood Oduwole	PM	USEPA	(215) 814-3362	oduwole.moshood@epa.gov	
Bill Friedmann	Activity Manager (AM)	CH2M HILL	(757) 671-6223	william.friedmann@ch2m.com	
Mary Anderson	Deputy AM	CH2M HILL	(757) 671-6204	mary.anderson@ch2m.com	
Adam Forshey	PM	CH2M HILL	(757) 671-6267	adam.forshey@ch2m.com	
Doug Bitterman	Activity Quality Manager (AQM)	CH2M HILL	(757) 671-6209	doug.bitterman@ch2m.com	
Janna Staszak	Project Delivery Lead (PDL)/ Program QAPP Reviewer	CH2M HILL	(757) 671-6256	janna.staszak@ch2m.com	
Timothy Garretson	Munitions Response Program (MRP) Technical Lead/Senior Technical Consultant (STC)	CH2M HILL	(904) 374-5633	timothy.garretson@ch2m.com	
David Wright	Project Geophysicist	CH2M HILL	(919) 520-8673	david.wright@ch2m.com	
To be determined (TBD)	PM	Site Survey Subcontractor			
TBD	PM	Anomaly Inspection Subcontractor			

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MEC-QAPP Worksheet #4—Project Personnel Sign-off Sheet

Name	Organization/Title/Role	Telephone Number (optional)	Signature/e-mail Receipt	QAPP Section Reviewed	Date QAPP Read
Doug Bitterman	AQM	(757) 671-6209	doug.bitterman@ch2m.com		
Janna Staszak	CH2M HILL/PDL and Program QAPP reviewer	(757) 671-6256	janna.staszak@ch2m.com		
Timothy Garretson	CH2M HILL/MRP Technical Lead and STC	(904) 374-5633	timothy.garretson@ch2m.com		
David Wright	CH2M HILL/Project Geophysicist	(919) 520-8673	david.wright@ch2m.com		
Mark Orman	CH2M HILL/Health and Safety Officer (HSO)	(414) 847-0597	mark.orman@ch2m.com		
George DeMetropolis	CH2M HILL/MRP Health and Safety (H&S) and Quality Manager	(619) 272-7239	george.demetropolis@CH2M.com		
TBD	CH2M HILL/Field Team Leader (FTL)/Site Safety Coordinator (SSC)				
TBD	Site Survey Subcontractor (Phase I)				
TBD	Anomaly Inspection Subcontractor (Phase II)				

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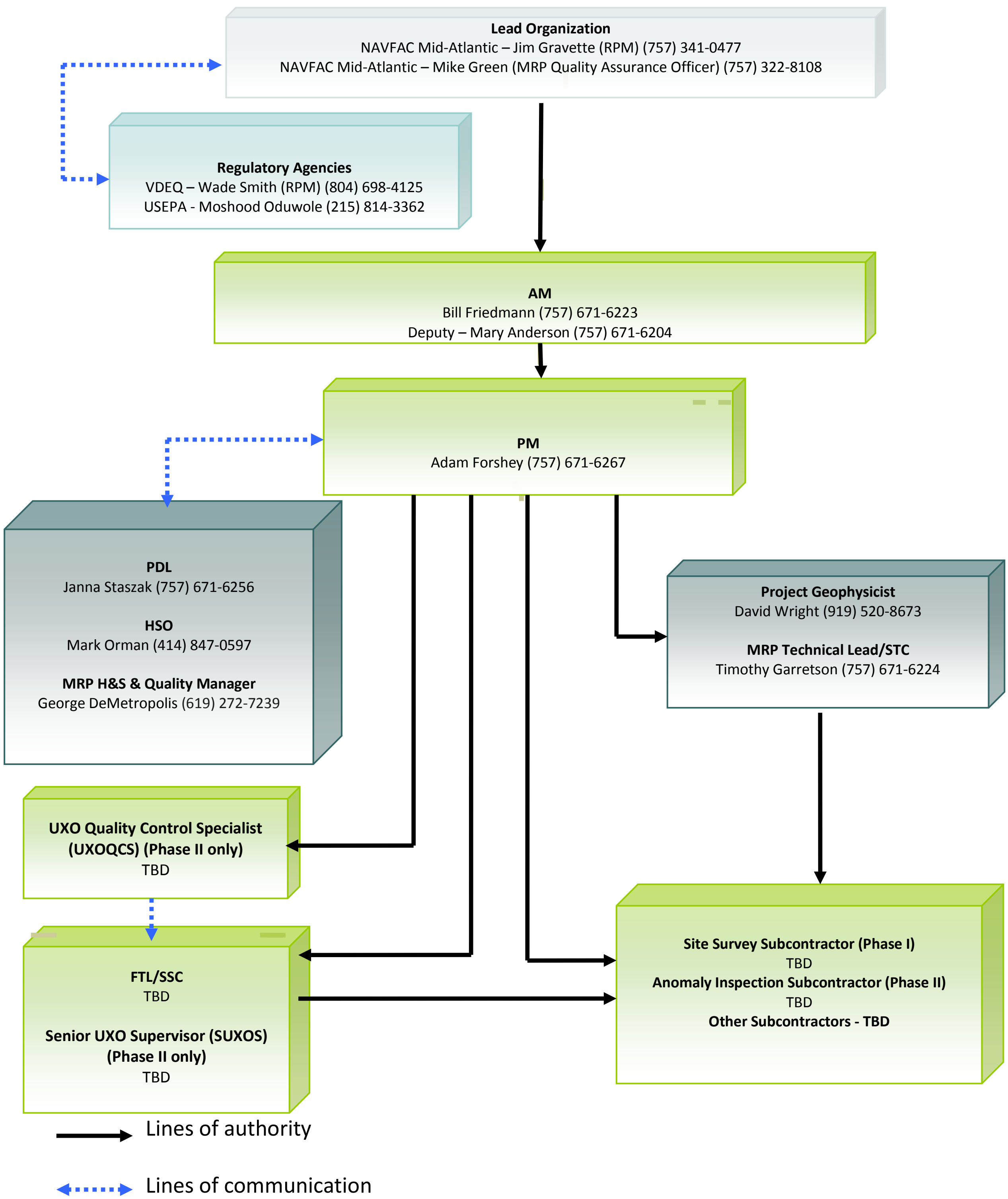
MEC-QAPP Worksheet #5—Project Organizational Chart



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MEC-QAPP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure
Communication with Navy (lead agency)	Navy RPM for WPNSTA Yorktown	Jim Gravette	(757) 341-0477	Primary point of contact (POC) for Navy, stakeholder, and agency managers; can delegate communication to other internal or external POCs. Any issue that may affect project work should be reported to Jim Gravette immediately.
Communication with VDEQ	RPM	Wade Smith	(804) 698-4125	Primary POC for VDEQ; can delegate communication to other internal or external POCs. Upon notification of field changes, VDEQ will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during site meetings.
Communication with USEPA	RPM	Moshood Oduwole	(215) 814-3362	Primary POC for USEPA; can delegate communication to other internal or external POCs. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during site meetings.
Oversight of Environmental Restoration Program and MRP implementation	CH2M HILL AM for WPNSTA Yorktown	Bill Friedmann	(757) 671-6223	POC for CH2M HILL; can delegate communication to other contract staff as appropriate. Issues reported to the Navy RPM immediately and followed up in writing within 2 business days.
Oversight of Environmental Restoration Program and MRP implementation backup	CH2M HILL Deputy AM for WPNSTA Yorktown	Mary Anderson	(757) 671-6204	Serves as backup or alternate for the AM.
Management of Project Implementation	CH2M HILL PM	Adam Forshey	(757) 671-6267	Primary POC for field and project-specific activities; timing dependent on nature of communication and predefined schedules as applicable and as requested by stakeholder agencies. All information and materials about the project will be forwarded to the AM on a daily basis.
Management of MRP Implementation	MRP Technical Lead/STC	Timothy Garretson	(904) 374-5633	Primary POC for issues relating to MEC during implementation of any field work. Any MEC-related issues should be immediately communicated to the PM.
QAPP changes in the field	CH2M HILL FTL	TBD	TBD	Notify the PM by phone and e-mail of changes to the QAPP made in the field, and the reasons, within 24 hours. Documentation of deviations from the work plan will be kept in the field logbook; deviations made only with the approval of the PM.
Field CA	CH2M HILL FTL	TBD	TBD	The need for CA for field and analytical issues will be determined by the FTL and AQM. The AQM will make sure QAPP requirements are met by field staff. The FTL will notify the PM of any needed field CAs. The PM will have 24 hours to respond to the request for field CA.
MEC-QAPP implementation, compliance, and data interpretation	CH2M HILL Project Geophysicist	David Wright	(919) 520-8673	POC for CH2M HILL regarding site survey subcontractor scoping, acoustic and geophysical data evaluation and QC, questions/issues encountered in the field, and data interpretation. The Project Geophysicist will communicate directly with the CH2M HILL PM by e-mail or phone.
Implementation of data collection and MEC-QAPP changes in the field	CH2M HILL FTL and/or Unexploded Ordnance Quality Control Specialist (UXOQCS)	TBD	TBD	Documentation of deviations from the MEC-QAPP made in field logbooks, and rationale for deviations, made within 24 hours of deviation; assistance in material procurement and delivery; survey oversight and implementation; anomaly inspection; deviations made only with approval from contractor PM.
Field CAs	CH2M HILL FTL and/or UXOQCS	TBD	TBD	See **Worksheet #32** of the MEC-QAPP guidance for Assessment Findings and CA Responses. If CAs are identified, **Worksheet #32-1** will be completed and saved with the project file.

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MEC-QAPP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Jim Gravette	RPM	NAVFAC	Coordinates all environmental restoration activities for WPNSTA Yorktown. Ensures project completion in accordance with the scope of work.
Mike Green	MRP QA Officer	NAVFAC	Provides quality review of MRP-related projects and activities for NAVFAC, including review of MEC-QAPP documents.
Wade Smith	PM	VDEQ	Provides regulatory review of project documents and activities for the Commonwealth of Virginia.
Moshood Oduwole	PM	USEPA	Provides regulatory review of project documents and activities for the USEPA.
Bill Friedmann	AM	CH2M HILL	Responsible for CH2M HILL project implementation at WPNSTA Yorktown.
Mary Anderson	Deputy AM	CH2M HILL	Responsible for CH2M HILL project implementation at WPNSTA Yorktown as necessary to support the AM.
Adam Forshey	PM	CH2M HILL	Ensures proper implementation of all phases of work for the project. Directs and oversees staff.
Doug Bitterman	AQM	CH2M HILL	Ensures overall quality of the project is achieved and appropriate. Provides overall quality review of project deliverables.
Janna Staszak	PDL and Program QAPP Reviewer	CH2M HILL	Provides program-level review of MEC-QAPPs. Provides oversight and approval for all technical issues related to the project.
Timothy Garretson	CH2M HILL Munitions Response (MR)Technical Lead	CH2M HILL	As the technical lead, supports decision making with respect to MEC investigations and procedures.
	CH2M HILL STC		Provides senior technical advice on technologies used, as well as program-level technical quality delivery.
David Wright	Project Geophysicist	CH2M HILL	Oversees geophysical subcontractor operations, serves as the CH2M HILL POC for geophysical subcontractors, performs data review and QC as data are delivered, provides interpretation of results to project team and stakeholders, and communicates to STC and PM issues regarding data quality, QC failures, or non-compliance with the MEC-QAPP by the site survey subcontractor.

MEC-QAPP Worksheet #7—Personnel Responsibilities and Qualifications Table (continued)

Name	Title/Role	Organizational Affiliation	Responsibilities
George DeMetropolis	CH2M HILL/MRP H&S and Quality Manager	CH2M HILL	Oversees development of the Accident Prevention Plan and MEC-QAPP to define site-specific needs of the project and that appropriate H&S and QC requirements specifically related to MEC are defined and properly executed.
Mark Orman	CH2M HILL HSO	CH2M HILL	Oversees development of the Site Safety and Health Plan to define site-specific needs of the project and makes sure that the appropriate H&S requirements are defined and properly executed.
TBD	Senior Unexploded Ordnance Supervisor (SUXOS)	CH2M HILL	Provides technical oversight and support for MEC-QAPP revisions and field work implementation during munitions-related field activities (Phase II). Implements approved MEC-QAPP during munitions-related activities. Plans, coordinates, and supervises all explosives operations. Coordinates all aspects of QC and H&S with the UXOQCS/Unexploded Ordnance Safety Officer (UXOSO).
TBD	UXOQCS/UXOSO	TBD	Implements the MEC-related QC provisions of the project (Phase II). Implements the Site Safety and Health Plan, including MEC-related and general safety components.
TBD	FTL/SSC	CH2M HILL	Provides technical oversight and support for MEC-QAPP revisions and field work implementation. Supervises and coordinates all field activities.
TBD	Site Survey Subcontractor (Phase I)	TBD	Collects, analyzes, and delivers acoustic and geophysical data in accordance with the scope of work and requirements set forth in the MEC-QAPP. Communicates with CH2M HILL Project Geophysicist on geophysical technical matters prior to and during geophysical data collection.
TBD	Anomaly Inspection Subcontractor (Phase II)	TBD	Implements approved MEC-QAPP for anomaly inspection activities.

MEC-QAPP Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
Fieldwork	Use of acoustic/DGM survey equipment	---[a]	Prior to survey activities	---[a]	CH2M HILL geophysicists, Site Survey subcontractor	Resume, as demonstrated experience and qualifications with equipment and software
Fieldwork	Hazards of Electromagnetic Radiation to Ordnance	NAVFAC	Prior to Field work (must provide equipment specification for review in advance of training)	All field crew members who will be using radio transmitters, cell phones, and other transmitting devices (including survey equipment) onsite	Field team members and SSC from CH2M HILL Site Survey and Anomaly Inspection subcontractors	Document in project files
Fieldwork	Boat Safety Course or United States Coast Guard Operator's (Captain's) license	United States Coast Guard or other approved National Association of State Boating Law Administrators as required by the Commonwealth of Virginia	Prior to mobilization	Boat Captain	Site Survey and Anomaly Inspection subcontractors who will operate a boat	Project file, subcontractor records
Fieldwork	MEC Awareness Training[b]	CH2M HILL UXO-Qualified Personnel	Prior to field work	FTL (TBD), field team members (TBD), SSC (TBD), subcontractor	Field team members and SSC from CH2M HILL Site Survey and Anomaly Inspection subcontractors	Project file
Fieldwork	Use of Anomaly Inspection technology/methodology (TBD)	---	Prior to field activities	---	Anomaly Inspection subcontractor	Resume, as demonstrated experience and qualifications with equipment and software
Fieldwork	UXO Technician Training to meet minimum requirements of Department of Defense Explosives Safety Board Technical Paper 18 for the relevant UXO Technician level	• United States military Explosive Ordnance Disposal (EOD) school • Canada, Great Britain, Germany, or Australia military EOD school • Formal UXO training course of instruction, or EOD assistant courses	SSC will verify that training is current prior to starting field activities; training will not be provided by CH2M HILL	UXO Technician II or higher	UXO Technician	Subcontractor records and CH2M HILL field safety files. Records to include resume (as demonstrated experience), qualifications, and copies of certifications

[a]Training in the use of side-scan sonar, multibeam sonar and geophysical sensors will not be provided onsite by CH2M HILL, the Site Survey subcontractor, or an outside vendor. Onsite geophysical personnel must have demonstrated experience and qualifications with the proposed equipment (and analysis software) prior to mobilization to the site and project kickoff.

[b] MEC training is often referred to as Recognize, Retreat, Report (3-R) training. This training is intended to make the trainees aware of the potential presence of MEC, ways to recognize potential MEC, and what to do if potential MEC is observed. This training DOES NOT enable the trainee to identify the type of MEC or handle the potential MEC item.

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MEC-QAPP Worksheet #9-1—Project Scoping Session Participants Sheet

Project Name: SI of UXO 3 Weapons Loading Pier R-1 and Structure R-2 **Projected Date(s):** 2013/2014 **PM:** Adam Forshey/VBO			**Site Name:** UXO 3 Weapons Loading Pier R-1 and Structure R-2 **Site Location:** WPNSTA Yorktown, Yorktown, Virginia		
Date of Session: 05/21/2013 **Scoping Session Purpose: Partnering meeting to discuss the Preliminary Assessment (PA) recommendations and preliminary SI planning.**					
Name	**Title**	**Affiliation**	**Phone #**	**E-mail Address**	**Project Role**
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Jim Gravette	RPM	NAVFAC Mid-Atlantic	(757) 341-0477	james.gravette@navy.mil	Navy RPM
Bill Friedmann	AM	CH2M HILL	(757) 671-6223	William.friedmann@ch2m.com	AM
Adam Forshey	PM	CH2M HILL	(757) 671-6267	adam.forshey@ch2m.com	PM

A summary of the site description and background from the PA was reviewed. The conclusions and recommendations from the PA were also presented. Based on the findings of the PA, no documented instances of a release of MEC were located. However, because of the piers' significant historical use and the possibility for an undocumented release to have occurred, an SI was recommended. The PA recommended that investigation of Pier R-1 be performed because it is no longer operational for munitions handling. It was also recommended that the SI for Pier R-3 be delayed until after munitions-handling operations at this pier cease. The PA will be finalized and the public will be notified of the MR site prioritization protocol score availability for public input.

Next, the Team reviewed the proposed path forward for conducting the SI. The SI will include underwater surveys of the Pier R-1 area (a 250-foot area surrounding the former pier berthing area). The site survey will first include side-scan and multibeam (bathymetric) surveys to obtain imaging and locations of potential obstructions that may affect the DGM survey activities. The bathymetric data will provide seafloor contour information to be sure data are collected near the sediment surface. A DGM survey will then be performed for the area surrounding Pier R-1 to locate geophysical anomalies that may represent MEC. If geophysical anomalies are identified, the SI will include anomaly inspection of a select number of geophysical anomalies (this number will need to be determined by the Team for making risk management decisions) to determine if the geophysical anomalies located during the DGM survey are MEC. This phase of investigation will be included conceptually in the SI MEC-QAPP so the entire SI process is presented; however, the technology and methodology for conducting the anomaly inspections will not be selected until after the site survey activities are complete. Therefore, the specifics of the technologies and methodologies, including the type of equipment and anomalies requiring additional inspection, will need to be identified in an addendum to the MEC-QAPP. Potential technologies, such as diving, a remotely operated vehicle (ROV) with a camera, or dredging (for example, magnetic dredging), were reviewed with the Team as possible technologies to use during the anomaly inspections. From meetings conducted with the WPNSTA Yorktown Commanding Officer, it was noted that Pier R-1 historically loaded underwater mines that may be magnetically influenced; therefore, magnetic recovery of anomalies may not be feasible.

MEC-QAPP Worksheet #9-1—Project Scoping Session Participants Sheet (continued)

During the meeting it was noted that field activities will have to be performed when they will not interfere with base operations at the pier. Dredging is performed approximately every 3 years and is expected to be conducted during the summer and fall of 2013. A sewer utility installation project is also scheduled during summer 2013. Mission-critical actions such as munitions delivery could alter the investigation schedule. Because of scheduling for munitions shipments and base activities, it is currently anticipated that the side-scan sonar, bathymetric, and DGM surveys will be conducted between December 23, 2013, and January 2, 2014.

The Team agreed that the anomaly inspection phase will be included in the SI MEC-QAPP.

MEC-QAPP Worksheet #9-2—Project Scoping Session Participants Sheet

Project Name: SI of UXO 3 Weapons Loading Pier R-1 and Structure R-2 **Projected Date(s) of Sampling:** 2013/2014 **PM:** Adam Forshey/VBO	**Site Name:** UXO 3 Weapons Loading Pier R-1 and Structure R-2 **Site Location:** WPNSTA Yorktown, Yorktown, Virginia

Date of Session: 08/08/2013

Scoping Session Purpose: MEC-QAPP/SI Work Plan Detail development and discussion

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
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The objectives of this discussion were to present the Partnering Team with information about the MEC-QAPP format document, how Phase I (site survey activities) and Phase II (anomaly inspection) activities are being incorporated, and to discuss the environmental questions, PQOs, project action limits (PALs), and so forth from the primary worksheets of the MEC-QAPP. As previously discussed, the SI MEC-QAPP will incorporate both Phase I and Phase II portions of the investigation. **Worksheet #2** of this QAPP contains a summary table of the worksheets included and excluded from the QAPP. The comments column discusses why a worksheet may be excluded as well as which worksheets are anticipated to require an update in the MEC-QAPP Addendum for Phase II. For worksheets that are specific to Phase I or Phase II quality requirements or approach, a Worksheet "a" and Worksheet "b" will be noted, respectively.

The Team discussed that there has been some confusion regarding the structure "R-2." R-2 was not initially identified as an area of munitions handling at UXO 3 during the PA. However, based on anecdotal evidence, R-2 is a structure that was attached to the trestle of Pier R-1 and served as a small boat launch and boathouse where small arms and small munitions may have been loaded. It is proposed that the SI investigative area be expanded to include the area around structure R-2. The Team agreed to include R-2 as a conservative measure. The investigation area around Structure R-2 will be approximately 100 feet surrounding the former structure, since only small boats would have been loaded here. This inclusion will be documented in the SI MEC-QAPP.

The Team reviewed the main worksheets of the MEC-QAPP (**Worksheets #10, 11**, and **12**) and the proposed environmental questions, PQOs, and PALs. **Worksheet #10** is the CSM. This worksheet details the current understanding of the site and sets up the background information necessary for defining the problem and developing the subsequent worksheets. **Worksheet #11** provides the PQOs and the planning process statements. The group discussed the proposed environmental questions, PQOs, PALs, and other items to be included in this worksheet. The Team agreed with the proposed environmental questions, PQOs, and PALs (**Worksheet #11**). QC requirements for DGM survey were discussed and agreed upon (100 percent coverage of the area and platform and to maintain an altitude of no more than 1.5 meters above the sediment surface). Additional detail for these QC requirements will be included in the MEC-QAPP for review. The environmental question will state, "Are MEC items present within the vicinity of former Pier R-1 and former structure R-2?"

MEC-QAPP Worksheet #9-2—Project Scoping Session Participants Sheet (continued)

Moshood asked how the Team will determine what areas need additional anomaly investigation. Jim noted that some items may be identifiable and can be ignored (such as obvious shapes like ladders or tires), but likely there will be anomalies that cannot be identified. All of the results will have to be considered to decide what warrants further investigation. Adam added that a statistical approach may be used based on the number of anomalies. However, if there are a significant amount of anomalies or anomaly concentrations are very dense, a statistical approach may not be feasible and the Team may decide to inspect groups of contacts or only certain areas that are most likely to contain MEC. Wade asked if technical experts will be involved in the discussion. Bill confirmed MEC-experienced geophysicists from CH2M HILL will provide support when the Team is determining what should be investigated further.

The Team discussed that the window of opportunity for field work at UXO 3 is between December 23, 2013, and January 2, 2014, due to base operations at the pier. Moshood noted this timeframe will be challenging considering the amount of work that is projected. Jim discussed that Phase II field work will be scheduled with the pier operations personnel once results from Phase I have been received and analyzed. Bill showed the team the Explosives Safety Submission Determination Request (ESS-DR) that will be submitted prior to field work for Phase I. Wade noted the ESS-DR does not include the R-2 structure. Adam agreed that the ESS-DR should be revised to include R-2, but it is not anticipated this inclusion will alter the level of risk.

Finally, Jim discussed that there is upcoming dredging (clam shell) that will take place around Pier R-3. Analytical sampling was conducted in the proposed footprint of the dredge area and no risk was identified; therefore, the dredge spoils will be barged downstream for offshore disposal. The Facility Engineering and Acquisition Division (FEAD) is funding the dredging action to ensure there is an adequate operational depth. This dredging is taking place in the same spatial area where previous dredging has occurred. Jim made the FEAD aware of UXO 3; however, FEAD noted no concern due to previous dredging actions. The FEAD will not be checking the dredge spoils for munitions. Jim noted there was a representative from VDEQ at the kickoff meeting for the dredge work. The Team may consider the historical dredging operations that have been performed during future decision making for the Pier R-3 area.

Scoping Session Follow-up Discussion

Subsequent to the August 8, 2013 scoping session, the Partnering Team held a conference call to discuss the schedule of planned field activities. The Team discussed that the initial schedule assumed a quick turn-around time for the side-scan sonar data collection. However, based on input that has been received from potential subcontractors, it is estimated that once side-scan sonar and bathymetry data are collected, approximately 1-2 weeks will be necessary to process the data to make it usable during the DGM survey. Because the side-scan sonar and bathymetry data are needed prior to the DGM survey for planning and safety, these data must be obtained prior to performing the DGM survey.

Because of schedule requirements with the facility, all field activities must occur when there are no ships at the active Pier R-3. Therefore, the Team agreed that side-scan sonar and bathymetry data will be collected around the Thanksgiving holiday (when pier operations will be down and ships will not be at Pier R-3), if possible. That way the schedule for doing the DGM data collection between December 23, 2013 and January 2, 2014 can be maintained. Based on the current schedule, if the full 60-day regulator review is required, it is anticipated that a final MEC-QAPP may not be available prior conducting the side-scan/bathymetry fieldwork. The Team agreed that the side-scan sonar and bathymetry field activities can occur as an initial data collection step prior to finalizing the MEC-QAPP, if necessary. The ESS-DR and all health and safety documentation will still be finalized and available before any data collection can occur. General and subcontractor specific SOPs may be used for field work planning of the side-scan sonar and bathymetry survey activities.

MEC-QAPP Worksheet #10—Conceptual Site Model

A three-dimensional CSM depicting the current understanding of UXO 3 is provided on **Figure 1**. The information used to develop the model is detailed as follows.

Facility Description

WPNSTA Yorktown is a 10,624-acre installation located on the Virginia Peninsula in York and James City counties, Virginia (**Figure 2**). WPNSTA Yorktown is bounded on the northwest by Cheatham Annex and the King's Creek Commerce Center, on the northeast by the York River and the Colonial National Historic Parkway, on the southwest by Route 143 and Interstate 64, and on the southeast by Route 238 and the town of Lackey. The Colonial National Historic Parkway runs between the inland portion of WPNSTA Yorktown and the munitions loading piers.

Site Background and Physical Characteristics

UXO 3 includes areas along and beneath the current and former piers at WPNSTA Yorktown, where historical munitions loading and unloading activities may have resulted in a release of MEC to the York River. UXO 3 comprises approximately 289 acres of river along the shoreline of the York River and includes former Pier R-1, Structure R-2, and the currently active Pier R-3. Pier R-1 operated from 1920 to the 1970s and remnants of former wooden pier pilings remain beneath the water surface adjacent to Pier R-3. Structure R-2 is identified as a small boat landing in historical dredging documents (circa 1929). Pier R-3 became operational in 1941 and includes approximately 6,400 linear feet of standing concrete pier. For the purposes of the PA and this SI, delineation of the UXO 3 boundary was defined as the prohibited area identified in Title 33 of the Code of Federal Regulations: Title 33, Paragraph 334.260.a.1. However, the investigation area has been further refined based on the berthing areas where munitions handling most likely occurred. This is estimated to be an approximately 250-foot-wide area surrounding the berthing areas of Piers R-1 and R-3 based on the largest ships that may have been loaded at these piers, and an approximately 100-foot-wide area surrounding Structure R-2, based on the smaller boats that may have been loaded at the small boat landing (**Figure 3**). Because Pier R-3 is currently active and will not be investigated during this SI, no additional information regarding Pier R-3 will be presented in this MEC-QAPP.

Pier R-1

Construction of former Pier R-1 was completed in 1920 to facilitate munitions loading to ships and barges. It consisted of a 1,100-foot-long trestle and 600-foot-long berthing area (**Figure 4**) (WPNSTA Yorktown, 2008). In 1933, a hurricane caused severe damage to Pier R-1. It was subsequently rebuilt over the next several years. In the 1940s, the pier was expanded 250 feet out into the York River to allow for additional berthing options.
Pier R-3 was constructed during the 1940s, and use of Pier R-1 began to diminish. In 1954, a fire caused severe damage to Pier R-1 and destroyed a significant portion of the berthing area. By the 1970s Pier R-1 was converted to a recreational pier and was no longer used for munitions handling. In 2003, Hurricane Isabel destroyed the remaining portions of the pier. Currently, no remnants of Pier R-1 are visible; however, pilings may remain below the water level.

Reports reviewed during the desktop study indicated munitions-loading operations occurred along the berthing area of Pier R-1; no munitions-loading operations were reported along the trestle of Pier R-1. Currently, no maintenance (pier or dredging) activities occur in the vicinity of the former footprint of Pier R-1.

Structure R-2

Structure R-2 was identified as a small boat landing that was constructed along the eastern side of the trestles of Pier R-1. Little information was identified for Structure R-2 during the PA. There was no documentation of munitions handling occurring at this location during the PA; however, recent anecdotal evidence indicates that

MEC-QAPP Worksheet #10—Conceptual Site Model (continued)

small arms and small munitions may have been hand-loaded from Structure R-2. Structure R-2 is believed to have been constructed sometime in the late 1920s.

Surface Water Hydrology

The York River in the vicinity of Pier R-1 and Structure R-2 is a tidally influenced sub-estuary of the Chesapeake Bay. The pier is approximately 8 miles upstream of the mouth of the river, and approximately 1.5 miles upstream of Gloucester Point, where the river channel constricts. At this location, the river is characterized by a deeper main channel (approximate depth of 40 to 45 feet) bordered on either side by well-developed shoals. Remnants of Pier R-1 (and potentially Structure R-2) may remain submerged in the water; the current water depth near the former berthing area of Pier R-1 ranges from approximately 10 feet mean low water (MLW) on the inland portion to approximately 40 feet MLW along the main channel of the York River. Water depth near Structure R-2 is estimated to be as shallow as 5 feet MLW.

The York River is a partially mixed estuarine system (Friedrichs, 2009). The mean tidal range near WPNSTA Yorktown is approximately 2 feet. The lower York River exhibits salinity stratification, with bottom salinities of 20 to 22 practical salinity units and surface salinities of 16 to 17 practical salinity units. Circulation is driven by tides, wind, and freshwater inflow. Tidal currents are stronger in the main channel than in the adjacent shoals. Spring tidal velocities near Pier R-1 are on the order of 2 feet per second. The flood tides tend to be stronger and more turbulent than the ebb tides because sediment is suspended and moved landward (upriver) on the flood tide compared to ebb tides in the York River. In the absence of wind or major freshwater discharge events, the mean estuarine circulation is weak, at approximately 2 to 3 inches per second in a landward (upriver) direction in the channel. Because the York River has a relatively small watershed, freshwater inflow is minor.

Waves are generally small in the York River, except when strong winds line up with the axis of the estuary (Friedrichs, 2009). Conditions for wind-wave growth are present only 3 to 4 percent of the time. However, large waves can occur during extreme events, such as Hurricane Isabel in September 2003, when significant wave heights of 5 feet were measured at Gloucester Point.

Sources of sediment to the York River include influx from the tributaries at the head of the river (the Mattaponi and Pamunkey rivers), influx from the Chesapeake Bay, local tributaries, and shoreline erosion. The net movement of sediment is from the Chesapeake Bay into the York River, although sediment is transported out of the river into the bay during storms and hurricanes (Friedrichs, 2009; United States Geological Survey, 2003). The need for periodic maintenance dredging at the WPNSTA Yorktown munitions loading pier (Pier R-3) suggests that the area is net depositional, though the rate of sedimentation is not known. Although there were no records of dredging around Pier R-1 and Structure R-2 identified during the PA, a review of historical nautical charts from 1914 to present suggests that sedimentation in the vicinity of these areas has been minimal (estimated less than 1-2 feet since 1914). Analytical data collected to support dredge material characterization indicate that the shallow surface sediments around the WPNSTA Yorktown pier are composed of predominantly silts and clays (92 to 99 percent) with a trace of sand.

Potential Contaminant Sources

The focus of this investigation is to determine whether a potential release of MEC may have occurred at the site. Although documentation of a MEC release was not identified during the PA, the potential exists for MEC to be present at UXO 3 as a result of undocumented releases during historical loading operations. WPNSTA Yorktown has been in use as a munitions facility since 1918; however, pier operations did not begin until 1920. Any type of conventional ordnance that was in the United States inventory during and after World War I may have been shipped to and from WPNSTA Yorktown. Most documentation, records, and other material examined during the desktop review indicate that a wide variety of munitions and munitions-related material was shipped to and from

MEC-QAPP Worksheet #10—Conceptual Site Model (continued)

and/or handled at WPNSTA Yorktown. Additional detail regarding the potential ordnance shipped to and from UXO 3 is provided in the PA report (CH2M HILL, 2013).

Based on a Tier 1 sediment evaluation of the York River presented in the PA, current velocities are not sufficient to transport intact munitions significantly. Therefore, the probable location for items that may have been dropped at UXO 3 is believed to remain localized to the pier areas as long as they remain undisturbed. However, the hydrodynamic environment in the York River is complex and variable, and the Tier 1 evaluation should be considered an initial, simplified assessment of site conditions. It is also possible that physical processes such as dredging, construction activities, and other investigations caused the movement or relocation of MEC; no reports or documentation were located during the desktop study that reported munitions were encountered during dredging or fishing operations in the vicinity of former Pier R-1 and Structure R-2.

Potential Receptors

Former Pier R-1 and Structure R-2 are no longer active or physically present at the site (except for the pilings that remain beneath the water surface); however, munitions were historically handled at this pier and were potentially handled at Structure R-2. Access to the pier area at WPNSTA Yorktown is controlled by WPNSTA Yorktown security forces from the waterfront area. Although there is no physical barrier to prevent access to the pier area by boat, the prohibited zone is enforced by the Navy and limits accessibility to the site. The Navy has a patrol boat in the water to enforce the restricted area 24 hours a day. The potential future land use for the pier area is assumed to remain unchanged.

Potential future human receptors may include Navy personnel (such as EOD divers) and construction workers (possibly involved in piling maintenance, dredging, or upgrading or demolishing portions of the piers). Future trespassers (such as fishermen and recreational swimmers and/or divers) within the restricted area will also be considered potential human receptors. Although ecological receptors do not typically engage in activities that result in direct exposure to MEC, accidental detonations or MR actions, such as blow-in-place operations, may affect ecological receptors. Recreational uses (fishing, boating, and swimming and/or diving) are not permitted in the prohibited zone; however, it is possible that future trespassers (fishermen or swimmers and/or divers) could be exposed to MEC (entangled in fishing nets and gear or interaction while swimming and/or diving) if site use changes and the prohibited area is no longer enforced. Although future use is not anticipated to change, this potential exposure pathway cannot be eliminated at this point.

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MEC-QAPP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Problem Definition

Based on the findings of the PA report, there is potential for MEC to have been dropped or released from munitions loading and unloading operations at former Pier R-1. Additionally, based on anecdotal evidence obtained since completion of the PA, there is potential for MEC to have been dropped or released from munitions loading and unloading operations at former Structure R-2. Therefore, the purpose of the SI activities discussed in this MEC-QAPP is to determine whether MEC is present in this area. The investigation boundary around Pier R-1 is based on an offset of approximately 250 feet around the berthing areas of the inactive Pier R-1, as detailed in the PA. The investigation area around Structure R-2 is an offset of approximately 100 feet around the structure and extending into the R-1 area. A smaller offset is warranted for the Structure R-2 area because only small ships were loaded at this location. The proposed investigation area is believed to be the area at the site that has the highest potential to contain MEC, if present.

Table 1 summarizes this SI investigation, describes the questions to be answered and the investigation approach, and lists the PQOs to determine the potential for MEC to be present at the Pier R-1 or Structure R-2 portion of UXO 3.

TABLE 1
Environmental Questions and Project Quality Objectives

Environmental Question	General Investigation Approach to Answer the Environmental Question	PQO in the form of if/then statements
Are MEC items present within the vicinity of former Pier R-1or Structure R-2?	Phase I (Site Survey): Side-scan sonar and bathymetric surveys will be conducted to image discrete targets proud of (that is, sitting on top of or protruding from) the riverbed sediment surface, provide the location of potential underwater navigational obstructions, and characterize riverbed topography for navigating DGM equipment. A DGM survey of the areas surrounding former Pier R-1 and Structure R-2 (see **Figure 4**) will be performed to identify geophysical anomalies that may be indicative of MEC. These data will be used to determine the magnitude and distribution of anomalies in the vicinity of the inactive pier and to select areas and anomalies for additional inspection to determine if MEC is present at the site.	If no geophysical anomalies are identified that may represent MEC within the investigation area, then no further investigation or action will be performed. If geophysical data that are collected indicate the presence of geophysical anomalies that may represent MEC within the investigation area, and the Navy, USEPA, and VDEQ determine that additional investigation is warranted, then the Navy, USEPA, and VDEQ will determine the number of anomalies or areas to be investigated further in order to obtain adequate representation of debris present for determining the presence or suggested absence of MEC. The most appropriate technology for the additional anomaly inspection activities will then be selected. This information will be documented in an addendum to this MEC-QAPP.
	Phase II (Anomaly Inspection): If additional investigation is deemed necessary based on the results of the DGM survey, then an inspection of select geophysical anomalies will be performed to determine if MEC is present within the vicinity of former Pier R-1 and Structure R-2.	If anomaly inspections are performed on an agreed-upon number of geophysical anomalies and no MEC is identified, then the potential for MEC to be present at the site is assumed to be low and no additional action or investigation for Pier R-1 or Structure R-2 will be performed. If MEC is identified, then the Navy, USEPA, and VDEQ will determine the need for additional investigation and action at Pier R-1 or Structure R-2.

MEC-QAPP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

Who will use the data?

- Representatives from the Navy, USEPA, and VDEQ will use the data to determine whether MEC is present in the vicinity of former Pier R-1 or Structure R-2 and to identify the need for additional investigations. Engineers, geophysicists, and scientists will use the data to aid in making site management decisions.

What are the Project Action Limits?

The purpose of this investigation is to gather supporting data to aid the decision-making processes and to determine the need for future investigations and MR actions at former Pier R-1 or Structure R-2. Although quantitative risk-based decisions cannot be generated from the data obtained during this SI, a qualitative assessment of explosive hazard may be performed to determine if additional investigations or actions are necessary for the site. The following PALs have been identified for this investigation:

- Phase I (Site Survey) PAL – A geophysical anomaly will be identified for any DGM response above the investigation-established background level for the DGM equipment. This level will be established by the Project Geophysicist based on the background geophysical response observed in the field.
- Phase II (Anomaly Inspection) PAL – If any MEC items are discovered during the anomaly inspection, a release has occurred and the Navy, USEPA, and VDEQ will determine if additional investigation or action is necessary for portions of the site.

What will the data be used for?

- Phase I (Site Survey) data will be used to determine the location and approximate number of geophysical anomalies that may represent MEC in the areas adjacent to former Pier R-1 and Structure R-2. The data collected from the survey will be discussed by the Navy, VDEQ, and USEPA to determine if additional investigation is necessary.
- If additional investigation is necessary, the Phase II (Anomaly Inspection Phase) data will be used to determine the presence or suggested absence of MEC in the areas adjacent to former Pier R-1 and Structure R-2.

What types of data are needed?

- Phase I Site Survey:

  Side-scan sonar data will be collected to locate underwater obstructions or navigational hazards in advance of the underwater DGM survey. The data will also be used to locate, to the extent possible, proud, discrete anomalies associated with objects on the riverbed that may be correlated to geophysical anomalies identified with underwater DGM data representing potential MEC.

  - Multibeam sonar data will be collected to develop the bathymetry of the Pier R-1 and Structure R-2 area. The data will be used to avoid contact with the sediment surface or other obstructions during the subsequent DGM survey.
  - Underwater DGM will be performed to locate geophysical anomalies on or just below the sediments around Pier R-1 and Structure R-2. Water depth and the height of the sensor above the seafloor will also be recorded with the DGM data.
  - Data positioning will be recorded through a global positioning system (GPS) unit on the boat used to support the survey.
  - Data positioning will be performed in accordance with the topside GPS accuracies and sensor positional accuracies specified in this MEC-QAPP and the Site Survey SOP in **Appendix A**.

MEC-QAPP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

  - QC testing will be performed on the survey equipment to verify its functionality. The equipment used to support this investigation will be tested to verify its functionality on a daily basis in accordance with the SOPs (**Appendix A**) and the QC requirements established in **Worksheet #12a**.
  - Information collected during all field activities will be recorded on paper or in digital logbooks. If digital logbooks are used, all information recorded using the digital logbook will be converted into a portable document format (PDF) file that will contain a digital signature (including date and time stamp) of the personnel logging the field activities.
- Phase II Anomaly Inspection (if necessary):
  - Visual confirmation of a select number of geophysical anomalies will be performed to characterize the anomaly source (to determine if MEC is present).
  - Data positioning will be performed in accordance with the Anomaly Inspection SOP(s) to be included in the MEC-QAPP Addendum.
  - QC will be performed in accordance with the SOP and the QC requirements to be established in **Worksheet #12b** when the MEC-QAPP Addendum is prepared.
  - Information collected during all field activities will be recorded on paper or in digital logbooks. If digital logbooks are used, all information recorded using the digital logbook will be converted into a PDF file that will contain a digital signature (including date and time stamp) of the personnel logging the field activities.

How “good” do the data need to be in order to support the environmental decision?

- Phase I Site Survey:
  - Functionality QC testing will be conducted for all site survey equipment (side-scan sonar, multibeam sonar, and DGM) to verify adequate detection capabilities. Equipment must pass all QC tests as described in **Worksheet #12a** and detailed in **Appendix A**. This testing will verify that the equipment is functioning properly, capable of detecting the munitions of interest, and providing usable data.
  - The detection performance for currently available DGM systems is very sensitive to the separation distance between the target of interest and the DGM sensor. Signal levels are nominally proportional to $1/r^5$ where r is the separation distance. In addition, the signal levels are proportional to the size of the objects; therefore, larger items can be detected at greater distances from the DGM sensor than smaller items. Items located deeper in the sediment may not provide sufficient signal to be detected above the instrument noise levels. Industry predicted responses curves for various munitions items as a function of separation distance based on Naval Research Laboratory studies are presented in SOP #3 of **Appendix A**.
  - Data obtained from the survey and field logbooks will be available for QC. The QC review of the field logbooks will allow the reviewer to verify that equipment functionality tests are being conducted at least once a day and that other details pertaining to the investigation have been recorded.
  - Data will be collected from 100 percent of the site, to the maximum extent practicable. Underwater obstructions and hazards may make data collection in certain areas impractical and may present safety issues to those conducting the investigation. These locations will be noted by the field team. The Project Geophysicist will review the data during collection to minimize data gaps as a result of routine survey operations. Acoustic survey data (side-scan sonar and multibeam sonar) will also be collected with 100 percent redundancy for optimal imaging.

MEC-QAPP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

- Phase II Anomaly Inspection (if necessary):
  - If the Navy, USEPA, and VDEQ determine additional investigation is necessary based on the results of the DGM survey, the Navy, USEPA, and VDEQ will determine the number and locations of anomalies to inspect to determine whether MEC is present at the site. The number and location of anomalies requiring inspection will be documented in an addendum to this MEC-QAPP. Any technology- specific quality requirements for conducting the Anomaly Inspection Phase will be included in **Worksheet #12b** when the MEC-QAPP Addendum is prepared.
  - The anomaly inspections will rely on visual confirmation of the anomaly source based on UXO Technician experience; therefore, visibility of the item must be adequate to perform such an assessment. A quantifiable measurement of adequate visibility cannot be included in this MEC-QAPP, but will rely on the experience of qualified UXO personnel. Positive identification of a MEC item will also require independent verification by a second qualified UXO Technician as a QC check of the initial identification.
  - Data recorded throughout the Anomaly Inspection Phase (including item description, location, photos, and so forth) will be thoroughly documented in a log and made available for QC review.
  - If underwater obstructions and hazards make inspection of anomalies in certain areas impractical or present safety issues to those conducting the investigation, then the location(s) and reason(s) why an inspection is impractical will be documented by the field team.

How much data should be collected?

- Phase I Site Survey:
  - Side-scan sonar and bathymetric data will be collected from 100 percent of the investigation area with 100 percent redundancy along transects within the survey area (see **Figure 4**) to provide comprehensive coverage of the survey area. The comprehensive coverage will provide potential route options for the underwater DGM if navigational hazards are identified along idealized DGM transects.
  - An attempt will be made to collect DGM data from 100 percent of the immediate area of former Pier R-1 and Structure R-2 (see **Figure 5**) where accessible. The investigation boundary around former Pier R-1 is an offset of approximately 250 feet around the pier, as detailed in the PA report (CH2M HILL, 2013). The investigation area around Structure R-2 is an offset of approximately 100 feet around the former structure and extending up to the Pier R-1 investigation area. The total site area is approximately 18 acres. Areas that are inaccessible will be documented in field notes and the field logbook.
- Phase II Anomaly Inspection (if necessary):
  - The number and location of anomalies to be inspected will be identified by the Navy, USEPA, and VDEQ, and will be documented in an addendum to this MEC-QAPP. An attempt will be made to reacquire and inspect the selected subset of anomalies. Anomalies that are inaccessible or cannot be reacquired during the Anomaly Inspection Phase will be documented by the field team.

MEC-QAPP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

Who will collect and generate the data? How will the data be reported?

- Phase I Site Survey:
  - The field team, which will consist of a CH2M HILL FTL and the selected site survey subcontractor (TBD), will collect the site survey data (side-scan sonar, multibeam sonar, and DGM survey data). The data collected will be used to generate maps, obstruction and anomaly lists, and bathymetry data that may be presented in the SI report.
  - Raw data files will be provided to CH2M HILL from the subcontractor on a daily basis.

    For side-scan sonar and bathymetry, all production data, including initial data imaging, contact positions, and QC data, will be processed, interpreted, and delivered to the CH2M HILL Project Geophysicist within 5 days of data collection. The side-scan sonar and bathymetry deliverable will include geo-referenced tagged image file format (TIFF) images and shape files appropriate for import into geographic information system (GIS) software. Images will be broken into blocks of no greater than 100 megabytes each.
  - The QC Geophysicist will review the preliminary geo-referenced images and data and provide approval prior to any follow-on DGM survey work.
  - All potential targets from the side-scan sonar survey will be identified in Excel spreadsheets with the coordinates of the potential targets and an image of the target for final reporting.
  - All positioning data will be reported in North American Datum (NAD) 1983 (Continental United States [CONUS]), Universal Transverse Mercator (UTM) Zone 18N, meters.
  - Initial PDF maps of raw DGM results will be provided to CH2M HILL from the subcontractor within 24 hours of data collection to allow for a determination as to whether data collection spacing should be adjusted.
  - All DGM data will be accompanied by a field data sheet documenting the field activities associated with the data and the processing performed. An example field data sheet is provided in **Table 2**.

TABLE 2
Example DGM Field Data Sheet

Site Identification
Grid Identification (or other identifier of surveyed area)
FTL Name
Field Team Member Names
Date of Data Collection
Instrument Used
Positioning Method Used
Instrument Serial Numbers
File Names in Data Recorders
Data Collection Sampling Rate
Line Numbers, Survey Direction, Fiducial Locations, and Start and End Points
Weather Conditions
Survey Area Sketch (if applicable)
Associated Base Station Data File Names (magnetometer)
Associated QC Data File Names
Field Notes (other)

MEC-QAPP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

- Within 3 working days of data collection, CH2M HILL or its site survey subcontractor (TBD) will provide pre-processed results. Pre-processed data will be corrected for sensor offsets, latency, and drift. Also provided will be a digital planimetric map, in Geosoft format and coincident with the location of the geophysical survey, so that each day's geophysical data set can be registered within the original mission plan survey map and coordinates can be extracted for decision making purposes.
- Within 5 working days of data collection, final processed geophysical data, maps, and supporting geophysical interpretations will be provided by CH2M HILL or its DGM subcontractor (TBD) in accordance with the procedures outlined in this MEC-QAPP and the SOPs in **Appendix A**. Geophysical field data will be provided in delineated fields as x, y, z, d, v1, v2, and so on, where x and y are NAD 1983 (Continental United States [CONUS]), UTM Zone 18N, meters in Easting and Northing directions, and z (altimeter reading), d (depth sensor reading), and v1, v2, and so on are the geophysical response readings. The last data field will be a time stamp. Each data field will be separated by a comma or tab. Each file containing data will be logically and sequentially named so that the file name can be easily correlated with the area surveyed. The information to be provided is summarized in **Table 3**.

TABLE 3
DGM Data Processing Documentation Requirements

Information Type	Raw/Pre-processed Data Delivery	Final Data Delivery	Must be in File Headers
Site Identification	X	X	X
Geophysical instrument type used	X	X	X*
Positioning method used	X	X	X*
Instrument serial numbers (geophysical and positioning)	X	X	
Coordinate system and unit of measure	X	X	X*
Grid Identification (or other identifier of surveyed area)	X	X	X
Date of data collection	X	X	X
Raw data file names associated with delivery	X	X	X*
Processed data file names associated with delivery		X	X*
Name of Project Geophysicist	X	X	
Name of Site Geophysicist	X	X	
Name of data processor	X	X	X*
Data processing software used	X	X	
Despiking method and details		X	
Sensor drift removal and details	X	X	
Latency and/or lag correction and details	X	X	
Heading correction and details (magnetometer data)	X	X	
Sensor bias, background leveling, and/or standardization adjustment method and details		X	
Diurnal correction (magnetometer data)	X	X	

MEC-QAPP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

TABLE 3
DGM Data Processing Documentation Requirements

Information Type	Raw/Pre-processed Data Delivery	Final Data Delivery	Must be in File Headers
PDF document showing graphical results of each field QC test	X	X	
Geophysical noise identification and removal (spatial, temporal, motional, terrain-induced) and details		X	
Other filtering and/or processing performed and details		X	
Gridding method		X	
Anomaly selection and decision criteria details		X	
Geosoft ".xyz" file for unit of survey being delivered (such as the grid or area agreed upon with MR Geophysicist)		X	
Geosoft ".grd" file for unit of survey being delivered		X	
Geosoft ".map" file for unit of survey being delivered		X	
PDF of Geosoft map for unit of survey being delivered		X	
Geosoft ".map" mosaic of all processed data to date		X	
PDF mosaic of Geosoft map of all processed data to date		X	
Other processing comments		X	
Date data processing is completed		X	
Data delivery date	X	X	
Scanned copy of field notes and field personal digital assistant notes (if applicable)	X	X	

*If CH2M HILL's Munitions Response Site Information Management System (MRSIMS), MRP Enterprise, or other database accepted by CH2M HILL's MR Geophysicist is used, then the fields marked with an asterisk are not required in the file headers.

- All data will be provided via a file transfer protocol site.
- Field notes documented by the field team during the survey will be scanned and included in the SI report as an appendix (if necessary).

Phase II Anomaly Inspection:

- The field team, which will consist of CH2M HILL subcontractor members (TBD), a CH2M HILL FTL, CH2M HILL SUXOS and UXOSO and UXOQCS will inspect anomalies (and locations) selected by the Navy, VDEQ, and USEPA.
- Raw data forms, field photographs, and field notes will be provided to CH2M HILL from the subcontractor on a daily basis.

MEC-QAPP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

- Within 10 working days of data collection, maps and anomaly inspection interpretations will be provided in accordance with the procedures outlined in this MEC-QAPP, the MEC-QAPP Addendum, and the anomaly inspection subcontractor SOP. General information for anomalies inspected will be documented in a table. Each anomaly or group of anomalies will be assigned an identification number and will include a description. If an item is suspected to be MEC-related, general information is required to be recorded. Table 4 summarizes these data.

TABLE 4
Anomaly Inspection MEC Field Data Documentation Requirements

Information Type
Site Identification
Inspection Technology Used
Positioning Method Used
Instrument Serial Numbers (inspection and positioning)
Coordinate System and Unit of Measure
Date of Data Collection
Name of Project Geophysicist
Name of FTL
Anomaly Group
Anomaly Class
Anomaly Category
Type/Filler
Description/Fuzing
Quantity
Water Depth
Depth in Sediment
Weight
Fragmentation
UXO Leader Comment for Anomaly
Location
Action Taken

- Anomaly inspection activities will be recorded in the daily field log to the extent possible. Copies of field logs will be provided daily via a file transfer protocol site or e-mail for files less than 5 megabytes. Recorded video footage (if any) will be provided within 20 days of data collection and will be submitted on compact discs or digital variable discs.
- All production data, including initial data imaging, obstruction position and location, and QC data, are to be processed, interpreted, and delivered to CH2M HILL within 10 days of data collection. The deliverable must include geo-referenced TIFF images and shape files appropriate for import into GIS software. Images will be broken into blocks of no greater than 100 megabytes each.
- Field notes documented by the field team during the survey will be scanned and included in the SI report as an appendix (if necessary).

MEC-QAPP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

How will the data be archived?

- All files will be made available for QC verification throughout the project to verify that the field procedures are properly implemented. All raw data files, hard copy documents, and field notes will be maintained by CH2M HILL for the duration of the project. Hard copy documents will be maintained at the CH2M HILL office in Virginia Beach, Virginia. Electronic data will be stored on the local CH2M HILL server. All hard copy and electronic documents will be maintained at the CH2M HILL office in Virginia Beach, Virginia, through the duration of the project (at a minimum). Upon project completion, relevant data and documents will be archived at the Federal Record Center. Additionally, final hard copy and electronic reports will be stored in the Administrative Record for WPNSTA Yorktown.
- The data will be archived in accordance with Navy guidance. At the end of the project, archived data will be returned to the Navy.

List the Project Quality Objectives in the form of if/then qualitative and quantitative statements.

PQOs are provided in **Table 1**.

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MEC-QAPP Worksheet #12-1a—Measurement Performance Criteria Table – Munitions Response

DFOW Data Type	Measurement Data Quality Indicator[a]	QC Sample and/or Activity to Assess Measurement Performance	MPC	Frequency
Side-scan Sonar, Multibeam Sonar, and DGM Survey Data Collection Equipment Warm-up	Functionality	Each system is inspected and warmed up prior to data collection. Instruments boot properly and all internal diagnostic routines demonstrate that the necessary sensors are operating correctly.	System does not show drift in response in static measurements.	At the beginning of each work day or after major system component is repaired or replaced.
Side-scan Sonar, Multibeam Sonar, and DGM Survey Data Collection Topside GPS Positioning	Accuracy	Topside GPS positions are of sufficient accuracy to translate sensor positions. Topside GPS evaluated at GPS check point established near survey vessel launch site.	Measured positions are within 10 centimeters (cm) (4 inches) of known position.	At the beginning of each work day.
Side-scan Sonar and Bathymetry Data Collection System Response	Accuracy, repeatability	The system will return consistently clear images/depth data from a known underwater stationary feature (such as a manmade structure, pile, sand bar, obstruction, and so forth) convenient to the survey vessel launch site.	The resulting images/depth data consistently and clearly depict and position the feature to within ±2 meters (6.5 feet) of previously recorded location	At the beginning and end of each work day.
Side-scan Sonar and Bathymetry Data Collection Survey Coverage	Accuracy	Comprehensive coverage of the survey area is achieved.	Data will be evaluated with each submittal for overall coverage to ensure 100% coverage of the accessible areas and 100% redundancy of the data collected.	At the end of survey to verify overall coverage, or more frequently as needed.
DGM Data Collection Sensor Positioning	Accuracy	DGM data are positioned at a sufficient enough accuracy to allow for appropriate relocation of geophysical anomalies for further inspection. This will be evaluated by comparing anomaly positions from repeat lines to ensure position repeatability to within this metric.	Derived target locations (electromagnetic [EM] peak amplitude response or magnetic dipole fit positions) will be ±2 meters (6.5 feet) of ground truth.	At the beginning of each work day.

MEC-QAPP Worksheet #12-1a—Measurement Performance Criteria Table – Munitions Response (continued)

DFOW Data Type	Measurement Data Quality Indicator[a]	QC Sample and/or Activity to Assess Measurement Performance	MPC	Frequency
DGM Data Collection Static Background/ Standard Response Test	Sensitivity	Test jig with industry standard object attached to the array platform and collect measurements.	Performed to determine if unusual levels of instrument or ambient noise exist. If EM method is used, value must be within ± 20% of running average response, after background correction. If mag, qualitative assessment of response will be performed.	At the beginning and end of each work day or if results appear to be questionable.
DGM Data Collection Depth Test	Sensitivity	Two depth measurements will be recorded at a known depth location.	System must demonstrate depth results within 15 cm (6 inches) of the known depths.	At the beginning of each work day.
DGM Data Collection Repeat Data	Repeatability	Data collected in survey mode over metallic object underwater. The object will be either a known object that was seeded or an object that already existed near the survey area.	Item position is within 2 meters (6.5 feet) of known position (if known location), or multiple passes over object result in anomalies representing object from all passes within the 2-meter (6.5-foot)-radius circle.	Beginning and end of each work day.

[a] Measurement Data Quality Indicators are defined as follows:

- Functionality – target system is mechanically operational
- Accuracy – target system is providing sufficiently accurate data as defined by the MPC
- Sensitivity – target system is responsive to given site conditions as defined by the MPC
- Repeatability – target system is capable of providing repeatable data as defined by the MPC

MEC-QAPP Worksheet #12-1b—Phase II Measurement Performance Quality Table -Munitions Response

Following completion of Phase I activities, the details of the Anomaly Inspection Phase will be developed by the Navy, USEPA, and VDEQ. This worksheet will be populated when the MEC-QAPP Addendum is prepared.

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MEC-QAPP Worksheet #12-2a—Definable Features of Work Auditing Procedure

DFOW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Pre-mobilization Activities	Work Plan	Verify the Project Work Plan has been developed and approved	Preparatory Phase (PP)	Once	Work Plan has been prepared and approved, all parties agree to the technical and operational approach	Do not proceed with field activities until criterion is passed
	ESS-DR	Verify the ESS-DR has been developed and approved	PP	Once	ESS-DR has been prepared and approved, all parties agree to the technical and operational approach	Do not proceed with field activities until criterion is passed
	GIS Setup	Verify GIS system is functional and ready for site data	PP	Once	GIS system has been set up and is ready for site data	Do not proceed with field activities until criterion is passed
	MRSIMS Setup	Verify MRSIMS system is functional and ready for site data	PP	Once	MRSIMS system has been set up and is ready for site data	Do not proceed with field activities until criterion is passed
	Document Management and Control	Verify appropriate measures are in place to manage and control project documents	PP	Once	Appropriate measures are in place to manage and control project documents	Do not proceed with field activities until criterion is passed
	Subcontractor Procurement	Ensure procurement of subcontractors and verify qualifications, training, licenses	PP/ Initial Phase (IP)	Once	Subcontractors' qualifications, training, and licenses are up to date and acceptable	Be sure subcontractor provides qualifications, training, and licenses or change subcontractor
Mobilization/ Site Preparation	Onsite Document Review	Verify Project Plans are approved and review with project team and get appropriate signatures	PP/IP	Once	Document is approved and has been reviewed and acknowledged by appropriate project team members	Personnel who are not familiar with the Project Plans may not proceed with field activities until criterion are passed
	Establish Communication and Logistics	Verify functionality of communications equipment and logistical support is coordinated	PP/IP	Once	Communications and other logistical support are coordinated	Do not proceed with field activities until criterion is passed

MEC-QAPP Worksheet #12-2a—Definable Features of Work Auditing Procedure (continued)

DFOW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Mobilization/ Site Preparation (continued)	Local Agencies and Emergency Services Notification	Verify that local agencies and emergency services have been notified of site activities	PP/IP	Once	Emergency services and local agencies are aware of site activities	Do not proceed with field activities until criterion is passed
	Verify site-specific training	Verify that all site-specific training has been performed and acknowledged	PP/IP	Once	Site-specific training is performed and acknowledged	Do not proceed with field activities until criterion is passed
	Site Boundary and Transect Establishment	Verify area/boundary and transects	PP/IP	Once	Area/boundary is correct and transects are appropriate	Stop activities until area/boundary/transect approach is verified
Side-scan Sonar, Multibeam, and DGM Survey	Equipment Testing	Verify through review of daily field log and/or MRSIMS entries that equipment testing has been performed and equipment is functional	IP/ Follow-up Phase (FP)	Once/Daily/ As Required	Equipment passes warm-up and functionality test as required by this MEC-QAPP	Repair or replace defective instrument components
	Work Methods	Verify through project kick-off and daily data review that work methods are established and communicated	IP/FP	Once/As Required	Work methods are established and communicated to site survey subcontractors	Stop activities if deviations from MEC-QAPP and scope of work are identified, until appropriate corrective measures are established.
	Data Collection	Verify through daily QC that data meet the quality requirements established in this MEC-QAPP	IP/FP	Daily	Acoustic and geophysical surveys are carried out in accordance with this MEC-QAPP and SOPs	If any QC criteria are not achieved, notify site survey subcontractor, perform root cause analysis, and implement an appropriate CA.
	Data Delivery	Verify through daily QC that data are transferred for review in accordance with delivery schedule	IP/FP	Per Data Package	Data have been delivered in accordance with time frames listed in this MEC-QAPP subcontractor scope of work	Request data if not delivered on time.

MEC-QAPP Worksheet #12-2a—Definable Features of Work Auditing Procedure (continued)

DFOW	Task with Auditable Function	Audit Procedure	QC Phase	Frequency of Audit	Pass/Fail Criteria	Action if Failure Occurs
Side-scan Sonar, Multibeam, and DGM Survey Data Evaluation	Acoustic and Geophysical Data Processing and Interpretation	Verify data processing is adequately performed and interpretation/anomaly selection is appropriate	IP/FP	Per Data Package	Data are processed, interpreted, and anomaly selection has been performed in accordance with the geophysical survey SOPs	CH2M HILL Project Geophysicist may request that data be resubmitted or recollected. If QC failure is detected, notify site survey subcontractor, perform root cause analysis, and implement an appropriate CA.
Data Evaluation and Documentation	Subcontractor Reports	Verify that subcontractor report meets requirements outlined in statement of work/technical specifications, MEC-QAPP, and applicable SOPs	IP/FP	Once	Subcontractor report meets requirements outlined in statement of work/technical specifications, MEC-QAPP, and applicable SOPs	CH2M HILL Project Geophysicist may request re-submittal of data packages if not in correct format or if elements are missing; may request revision of report if determined to not meet requirements set forth in statement of work, MEC-QAPP, and applicable SOPs
	Data Compiling and Reporting	Verify geophysical data have been properly reported and included within a presentable report	IP	Once	Data are available in a report	Retrieve all data necessary and compile into report
	Data Archiving	Verify data back-up systems are in place	IP	Once	Data back-up systems are in place	Ensure data back-up systems are in place
Demobilization	Demobilize from the site	Verify equipment and personnel have been demobilized from the site and the site is returned to pre-mobilization condition	FP	Once	All personnel and equipment have been demobilized and the site is in pre-construction condition	Notify subcontractor if equipment is left behind; subcontractor will be responsible for equipment or materials left behind after completion of field work

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MEC-QAPP Worksheet #12-2b—Phase II Definable Features of Work Auditing Procedure

Following completion of Phase I activities, the details of the Anomaly Inspection Phase will be developed by the Navy, USEPA, and VDEQ. This worksheet will be populated when the MEC-QAPP Addendum is prepared.

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MEC-QAPP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
Final PA Report	*Final Preliminary Assessment Report – UXO-0003 Munitions Loading Piers Naval Weapons Station Yorktown, Yorktown, Virginia*	CH2M HILL, 2013	Information from this report will be used to define the UXO 3 Weapons Loading Pier R-1 SI boundary and potential MEC that may have been handled at the site. Additionally, the PA did not identify any documentation of a release. Therefore, this information and the SI information collected will be used to determine the appropriate path forward for the site.	PA data are limited to desktop records and interviews. Sampling/ investigation activities at Pier R-1 were not performed during the PA. Additionally, Structure R-2 was not included or detailed in the PA.

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MEC-QAPP Worksheet #14a—Summary of Phase I Project Tasks

This section of the MEC-QAPP details the specific DFOWs to be performed to meet the objectives of the investigation. The principal tasks associated with the DFOWs are detailed as follows. Each of these work elements for the investigation, the SOPs that define the methods for performing the activities, and any other supporting documentation for performing the SI are presented in **Table 5a**.

TABLE 5a
Site Survey Activities Summary

DFOW	SOP	Supporting Document(s)
Phase I Site Survey		
Pre-Mobilization Activities	-	MEC-QAPP
Mobilization/Site Preparation	-	MEC-QAPP
Side-scan Sonar, Bathymetric, and DGM Surveys	**SOP #2, SOP #3, and SOP #4* (Appendix A)**	MEC-QAPP
Data Evaluation and Documentation	-	MEC-QAPP
Demobilization	-	MEC-QAPP

*This SOP will be provided by the subcontractor upon award.

Pre-mobilization Activities

Prior to mobilization to the site, planning activities will be performed to enhance timely project execution. This MEC-QAPP has been developed to provide details for how the project will be performed and the quality standards to which it will be compared. Prior to mobilization to the site, this plan will be reviewed and approved by the Navy, the regulators, and CH2M HILL and its subcontractor(s). Project GIS and MRSIMS databases will be set up, as appropriate, equipment will be secured for the field work, and staffing will be arranged. Necessary subcontractors will also be procured and qualifications, certifications, safety documents, and licenses will be reviewed prior to selection. Additionally, field team personnel will provide information to the Navy that will be necessary for obtaining access to the facility and investigation area. Project planning meetings will be held as needed, culminating in a project kick-off meeting.

Mobilization and Site Preparation

Personnel, equipment, and materials will mobilize to the site upon completion of the planning activities. Onsite personnel will review this MEC-QAPP, relevant SOPs and appendixes, and H&S documents. Additionally, nautical charts will be reviewed to determine the approximate location of submerged pilings from former Pier R-1 and Structure R-2 and potential navigational hazards that may be expected during the survey. Appropriate site-specific training, including H&S review for site activities, site survey training, and “3-R training” will be verified or performed. Minimum training requirements are listed in **Worksheet #8**. Additionally, a morning safety meeting will be conducted each day to review the tasks to be performed that day and any potential hazards.

All equipment will be inspected upon arrival at the site, will be tested for functionality, and will be repaired or replaced as necessary to ensure quality performance. Equipment inspections will also be performed daily throughout the project to ensure proper functionality and prevent any damage. Good housekeeping procedures will be followed to reduce the risk of equipment damage.

The CH2M HILL FTL will make sure that onsite communications (such as mobile phones and two-way radios) have been established between team members. The FTL will also make sure that local agencies and emergency services have been notified of site activities. A third-order survey monument, or better, will be located (if an existing monument is available) or established prior to conducting the DGM survey.

MEC-QAPP Worksheet #14a—Summary of Phase I Project Tasks (continued)

Side-scan and Bathymetric Surveys

Side-scan sonar and bathymetric surveys will be conducted to locate obstructions and navigational hazards in advance of the underwater DGM survey. Side-scan and bathymetric surveys will be performed along transects spaced to provide comprehensive coverage of the survey areas at former Pier R-1 and Structure R-2. The comprehensive coverage is intended to provide potential route options if navigational hazards are identified along idealized DGM transect locations. Areas to be investigated and idealized proposed transect lanes are presented on **Figure 5**. The transects shown will be field-adjusted for maximum coverage and efficiency, while still achieving the quality requirements and coverage established in this MEC-QAPP.

The side-scan sonar and bathymetric survey will provide complete bottom coverage of the identified areas of concern. The surveying equipment will be capable of detecting and avoiding any obstructions that may be located within the investigation area.

- Side-scan data will be collected with an EdgeTech 4200 system or technically comparable (same resolution) system.
- The side-scan sonar system will be set to maximize the resolution of the sonar imagery. One hundred percent of the accessible survey area will be imaged during the side-scan sonar survey.
- Water and bottom conditions will be evaluated to select operating parameters and survey geometry to provide the best possible level of sonar record detail.
- Data will be collected with 100 percent redundancy to achieve total area coverage.
- All production data, including initial data imaging, contact positions, and QC data are to be processed, interpreted, and delivered to the CH2M HILL Project Geophysicist within 5 days of data collection. The deliverable must include geo-referenced TIFF images and shape files appropriate for import into GIS software. Images will be broken into blocks of no greater than 100 megabytes each. The QC Geophysicist will review the preliminary geo-referenced images and data and must provide approval prior to any follow-on DGM survey work.
- All potential targets will be noted in Excel spreadsheets provided with coordinates of the targets.
- Coordinates for all deliverables will be in NAD 1983 (CONUS), UTM Zone 18N, meters.

The locations of proud, discrete anomalies on the riverbed surface will be correlated with the results of the DGM survey to assist in evaluating potential locations for anomaly inspection activities. The side-scan sonar system will not intentionally contact the riverbed during the investigation, in accordance with the approved ESS-DR. Applicable QC checks are described in **Worksheet #12-1a** and **Appendix A**.

Digital Geophysical Mapping

After completion and review of the side-scan sonar and bathymetric data collection, DGM will be performed to identify geophysical anomalies within the investigation area. The survey will provide high-percentage bottom coverage of the identified areas of concern (complete coverage will be attempted but currents and obstacles may prevent effective accomplishment of this goal). Additional detail regarding acceptable coverage for data delivery is defined in **Appendix A**). The surveying equipment will be capable of detecting and avoiding any obstructions that may be located within the investigation area.

MEC-QAPP Worksheet #14a—Summary of Phase I Project Tasks (continued)

- The DGM survey will include the geophysical mapping of the designated areas of UXO 3 (see **Figure 5**) to the maximum extent accessible and that can be completed safely. Areas where access is infeasible or unsafe will not be surveyed.
- The instrument footprint along each transect will be sufficient for identifying potential MEC and material potentially presenting an explosive hazard (minimal swath width is estimated to be 2 meters [6.5 feet], although sensor array configuration will provide a greater width, if possible).
- The investigation areas are approximate, and the boundaries are not to be considered the exact extent of the investigation areas. Field modification of the investigation areas may be required to accommodate site conditions and data collection and to improve productivity and efficiency.
- Efforts will be made to maintain straight, evenly spaced transects to the extent that the river conditions permit.
- Detection of geophysical anomalies will be accurate to within 2 meters (6.5 feet) of the source of the anomaly. In order for geophysical data to be accepted, the geophysical equipment will be maintained at a depth that is no greater than 1.5 meters (5 feet) above the riverbed surface while acquiring data, unless localized, site-specific conditions (such as riverbed topography, water currents, or the presence of hazards) dictate otherwise.
- The DGM equipment will be capable of operating in water depths ranging between 1.5 and 12 meters (approximately 5 to 40 feet).
- The DGM activities will be performed under an approved ESS-DR. The DGM system will not intentionally contact the seafloor during the investigation, in accordance with the ESS-DR.
- The DGM system will be capable of detecting and avoiding potential underwater obstructions that may damage the vessel or entangle or snag the DGM equipment.
- Coordinates for all deliverables will be in NAD 1983 (CONUS), UTM Zone 18N, meters.

Applicable QC checks are described in **Worksheet #12-1a** and **Appendix A**.

Data Evaluation and Documentation

On a daily basis, the site survey subcontractor will provide each day's geophysical data for QC inspection. Such data are considered to be in raw form. These data will be corrected for sensor offsets, latency, and drift. Also provided will be a digital planimetric map, in Geosoft format and coincident with the location of the geophysical survey, so that each day's geophysical data set can be registered within the original mission plan survey map.

All geophysical field data will be provided to CH2M HILL in delineated fields as x, y, z, d, v1, v2, and so on, where x and y are accurately geo-referenced with NAD 1983 (CONUS), UTM Zone 18N, meters easting and northing coordinates, z (altimeter reading), d (depth sensor reading), and v1, v2, and so on as the geophysical response readings. The last data field will be a time stamp. Each data field will be separated by a comma or tab. Each file containing data will be logically and sequentially named so that the file name can be easily correlated with the area surveyed.

Within 5 working days of data collection, the processed geophysical field data, all final maps, and supporting geophysical interpretations will be developed. All geophysical data will include a report documenting the field activities associated with the data and the processing performed. Information to be provided is summarized in **Tables 3** and **4** of **Worksheet #11**.

MEC-QAPP Worksheet #14a—Summary of Phase I Project Tasks (continued)

Once QC inspection of all geophysical data has been performed, the data will be evaluated to determine the potential presence of MEC at the site. The data will be reviewed by MEC-experienced data processing geophysicists. The geophysicists will use the following criteria for selecting significant anomalies:

- Maximum amplitude of the response with respect to local background conditions
- Lateral extent (plan size) of the area of response
- Shape of the response
- Location of the response with respect to the edge of the transects, unsurveyable areas, and underwater features

Instrument-specific software will be used for initial data processing and the output will be imported into Geosoft Oasis Montaj for additional processing, graphical display, anomaly selections, and QA/QC. Types of processing will be system-specific, but the general processing steps that may be performed to ensure quality data include the following:

- Positional offset correction
- Sensor bias, background leveling, and/or standardization adjustment
- Sensor drift removal
- Latency or lag correction
- Geophysical noise identification and removal
- Contour level selection with background shading
- Digital filtering and enhancement (such as low pass, high pass, band pass, convolution, correlation, and non-linear)

All field data, quality procedures, methods, and interpretations of the DGM survey will be summarized and documented in a technical memorandum.

Demobilization

Prior to demobilization from the site, an evaluation of the data will be performed to be sure that all project objectives are achieved, the data are of acceptable quality, and they are approved by the Navy. Once approval of the data is received from the Navy, the crew and equipment will be demobilized from the site. All staging or storage areas will be removed, and the site will be returned to pre-mobilization condition.

MEC-QAPP Worksheet #14b—Summary of Phase II Project Tasks

This section of the MEC-QAPP details the specific DFOWs for the Anomaly Inspection Phase to be performed to meet the objectives of the anomaly investigation if the Navy, VDEQ, and USEPA agree additional investigation is warranted. This worksheet will be modified, as necessary, when the MEC-QAPP Addendum is prepared. The anticipated principal tasks associated with the DFOWs are detailed as follows. Each of these work elements for the investigation, the SOPs that define the methods for performing the activities, and any other supporting documentation for performing the SI are presented in **Table 5b**.

TABLE 5b
Anomaly Inspection Activities Summary

DFOW	SOP	Supporting Document(s)
Phase 2 Anomaly Inspection		
Pre-Mobilization Activities	-	MEC-QAPP and MEC-QAPP Addendum
Anomaly Inspection Mobilization/Site Preparation	-	MEC-QAPP and MEC-QAPP Addendum
Anomaly Inspection	**SOP #5* (Appendix A)**	MEC-QAPP and MEC-QAPP Addendum
Demobilization	-	MEC-QAPP and MEC-QAPP Addendum
SI Reporting		

*This SOP will be provided by the subcontractor upon award.

Pre-Mobilization Activities

If additional investigation is warranted based on the site survey data collected, an Explosives Safety Submission (ESS) or updated ESS-DR (depending on the activities to be performed) will be developed and submitted for Naval Ordnance Safety and Security Activity approval prior to anomaly inspection field activities. Additionally, an addendum to this MEC-QAPP will be developed to incorporate the specific details relating to the implementation and methodology of the anomaly inspection approach. The addendum will document the quality standards for the specific technology to be implemented, the agreed-upon anomalies or anomaly areas requiring inspection (to be selected by the Partnering Team based on the DGM results), and the SOPs for performing the anomaly inspection.

Before mobilization to the site, planning activities will be performed to be sure procedures are in place to perform the fieldwork. Before fieldwork is performed, the work planning documentation will be reviewed and approved by the Navy, the regulators, and CH2M HILL and its subcontractor(s). Applicable notifications and permits (if appropriate) will be completed prior to conducting any intrusive field activities. Additionally, internal coordination will take place so that GIS information and equipment are available and updated for project activities based on the most recent data (including DGM data); document and data management procedures are in place for conducting the Anomaly Inspection Phase; and all necessary subcontractors have been procured. Subcontractor qualifications, certifications, and licenses will be reviewed before selection. All field team personnel will provide information to the Navy that will be necessary for obtaining access to the facility and investigation area.

Anomaly Inspection Mobilization and Site Preparation

Once the ESS and ESS-DR and MEC-QAPP Addendum have been approved, the field personnel, equipment, and materials will be mobilized to the site to complete the Anomaly Inspection Phase. Onsite personnel will review this MEC-QAPP, the MEC-QAPP Addendum, the ESS, and all applicable SOPs and appendixes. Nautical charts, bathymetry and side-scan data, and DGM data will be reviewed to locate potential navigational or potential H&S hazards that may be encountered during the inspection. Appropriate site-specific training, including H&S review of site activities, emergency responses, and communications, will be conducted before the start of work.

MEC-QAPP Worksheet #14b—Summary of Phase II Project Tasks (continued)

Additionally, a morning safety meeting will be conducted each day to review the tasks to be performed that day and any potential hazards that may be encountered.

All equipment will be inspected upon arrival at the site, tested for functionality, and repaired or replaced as necessary for quality performance. Equipment inspections will also be performed daily throughout the project to ensure proper functionality and prevent any damage. Good housekeeping procedures will be followed to reduce the risk of equipment damage.

The CH2M HILL FTL will make sure that onsite communications (such as mobile phones and two-way radios) have been established between team members. Support zones and break areas will be identified before work begins.

Anomaly Inspection

The Partnering Team will determine a representative quantity and locations of geophysical anomalies requiring inspection. The type of technology to be used will be determined based on site conditions, H&S considerations, and DGM survey results. Specific procedures for the technology to be implemented will be included in an addendum to this MEC-QAPP. Examples of the types of technologies that may be used to conduct the anomaly inspection may include (but are not limited to) the following:

- ROV – An ROV equipped with high-resolution video cameras, navigation system, and high-intensity halogen lighting may be used to provide enhanced visual observation of select anomalies.
- Diver – An experienced UXO dive team may be employed to perform visual inspection of anomalies (high-resolution video cameras, navigation system, and high-intensity halogen lighting may be used) to provide enhanced visual inspection of select anomalies.
- Dredging or Magnetic Dredge Recovery – Anomaly sources may be recovered through the use of a barge-mounted, clamshell-type dredge or electromagnet with raking system (for ferrous anomaly recovery only, to reduce the amount of investigation-derived waste generated). Select sources of anomalies or anomaly areas will be recovered and will be visually inspected by UXO-qualified personnel.

The QC procedures and specifics regarding equipment operations and conducting the anomaly inspection will be provided in an addendum to this MEC-QAPP.

Anomaly Inspection Demobilization

Once approval of the data is received from the Navy, the crew and equipment will be demobilized from the site. All staging or storage areas will be removed, and the site will be returned to pre-mobilization condition.

Site Inspection Reporting

At the conclusion of all field activities (including Phase I and Phase II), an SI report will be prepared to document the activities performed at the site and summarize the results and conclusions of the site survey activities and anomaly inspections. The report will include maps of data collected and anomalies inspected, interpretations of the data obtained, and a narrative description of the field activities, including data collection methodology, processing, interpretation, and results. The narrative will also detail the accuracy of the equipment, describe the instrumentation that was used, provide the limitations of the equipment and data, and detail the QC checks performed to verify equipment functionality. Following the review by the Navy, the report will be distributed to the USEPA and VDEQ.

MEC-QAPP Worksheet #16—Project Schedule / Timeline Table

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Draft MEC-QAPP	Navy/CH2M HILL		10/25/13	Draft Project Plans	10/25/13
Regulatory Review	USEPA and VDEQ	10/28/13	11/29/13*	Regulatory Comments	11/29/13*
Resolve Regulatory Comments/Draft Final MEC-QAPP	CH2M HILL	12/02/13*	12/06/13*	Regulatory Response to Comments (RTC)	12/06/13*
Issue Final MEC-QAPP	CH2M HILL	12/06/13*	12/13/13*	Final Project Plans	12/13/13*
Phase I SI Field Work (Side-scan sonar and bathymetry survey)	CH2M HILL and Site Survey Subcontractor	11/23/13**	12/1/13**	Field Documentation, side-scan sonar and bathymetry data, QC Reports, and H&S documents	12/20/13
Phase I SI Field Work (Site Survey)	CH2M HILL and Site Survey Subcontractor	12/21/13**	01/02/14**	Field Documentation, Raw Geophysical Survey Data, QC Reports, and H&S documents	01/03/14
Data Evaluation/Technical Memorandum Summary	CH2M HILL and DGM Subcontractor	01/03/14	03/03/14	Preprocessed Data and Final Data	3/03/14
Draft MEC-QAPP Addendum	CH2M HILL	03/03/14	04/30/14	Draft Project Plan Addendum	04/30/14
Regulatory Review	USEPA and VDEQ	04/30/14	06/30/14	Regulatory Comments	06/30/14
Resolve Regulatory Comments on Draft Final MEC-QAPP Addendum	CH2M HILL	06/30/14	07/15/14	Regulatory RTC	07/15/14
Issue Final MEC-QAPP Addendum	CH2M HILL	07/15/14	07/17/14	Final Project Plan Addendum	07/17/14
Phase II SI Field Work (Anomaly Inspection)	CH2M HILL and Anomaly Inspection Subcontractor	08/15/14	09/15/14	Field Documentation, QC Reports, and H&S documents	09/15/14
Draft SI Report	CH2M HILL	09/15/14	11/15/14	Draft SI Report	11/15/14
Regulatory Review	USEPA and VDEQ	11/15/14	01/15/15	Regulatory Comments	01/15/15
RTC	CH2M HILL	01/30/15	02/01/15	Regulatory RTC	02/01/15
Final SI Report	CH2M HILL	02/15/15	02/15/15	Final SI Report	02/15/15

*Date is estimated based on expedited Team Review of the document. Dates will be adjusted as necessary based on Team Review.
**Firm date for field activities due to Facility Operations. Per USEPA and VDEQ email agreement (dated 9/3/13) and expedited review will be performed and Phase I field activities may be performed prior to finalization of the MEC-QAPP.

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MEC-QAPP Worksheet #17a—Sampling Design and Rationale

The primary objective of this investigation is to determine the presence or suggested absence of MEC at the inactive former Pier R-1 and Structure R-2. To do this, side-scan sonar, bathymetric, and DGM surveys will be completed as Phase I of the investigation, followed by an inspection of select geophysical anomalies (Phase II) if deemed necessary. The general investigation approach and rationale is provided in **Table 1** (**Worksheet #11**). A detailed description of the DFOWs and tasks to be performed during this investigation is presented in **Worksheet #14a**. The schedule of activities for the project is indicated in **Worksheet #16**. Additional details on the sample design and rationale for the proposed SI activities are provided as follows.

Phase I Side-scan and Bathymetric Surveys

Objective: Side-scan and bathymetric surveys will be performed along transects spaced to provide comprehensive coverage of the survey areas at former Pier R-1 and Structure R-2. The comprehensive coverage is intended to provide potential route options if navigational hazards are identified along idealized DGM transect locations. The proposed transects are depicted on **Figure 5**; the transects may be field-modified based on site conditions, the subcontractor and/or system selected, and safety concerns.

Sample Design and Rationale: The investigation area of former Pier R-1 was selected based on the locations of the berths (length of the piers) along the pier and the area where MEC is most likely to be present (an estimated 250 feet offset from all sides of the berthing area) where munitions-loading operations have historically occurred. The investigation area around Structure R-2 is an offset of approximately 100 feet around the structure and extending into the R-1 area. A smaller offset is warranted for the Structure R-2 area because only small ships were loaded at this location. Side-scan sonar and bathymetric surveys will be conducted to locate obstructions and navigational hazards in advance of the underwater DGM survey. In addition, the locations of proud, discrete anomalies that appear to be associated with objects on the riverbed surface will be correlated with the results of the DGM survey for identification of potential locations requiring anomaly inspection.

Phase I Digital Geophysical Mapping Survey

Objective: Identify the number and location of geophysical anomalies with a metallic response within the sediment or lying on the sediment surface within the investigation area of former Pier R-1 and Structure R-2 (see **Figure 4**). To the extent practicable, 100 percent coverage of the investigation area will be evaluated for geophysical anomalies. The proposed transects are depicted on **Figure 5**; the transects may be field-modified based on site conditions, the subcontractor and/or system selected, and safety concerns.

Sample Design and Rationale: The use of DGM technology is the most practicable and reliable technology to identify metallic items within and lying on the sediment within the investigation area. The use of DGM to identify metallic items is appropriate because a majority of MEC items were made of metal that can be detected by DGM technology. However, there are limitations to the maximum depth at which various sized items can be detected (see SOP #3 of **Appendix A**). To the extent practicable, DGM data will be collected along evenly spaced transects surrounding the pier and running parallel to the structure. The proposed transects may be field-modified based on site conditions and safety concerns. All recorded DGM data will be reviewed by the Project Geophysicist.

MEC-QAPP Worksheet #17b—Phase II Sampling Design and Rationale

Following completion of Phase I activities, the details of the Anomaly Inspection Phase will be developed by the Navy, USEPA, and VDEQ. This worksheet will be populated when the MEC-QAPP Addendum is prepared.

MEC-QAPP Worksheet #18a—Phase I Sampling Locations and Methods/SOP Requirements Table (Munitions Response)

Data collection activities performed at the site will include side-scan sonar and bathymetric surveying, underwater DGM, and anomaly inspection.

Grid Location / Identification Number	Exclusion Areas	Matrix	Maximum water Depth	Survey Methodology	Degree of Investigation or Coverage	SOP Reference
Munitions Loading Pier R-1 and Structure R-2	Trestle and navigational hazard areas	Underwater riverbed surface and near surface (sediment)	12 meters (40 feet)	Side-scan sonar, multibeam sonar, and DGM	100 percent coverage to the extent practicable	SOP #2, SOP #3, and SOP #4*

* SOP will be provided by the subcontractor upon award.

MEC-QAPP Worksheet #18b—Phase II Sampling Locations and Methods/SOP Requirements Table (Munitions Response)

Following completion of Phase I activities, the details of the Anomaly Inspection Phase will be developed by the Navy, USEPA, and VDEQ. This worksheet will be populated when the MEC-QAPP Addendum is prepared.

MEC-QAPP Worksheet #21—Project Sampling SOP References Table (Munitions Response)

Reference Number	Title, Revision Date, and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP 1	Preparing Field Log Books	CH2M HILL	Not applicable	N	None
SOP 2	Side-Scan Sonar SOP	CH2M HILL	Side-scan sonar equipment	N	None
SOP 3	Underwater DGM SOP	CH2M HILL	DGM Equipment	N	None
SOP 4*	Underwater Site Survey SOP	DGM Subcontractor	DGM Towed Array	N	None
SOP 5*	Anomaly Inspection SOP	Anomaly Inspection Subcontractor	TBD	TBD	None

* SOP will be provided by the subcontractor upon award.

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MEC-QAPP Worksheet #22a—Phase I Field Equipment Calibration, Maintenance, Testing, and Inspection Table

See also **Worksheet #12-1a**.

Field Equipment	Activity	Frequency	Acceptance Criteria	CA	Responsible Person	SOP Reference	Comments
Side-scan sonar, Multibeam sonar, and DGM Equipment Warm-up	Functionality	At the beginning of each work day.	System does not show drift in response in static measurements.	Inspect, repair, and replace equipment until functioning properly	Equipment operator	SOP 2, SOP 3, and SOP 4	QC Geophysicist to evaluate test compliance during daily data review
Side-scan sonar, Multibeam sonar, and DGM Topside GPS Positioning	Accuracy	At the beginning of each work day.	Measured positions are within 10 cm (4 inches) of known position.	Inspect, repair, and replace equipment until functioning properly	Equipment operator	SOP 2, SOP 3, and SOP 4	QC Geophysicist to evaluate test compliance during daily data review
Side-scan sonar and Multibeam sonar System Response	Accuracy, Repeatability	At the beginning and end of each work day.	The resulting images and depth data consistently and clearly depict and position the selected feature (such as a manmade structure, pile, sand bar, obstruction, and so forth) within ± 2 meters (6.5 feet) of the previously recorded location.	Inspect, repair, and replace equipment until functioning properly	Equipment operator	SOP 4	QC Geophysicist to evaluate test compliance during daily data review
Side-scan Sonar and Multibeam sonar Survey Coverage	Accuracy	At the end of survey to verify overall coverage, or more frequently as needed.	100 percent coverage of the accessible areas and 100 percent redundancy of the data collected.	Inspect, repair, and replace equipment until functioning properly	Equipment operator	SOP 4	QC Geophysicist to evaluate test compliance during daily data review
DGM Sensor Positioning	Accuracy	At the beginning of each work day.	Derived target locations (EM peak amplitude response or magnetic dipole fit positions) will be ±2 meters (6.5 feet) of ground truth.	Inspect, repair, and replace equipment until functioning properly	Equipment operator	SOP 2, SOP 3, and SOP 4	QC Geophysicist to evaluate test compliance during daily data review
DGM Static Background/Standard Response Test	Sensitivity	At the beginning and end of each work day or if results appear to be questionable.	Performed to determine if unusual levels of instrument or ambient noise exist. If EM method is used, value must be within ± 20 percent of running average response, after background correction. If mag, qualitative assessment of response will be performed.	Inspect, repair, and replace equipment until functioning properly	Equipment operator	SOP 2, SOP 3, and SOP 4	QC Geophysicist to evaluate test compliance during daily data review
DGM Sensor Depth Test	Sensitivity	At the beginning of each work day.	Equipment must demonstrate that depth results are within 15 cm (6 inches) of the known depth.	Inspect, repair, and replace equipment until functioning properly	Equipment operator	SOP 2, SOP 3, and SOP 4	QC Geophysicist to evaluate test compliance during daily data review
DGM Repeat Data	Repeatability	At the beginning and end of each work day.	Item position is within 2 meters (6.5 feet) of known position (if known location) or multiple passes over object result in anomalies representing object from all passes within 2-meter (6.5-foot)-radius circle.	Inspect, repair, and replace equipment until functioning properly	Equipment operator	SOP 2, SOP 3, and SOP 4	QC Geophysicist to evaluate test compliance during daily data review

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MEC-QAPP Worksheet #22b—Phase II Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Following completion of Phase I activities, the details of the Anomaly Inspection Phase will be developed by the Navy, USEPA, and VDEQ. This worksheet will be populated when the MEC-QAPP Addendum is prepared.

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MEC-QAPP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
• Field Notebooks • Field Work Plans • CA Forms • Electronic Data Deliverables • Meteorological Data from Field • Equipment and Instrument Check Logs • Field Team Notes and Field Logs • Equipment Maintenance, Testing, and Inspection Logs • Reported Result for QC Checks • Raw Data (stored on disk) • Field Photograph Log • Daily Project Reports • Daily H&S Documents • QC Documentation and Reports • Meeting Agendas, Minutes, and Presentations • Summary Reports	• Field data deliverables such as logbooks entries, electronic data deliverables, field work plans, and daily reports will be kept on CH2M HILL's network server. • Survey information hard copy deliverables and data processing and interpretation documents will be saved on CH2M HILL's network server. • Survey data and anomaly inspection results will be reported in the SI report.

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MEC-QAPP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
PHASE I ACOUSTIC AND DGM SURVEYS							
Field Performance Audit	Once during field event	Internal	CH2M HILL	CH2M HILL Geophysicist	Project Geophysicist	Project Geophysicist	CH2M HILL PM
Data storage and transfer system check	Before initial data collection and once weekly	Internal	CH2M HILL	CH2M HILL Geophysicist	Site Survey Subcontractor	Geophysical Subcontractor	CH2M HILL PM
PHASE II ANOMALY INSPECTION*							
Field Performance Audit	Once during field event	Internal	CH2M HILL	UXOQCS	UXOQCS	UXOQCS	CH2M HILL PM

*If additional investigation is warranted, the anomaly inspection technology will be selected by the Navy, VDEQ, and USEPA. Anomaly Inspection Phase planned project assessments specific to the selected technology will be discussed in greater detail in the MEC-QAPP Addendum.

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MEC-QAPP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response	Timeframe for Response
Field Performance Audit	Checklist and Written Audit Report	Adam Forshey PM, CH2M HILL	Within 1 week of audit	Memorandum	CH2M HILL FTL CH2M HILL Geophysicist	Within 1 week of receipt of CA Form

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MEC-QAPP Worksheet #32-1—Corrective Action Form

Person initiating CA ________________ Date ____________________

Description of problem and when identified (submit a drawing/sketch if necessary): ________________________

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Cause of problem, if known or suspected: ____

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Resolution/Sequence of CA: (including date implemented, action planned, and personnel/data affected) _______

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CA implemented by: ______________________ Date: __________________________________

CA initially approved by: ___________________ Date: __________________________________

Follow-up date: ____

Final CA approved by: ______________________Date: __________________________________

Information copies to:

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MEC-QAPP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.: ____________________ Date: ____________________

Project Location: ____________________ Signature: ____________________

Team Members:

Yes No 1) Is the approved work plan being followed?
Comments ____________________

Yes No 2) Was a briefing held for project participants?
Comments ____________________

Yes No 3) Were additional instructions given to project participants?
Comments ____________________

Site Survey Operations

Yes No 1) Are routine inspections and QC checks of the equipment being performed as outlined in this MEC-QAPP?
Comments ____________________

Yes No 2) Is the proposed location of transect lines clearly communicated with Survey Team?
Comments ____________________

Yes No 3) Is data collection being performed as required by the MEC-QAPP?
Comments ____________________

Yes No 4) Are data stored properly and uploaded for transfer in a timely manner?
Comments ____________________

MEC-QAPP Worksheet #32-2—Field Performance Audit Checklist (continued)

Yes No 5) Are photographs being taken and documented?
Comments ____

____

DGM/Anomaly Inspection Operations

Yes _ No _ 1) Are routine inspections and QC checks of the equipment being performed as outlined in this MEC-QAPP?
Comments ____

____

Yes _ No _ 2) Are the proposed locations (DGM transects or metallic anomaly locations) clearly communicated with the Investigation Team?
Comments ____

____

Yes _ No _ 3) Is data collection being performed as required by the MEC-QAPP?
Comments ____

____

Yes _ No _ 4) Are data stored properly and uploaded for transfer in a timely manner?
Comments ____

____

Yes _ No _ 5) Were photographs taken and documented?
Comments ____

____

Document/Data Control

Yes No 1) Are all work plan documents available onsite for review?
Comments ____

____

Yes No 2) Are daily reports and other documentation completed as required by the MEC-QAPP?
Comments ____

____

Yes No 3) Are equipment QC data and collected field data properly transferred for review?
Comments ____

MEC-QAPP Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date	Person Responsible for Report Preparation	Report Recipient(s)
Daily QC Report	Daily	Following day	Site QC Manager	CH2M HILL PM
QC Meeting Minutes	Post-meeting	Within 7 days	Site QC Manager	CH2M HILL PM
Preparatory Inspection Forms	Once for each applicable DFOW (prior to start of task)	With daily reports the following day after meeting	Site QC Manager	CH2M HILL PM
Initial Inspection Forms	Once for each applicable DFOW (prior to start of task)	With daily reports the following day after meeting	Site QC Manager	CH2M HILL PM
Follow-up Inspection Forms	Once for each applicable DFOW (document in daily reports)	Document in daily reporting	Site QC Manager	CH2M HILL PM

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MEC-QAPP Worksheet #34a—Phase I Verification (Step I) Process Table

Verification Input	Description	Internal / External	Responsible for Verification
Evidence of required approval of plan (MEC-QAPP)	Evidence of approval and completeness of MEC-QAPP. Includes establishment of PQOs, QC criteria, SOPs, PALs, figures, and so forth.	Internal	PM/FTL, CH2M HILL
Site-specific Training Records	Ensure project personnel have proper training and certification to perform site activities and achieve project data quality objectives.	Internal	PM/FTL, CH2M HILL
Site Survey Data Methods	Site survey data methods will be reviewed to be sure data collection is performed as defined in the MEC-QAPP.	Internal	Geophysicist, CH2M HILL
Data Collection and Transfer	Be sure data collection is complete and recorded accurately and that data transfer protocol is adequate.	Internal	Geophysicist, CH2M HILL
Performance Requirements (including QC criteria)	Be sure performance requirements are fully established (see **Worksheet #12**).	Internal	PM/FTL, CH2M HILL
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data collection, data collection times, site operations, site conditions, and so forth. The logbook will also be used to document, explain, and justify all deviations from the approved MEC-QAPP and other work planning documents.	Internal	PM/FTL, CH2M HILL

MEC-QAPP Worksheet #34b—Phase II Verification (Step I) Process Table

Following completion of Phase I activities, the details of the Anomaly Inspection Phase will be developed by the Navy, USEPA, and VDEQ. This worksheet will be populated when the MEC-QAPP Addendum is prepared.

MEC-QAPP Worksheet #35a—Phase I Validation (Steps IIa and IIb) Process Table

Step IIa / IIb[1]	Validation Input	Description	Responsible for Validation (name, organization)
IIb	Onsite Screening	Ensure that all field data meet Work Plan requirements for completeness and accuracy based on the field calibration records.	FTL, CH2M HILL
IIa	Site Survey Data Methods	Verify that all data collected were in accordance with the SOPs and requirements of the MEC-QAPP. Be sure any deviations from the MEC-QAPP are documented.	FTL and Geophysicist, CH2M HILL
IIa	Data Collection and Transfer	Ensure all data are usable and have been corrected in accordance with data processing procedures defined in the SOPs.	Geophysicist, CH2M HILL
IIa	Performance Requirements (including QC criteria)	Establish that QC tests were performed and are compliant with method-required limits as specified in **Worksheet #12-1a**.	FTL and Geophysicist, CH2M HILL
IIa	Field Log Notebooks	Review field logbooks, field documents, and data deliverables for compliance with methods and signatures.	FTL and PM, CH2M HILL
IIb	Performance Requirements (including QC criteria)	Ensure that the data report has been provided and that all data are complete. Evaluate if all data collection procedures were followed with respect to the equipment and QC process.	Geophysicist, CH2M HILL

[1] IIa = compliance with methods, procedures, and contracts
IIb = comparison with MPC in the QAPP

MEC-QAPP Worksheet #35b—Phase II Validation (Steps IIa and IIb) Process Table

Following completion of Phase I activities, the details of the Anomaly Inspection Phase will be developed by the Navy, USEPA, and VDEQ. This worksheet will be populated when the MEC-QAPP Addendum is prepared.

MEC-QAPP Worksheet #37—Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

- If all QC criteria are met, then the data are usable.
- If QC criteria are not met, then data are suspect and cannot be used until confirmed. Re-collection of data may be required.

Describe the evaluative procedures used to assess overall measurement error associated with the project.

- To assess whether a sufficient quantity of acceptable geophysical data are available for decision making, the data will be reviewed by MEC-experienced data processing geophysicists as described in **Worksheets #11, #12-1a, and #14a**. QC criteria outlined in this MEC-QAPP and the SOPs will be evaluated to be sure the data are collected within the specified parameters.
- To assess whether a sufficient quantity of acceptable data from the anomaly inspection is available to make further decisions for the site, the data will be reviewed by the Navy, VDEQ, and USEPA to make sure the inspection met the objectives identified in the MEC-QAPP Addendum.
- If significant inconsistencies in data are detected, they will be evaluated to assess their effect on decision making.
- If significant deviations are noted between the QC of equipment, background information, and field data, the cause will be further evaluated to assess their effect on decision making.

Describe the documentation that will be generated during the usability assessment and how usability assessment results will be presented so that they identify trends, relationships (correlations), and anomalies:

- Data tables will be produced for geophysical data and will reflect which anomalies were selected as significant and which were eliminated from consideration during data interpretation. These data tables will be presented in the technical memorandum summary and SI report.
- Graphical representations and site representative figures will be produced to reflect the areas that are most likely to contain MEC and those that do not.
- The Phase I technical memorandum will identify any data usability limitations and make recommendations for future investigations, if necessary. DGM equipment detection limitations for estimated maximum depth of various sized items will be summarized in an uncertainties section of the SI Report.
- A data quality evaluation section will be included as part of the Phase I technical memorandum to summarize the results of the data collection and interpretation.
- The Phase I technical memorandum will identify any data usability limitations and make recommendations for CA if necessary.
- A description of anomalies investigated during the Phase II Anomaly Inspection will be summarized and presented in the SI report as described in **Worksheets #11, #12-1b and #14b**. Appropriate details of the items (weight, orientation, location, and so forth) will be included to the extent practical. Additional details may be required by the MEC-QAPP Addendum.
- The SI will identify any data usability limitations and recommend additional investigations if necessary.
- A data quality evaluation section will be included as part of the final report to summarize the results of the data collection and interpretation.
- The SI will identify any data usability limitations and recommend CA if necessary.

MEC-QAPP Worksheet #37—Usability Assessment (continued)

Identify the personnel responsible for performing the usability assessment.

- The PM, Project Geophysicist, and other team members will be responsible for collecting and compiling the data. The data will then be presented to the Navy, USEPA, and VDEQ for evaluation of the data usability according to project objectives.

References

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Figures

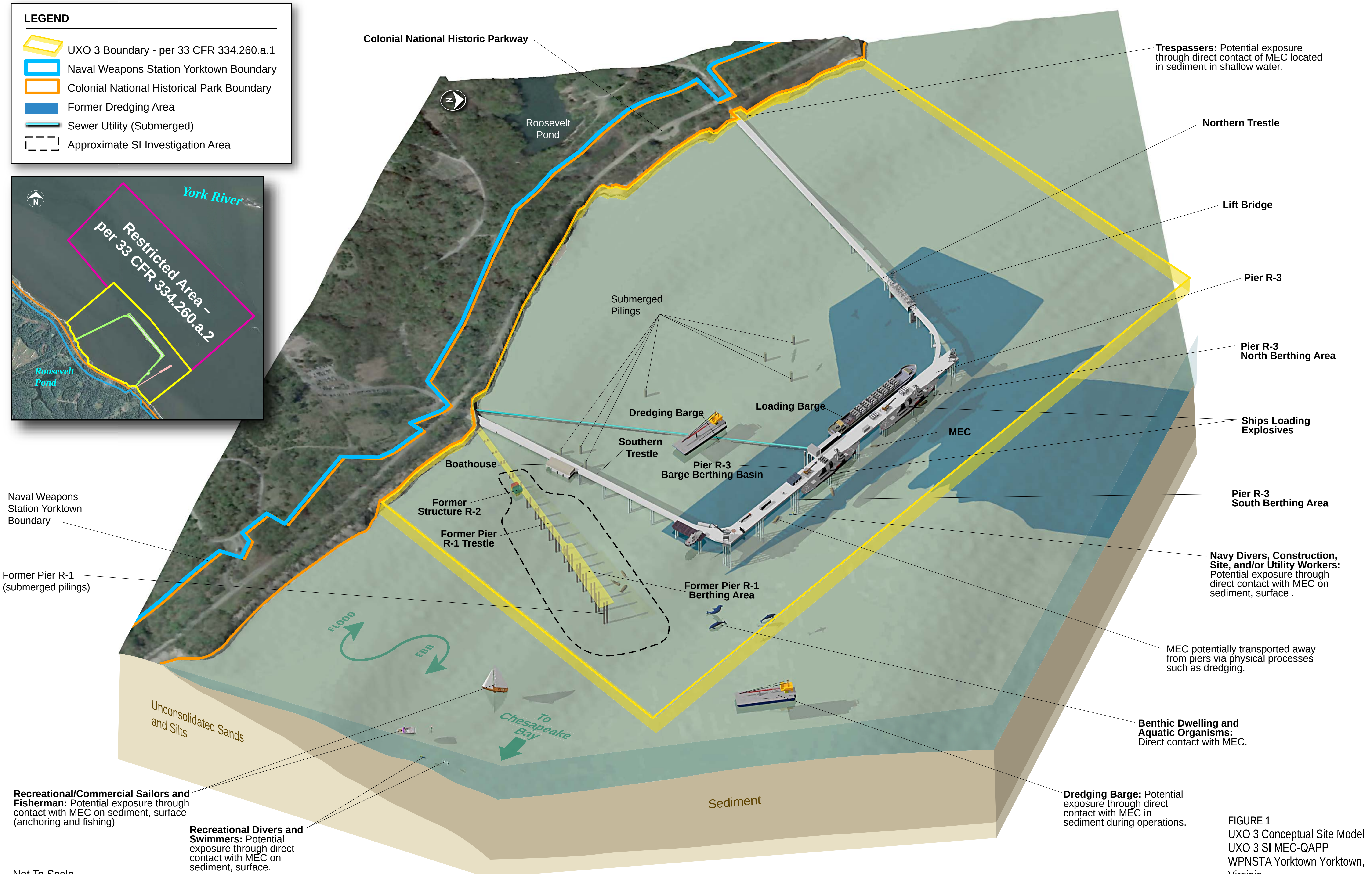
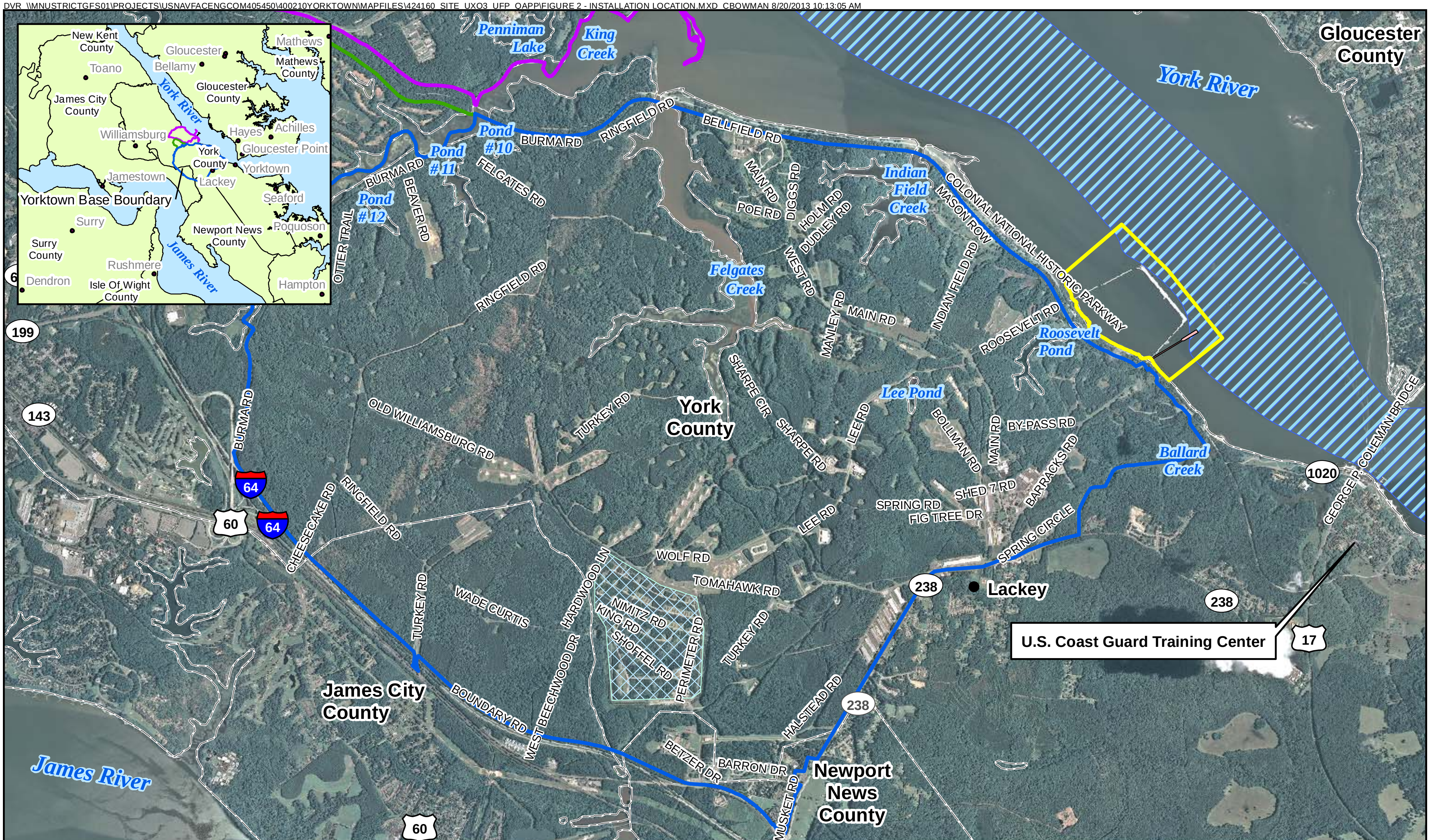


FIGURE 1
UXO 3 Conceptual Site Model
UXO 3 SI MEC-QAPP
WPNSTA Yorktown Yorktown, Virginia

CH2MHILL

ES050611133528GNV Fig4-1_UXO-00003 CSM_rev20.ai 08-28-2013 dash/LED

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\400210YORKTOWN\MAPFILES\424160_SITE_UXO3_UFP_QAPP\FIGURE 2 - INSTALLATION LOCATION.MXD CBOWMAN 8/20/2013 10:13:05 AM



Legend

UXO 3 Boundary	Kings Creek Commerce Park
Water Features	Cheatham Annex
York River Main Channel	Former Skiffes Creek Annex
County Boundary	Yorktown Base Boundary

N
W E
S

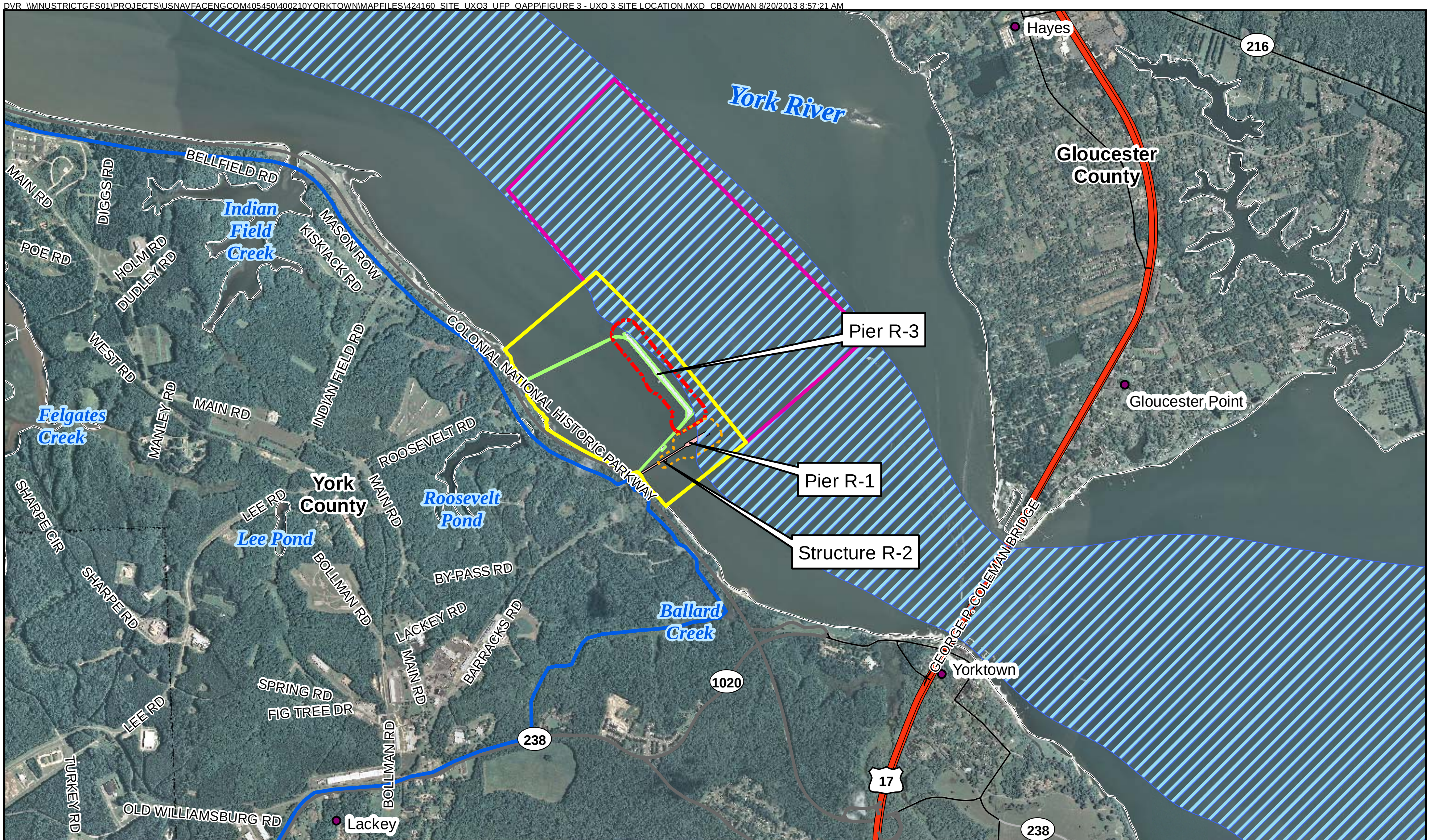
0 2,250 4,500
Feet

Imagery: 2011

Figure 2
Installation Location Map
UXO 3 SI MEC-QAPP
WPNSTA Yorktown
Yorktown, Virginia

CH2MHILL.

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\400210YORKTOWN\MAPFILES\424160_SITE_UXO3_UFP_QAPP\FIGURE 3 - UXO 3 SITE LOCATION.MXD CBOWMAN 8/20/2013 8:57:21 AM



Legend

- Yorktown Base Boundary
- Location of former pier known as Pier R-1 (submerged pilings remain)
- York River Main Channel
- Restricted Area (no unauthorized access during munitions loading/unloading activities)
- Site UXO 3 Boundary (Prohibited Area [no unauthorized access at all times])
- Pier R-3
- County Boundary
- Approximate SI Investigation Area
- Area Recommended for SI once munitions loading operations have ceased

N W E S

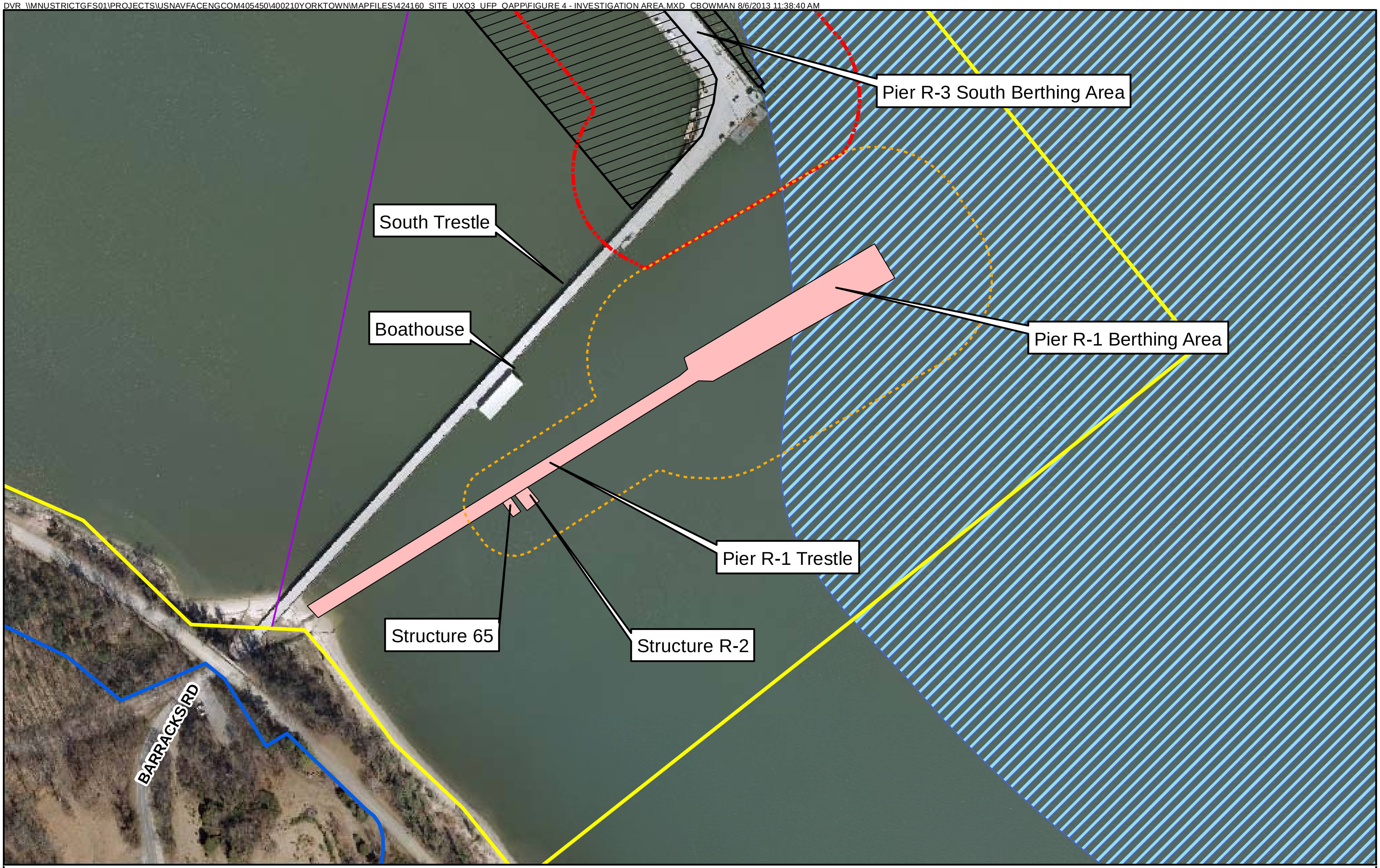
0 1,500 3,000 Feet

Imagery: 2011

Figure 3
UXO 3 Location and Vicinity
UXO 3 SI MEC-QAPP
WPNSTA Yorktown
Yorktown, Virginia

CH2MHILL.

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\400210YORKTOWN\MAPFILES\424160_SITE_UXO3_UFP_QAPP\FIGURE 4 - INVESTIGATION AREA.MXD CBOWMAN 8/6/2013 11:38:40 AM



Legend

- Approximate SI Investigation Area
- Area Recommended for SI once munitions loading operations have ceased
- Former Dredged Area
- Yorktown Base Boundary
- UXO 3 Boundary
- Location of former pier known as Pier R-1 (submerged pilings remain)
- York River Main Channel
- Sewer Utility (Submerged)

Note:
The investigation area boundary may be adjusted in the field based upon site conditions encountered during the investigation.

N W E S

0 175 350 Feet

Imagery: 2010

Figure 4
Investigation Area
UXO 3 SI MEC-QAPP
WPNSTA Yorktown
Yorktown, Virginia

CH2MHILL.

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\400210YORKTOWN\MAPFILES\424160_SITE_UXO3_UFP_QAPP\FIGURE 5 - PROPOSED TRANSECTS.MXD CBOWMAN 8/6/2013 11:49:48 AM

Legend

- Area Recommended for SI
- Side-scan Sonar/Multibeam Sonar Proposed Transects
- Proposed DGM Transects
- Yorktown Base Boundary
- UXO 3 Boundary
- Location of former pier known as Pier R-1 (submerged pilings remain)

Note:
The investigation area boundary may be adjusted in the field based upon site conditions encountered during the investigation.

N W E S

0 100 200 Feet

Imagery: 2010

Figure 5
Proposed Transects
UXO 3 SI MEC-QAPP
WPNSTA Yorktown
Yorktown, Virginia

CH2MHILL

Appendix A
Standard Operating Procedures

STANDARD OPERATING PROCEDURE

Preparing Field Log Books

I. Purpose

This SOP provides general guidelines for entering field data into log books during site investigation and remediation activities.

II. Scope

This is a general description of data requirements and format for field log books. Log books are needed to properly document all field activities in support of data evaluation and possible legal activities.

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

Properly completed field log books are a requirement for much of the work we perform under the Navy CLEAN contract. Log books are legal documents and, as such, must be prepared following specific procedures and must contain required information to ensure their integrity and legitimacy. This SOP describes the basic requirements for field log book entries.

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

1. Field notes commonly are kept in bound, hard-cover logbooks used by surveyors and produced, for example, by Peninsular Publishing Company and Sesco, Inc. Pages should be water-resistant and notes should be taken only with water-proof, non-erasable permanent ink, such as that provided in Sanford Sharpie® permanent markers.

2. On the inside cover of the log book the following information should be included:

   - Company name and address
   - Log-holders name if log book was assigned specifically to that person
   - Activity or location
   - Project name
   - Project manager's name
   - Phone numbers of the company, supervisors, emergency response, etc.

3. All lines of all pages should be used to prevent later additions of text, which could later be questioned. Any line not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's initials, the date, and the note "Intentionally Left Blank."

4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the

personnel performing the correction. If possible, all corrections should be made by the individual who made the error.

5. Daily entries will be made chronologically.

6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.

7. Each page of the log book will have the date of the work and the note takers initials.

8. The final page of each day's notes will include the note-takers signature as well as the date.

9. Only information relevant to the subject project will be added to the log book.

10. The field notes will be copied and the copies sent to the Project Manager or designee in a timely manner (at least by the end of each week of work being performed).

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

1. Entries into the log book should be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.

2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.

3. Scope: Describe the general scope of work to be performed each day.

4. Weather: Record the weather conditions and any significant changes in the weather during the day.

5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, issues/problems/concerns identified, and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.

6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE), record air monitoring data on a regular basis and note where data were recording (e.g., reading in borehole, reading in breathing zone, etc). Also record other required health and safety procedures as specified in the project specific health and safety plan.

7. Instrument Calibration; Record calibration information for each piece of health and safety and field equipment.

8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.

9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.

10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.

11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.

12. Heath and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.

14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.

15. Technical and Project Information: Describe the details of the work being performed. The technical information recorded will vary significantly between projects. The project work plan will describe the specific activities to be performed and may also list requirements for note taking. Discuss note-taking expectations with the Project Manager prior to beginning the field work.

16. Any conditions that might adversely affect the work or any data obtained (e.g., nearby construction that might have introduced excessive amounts of dust into the air).

17. Sampling Information; Specific information that will be relevant to most sampling jobs includes the following:

    - Description of the general sampling area – site name, buildings and streets in the area, etc.
    - Station/Location identifier
    - Description of the sample location – estimate location in comparison to two fixed points – draw a diagram in the field log book indicating sample location relative to these fixed points – include distances in feet.
    - Sample matrix and type
    - Sample date and time
    - Sample identifier
    - Draw a box around the sample ID so that it stands out in the field notes
    - Information on how the sample was collected – distinguish between “grab,” “composite,” and “discrete” samples
    - Number and type of sample containers collected
    - Record of any field measurements taken (i.e. pH, turbidity, dissolved oxygen, and temperature, and conductivity)

- Parameters to be analyzed for, if appropriate
- Descriptions of soil samples and drilling cuttings can be entered in depth sequence, along with PID readings and other observations. Include any unusual appearances of the samples.

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

1. Use the left side border to record times and the remainder of the page to record information (see attached example).
2. Use tables to record sampling information and field data from multiple samples.
3. Sketch sampling locations and other pertinent information.
4. Sketch well construction diagrams.

V. Attachments

Example field notes.

(47) MAY 12, 2003 EXAMPLE

0715 ARRIVE ON SITE AT XYZ SITE.
CH2M HILL STAFF:
John Smith: FIELD TEAM LEADER
Bob Builder: SITE SAFETY COORD.
WEATHER: OVERCAST + Cool, 45°F
CHANCE OF LATE SHOWERS
SCOPE: • Collect GROUNDWATER
SAMPLES for LTM work at SITE 14
• SUPERVISE SURVEY CREW
At SITE 17
0725 BB ~~Cal JS~~ (JS) Calibrates
PID: 101 ppm/100 ppm ok
PID Model #, SERIAL #
0730 BB Calibrates HORIBA METER
Model #, SERIAL #
→ List calibration Results
0738 Survey crew ARRIVES on Site
→ List NAMES
0745 BB Holds H+S TALK on Slips,
Trips, Falls, Ticks + AIR Monitoring
JS + Survey Crew ATTEND
No H+S ISSUES IDENTIFIED as
concerns. All work is in "Level D."
0755 JS Conducts site-wide Air Monitoring
All readings = 0.0 ppm in

JS
5-12-03

MAY 12, 2003 EXAMPLE (48)

SITE 14 LTM
Breathing Zone (BZ)
0805 Mobilize to well MW-22 to
Sample, surveyors setting up
At Site 17
0815 PM (PAUL PAPER PUSHER) Calls AND
INFORMS JS to collect GW SAMPLE
At well MW-44 today for 24 hour
TAT ANALYSIS OF VOC'S
0820 Purging MW-22
→ RECORD WATER QUALITY DATA

JS
5-12-03

0843 Collect SAMPLE At MW-22 for
total TAL Metals AND VOC's. No
Dissolved Metals Needed per PM
0905 JS + BB Mobilize to Site 17 to
show surveyors wells to survey.
0942 Mobilize to well MW-22 to
Collect SAMPLE
0950 CAN not ACCESS Well MW-22
due to BASE OPERATIONS; Contact
PAUL PAPERPUSHER AND he stated
he will check on GAINING ACCESS
with BASE contact.
0955 Mobilize to well MW-19

JS
5-12-03

STANDARD OPERATING PROCEDURE

Side-scan Sonar Survey for Munitions and Explosives of Concern (MEC) Projects

I. Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the instrumentation, approach, and quality control (QC) procedures for conducting side-scan sonar surveys. CH2M HILL, in most cases, will subcontract the actual performance of side-scan sonar surveys to a qualified and experienced firm capable of safely collecting the side-scan data, processing the data, and providing quality deliverables. Subcontractors are required to provide their own SOP(s) detailing their procedures. CH2M HILL geophysical staff responsibilities include reviewing SOP(s) provided by subcontractors, monitoring subcontractors for compliance with their SOP(s), and reviewing deliverables to determine whether subcontractors are in compliance with their scope of work.

II. Equipment

The objective of side-scan sonar surveys is typically to map the seafloor to identify significant features and/or detect individual items (such as munitions) on the sediment surface. The project objective drives the selection of the equipment to be used. CH2M HILL personnel shall ensure that the side-scan sonar subcontractor provides equipment and materials appropriate to the objectives of the project. The following are the equipment of primary concern:

- Side-scan sonar system (type depends on resolution required to achieve project objectives)
- Global positioning systems (GPS) (type depends on positioning accuracy required to achieve project objectives)
- Survey Vessel with instrument rigging capability

III. Procedures and Guidelines

CH2M HILL personnel shall follow procedures described in applicable work plans associated with the project. The following general procedures are applicable to all side-scan sonar survey work performed on CH2M HILL projects:

- The side-scan sonar system will not be permitted to intentionally encounter the sea floor because of the possible presence of environmentally sensitive habitat and underwater munitions present within the survey area.
- The survey vessel will be operated by personnel familiar with the safe operation of the vessel in open water. Proper operational licenses and training will be required and verified prior to the start of field work.
- Activities may need to be performed under an approved Explosives Safety Submission (ESS) or ESS Determination Request (ESS-DR) as appropriate to the project. Field personnel shall comply with the applicable document.
- Side-scan data should be collected with a system capable of providing sufficient image resolution to detect objects and obstacles proud of the seafloor.
- The side-scan sonar system shall be set to maximize the resolution of the sonar imagery. 100% of the accessible survey area should be imaged during the side-scan sonar survey.

- Water and bottom conditions should be evaluated to select operating parameters and survey geometry to provide the best possible level of sonar record detail.
- Data should be collected with 100% redundancy to ensure total area coverage.
- The deliverable should include georeferenced tiff images and shape files appropriate for import into Geographic Information System (GIS) software. Images should be broken into blocks of no greater than 100 megabytes each.

IV. Personnel Qualifications

CH2M HILL geophysical personnel performing oversight of a side-scan sonar subcontractor shall have demonstrated experience and or/ understanding of the technical operations associated with side-scan surveys, the required data deliverables, and how the data will be used on the project for which it is being collected. Determination of whether personnel are qualified to perform oversight of side-scan sonar work will be made by the Munitions Response Geophysical Group Manager or his designee.

VI. Quality Control

Quality control (QC) should include tests confirming that the measurement quality objectives (MQOs) outlined in the project work plan are being met. Subcontractors should provide QC testing procedures within their SOP.

STANDARD OPERATING PROCEDURE

Underwater Digital Geophysical Mapping

I. Purpose and Scope

The purpose of this Standard Operating Procedure (SOP) is to identify the instrumentation, approach, data verification and quality control (QC) procedures for conducting underwater digital geophysical mapping (DGM) in support of munitions response (MR) activities at UXO 3, the Munitions Loading Piers, located at Naval Weapons Station Yorktown, Yorktown, Virginia. DGM operations use instruments that record instrument response digitally, allowing for the subsequent download and interpretation of the data.

For the underwater investigations, DGM will be conducted using either an underwater electromagnetic (EM) system or an array of underwater magnetometers.

II. Equipment and Materials

- Geonics marine EM61-MK2 time domain electromagnetic (TDEM) metal detector
- Geometrics G-882 marine magnetometer array (or equivalent system)
- Global positioning systems (GPS)
- Survey Vessel with instrument rigging capability

III. Procedures and Guidelines

- The DGM system will not be permitted to intentionally encounter the sea floor because of the possible presence of environmentally sensitive habitat and underwater Munitions and Explosives of Concern (MEC) within the survey area.
- DGM survey personnel will have reviewed data from side-scan sonar (SSS) surveys conducted prior to the start of DGM as well as other available information that may be useful in the safe operation of the DGM instrument.
- The survey vessel will be operated by personnel familiar with the safe operation of the vessel in open water. Proper operational licenses and training will be required and verified prior to the start of field work.
- DGM activities will be performed under an approved Explosives Safety Submission (ESS) or ESS Determination Request (ESS-DR). Field personnel will comply with the applicable ESS/ESS-DR.

DGM Personnel Qualifications

- **Program Geophysicist (CH2M HILL) -** This individual will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have a minimum of 5 years of experience directly related to the geophysical mapping, detection and discrimination of buried military munitions. This individual has overall responsibility for design, implementation, and management of geophysical investigations required for the work effort related to military munitions, but may not necessarily be on site full time. This individual will be the program geophysicist-of-record.
- **Project/QC Geophysicist (CH2M HILL)** - This individual will have a degree in geophysics, geology, geological engineering, or a closely related field. The Project Geophysicist will have training and experience appropriate to the geophysical investigations managed. This individual is responsible for

design, implementation, management and quality control (QC) of the geophysical investigation but may not be on site full time.

- **Site Geophysicist (SUBCONTRACTOR)** - This individual will have a degree in geophysics, geology, geological engineering, or a closely related field and have demonstrated experience in the operation of the DGM instrument and positioning equipment. The Site Geophysicist will be responsible for the safe operation of the DGM instrument and data collection in accordance with the project safety requirements, project scope of work and measurement quality objectives (MQOs). The Site Geophysicist will be responsible for QC of field data and transmittal of survey data, results and relevant field information to CH2M HILL in accordance with the project scope of work.
- **Field Geophysicists (SUBCONTRACTOR) -** These individuals will have a degree in geophysics, geology, geological engineering, or a closely related field, and will have training and experience in the safe operation of the DGM instrument and positioning systems.

IV. DGM Measurement Quality Objectives

The primary objective of the DGM is to identify metallic objects on or beneath the sea floor that may be indicative of MEC. The DGM MQOs are summarized in the following subsections.

General Geophysical Systems Functioning

- **Topside Positional Accuracy:** The MQO for topside GPS positional accuracy is that the coordinates being obtained from the topside positioning system allow for accurate translation of the DGM sensor positions. The measurement performance criterion (MPC) for this is that the topside GPS positional accuracy will be ±10 cm (4 in). This will be evaluated by utilizing real-time kinematic GPS (RTK GPS) to record the position at a pre-established GPS check point near the survey vessel launch site and comparing this position against the surveyed coordinates prior to embarking for daily survey work.
- **DGM Target Positional Accuracy**: The MQO for DGM target positional accuracy is that the translated coordinates of the DGM data are at a sufficient enough accuracy to allow for appropriate relocation of MEC items for further inspection. The measurement performance criterion (MPC) for this is that the derived target locations (EM peak amplitude response or magnetic dipole fit positions) will be ±2 m (6.6 ft) of the ground truth. This will be evaluated by comparing anomaly positions from repeat lines to ensure position repeatability to within this metric.
- **DGM Target Repeatability:** The MQO for DGM target repeatability is that the derived target locations (EM peak amplitude response or magnetic dipole fit positions) are repeatable from the beginning to the end of an operation. The MPC for this is that the target locations will be repeatable to ±2m. This will be evaluated by comparing the positions of data collected over an area where anomalies have been detected (assuming sea state conditions don't change significantly during the survey operation).

DGM Survey

- **Down line Data Density:** The MQO for down line (along the survey transect) data density is to have sufficient data collected along each transect to detect MEC items. The MPC for this is that at least 98% of possible sensor readings are captured along each transect at 0.3 m (1 ft) or less. In addition, any transect (or portion thereof) containing a data gap (relative to other collected data points) of 1 m (3.3 ft) or greater does not meet the MQO. This will be evaluated by verifying that all of the DGM data collected and used for anomaly selection meets this objective.

- **Height Above Sea Floor:** The MQO for height above the sea floor is the height that the DGM sensor is towed above the sea floor during data collection. If the height increases too much, the detection capability of the sensor is reduced. Side scan sonar data will be acquired prior to the start of the DGM and will be provided to the DGM SUBCONTRACTOR for review. CH2M HILL estimates that the maximum operational depth for the DGM system is approximately 12 m (40 ft). The MPC is that the sensor will be towed at a maximum height of 1.5 m (5ft) above the sea floor for 98% of the data collected along each transect (i.e. no more than 2% of the DGM data for each transect may be from heights of 1.5 m (5 ft) or more. Exceptions include raising the system higher to avoid obstructions, localized depressions or trenches in the sea floor that are too small to adjust the sensor height accordingly, or if the sea state conditions significantly change during the DGM operation. The DGM system will have an on-board altimeter to record the height and an onboard depth transducer to record the sensor depth. The system will have the capability to both monitor and output the sensor height and depth below the sea surface as data channels that can be evaluated during QC.

V. Geophysical Instrumentation

For the underwater investigation, DGM will be conducted using either a marine EM61-MK2 system or an underwater magnetometer such as the Geometrics G-882. The system may consist of a single sensor or an array of ganged sensors. General descriptions of the instruments are provided below for these specific instruments, although equivalent systems or proprietary configurations may be ultimately utilized by the DGM SUBCONTRACTOR.

Marine EM61-MK2

The marine EM61-MK2 system consists of a coil that transmits a pulsed (i.e. time-varying) primary magnetic field into the earth that induces eddy currents in electrically conductive materials. The decay of these eddy currents produces a secondary magnetic field measured by the same coil. If the secondary field is measured at a relatively long time after termination of the primary pulse, the current induced in the relatively non-conductive ground will fully dissipate, while the current in the conductive media (metallic objects) will continue to produce a secondary magnetic field. The measured response is reported in units of millivolts (mV). Electromagnetic data are generally acquired over a predetermined grid or survey transects depending on the specific project objective. The data provide a spatial distribution of the instrument response over the surveyed area.

The strength or amplitude of a target's response is dependent on the object's size, orientation and distance relative to the sensor. The sensor-target separation distance is the dominant factor because the response amplitude is nominally proportional to $1/r^5$, (where 'r' represents the separation distance). **Figure 1** presents the response of a range of ordnance, oriented in a 'worst case' scenario, as a function of distance (adapted from Nelson et al, 2008 and Nelson et al, 2009). Although some marine systems utilize 'high power' transmitters resulting in a ten-fold increase in output current and received signal levels, the noise levels on these systems are also ten times higher, resulting in similar signal to noise performance. For this reason the expected signal to noise ratio of these technologies as presented are applicable to any instruments using this technology.

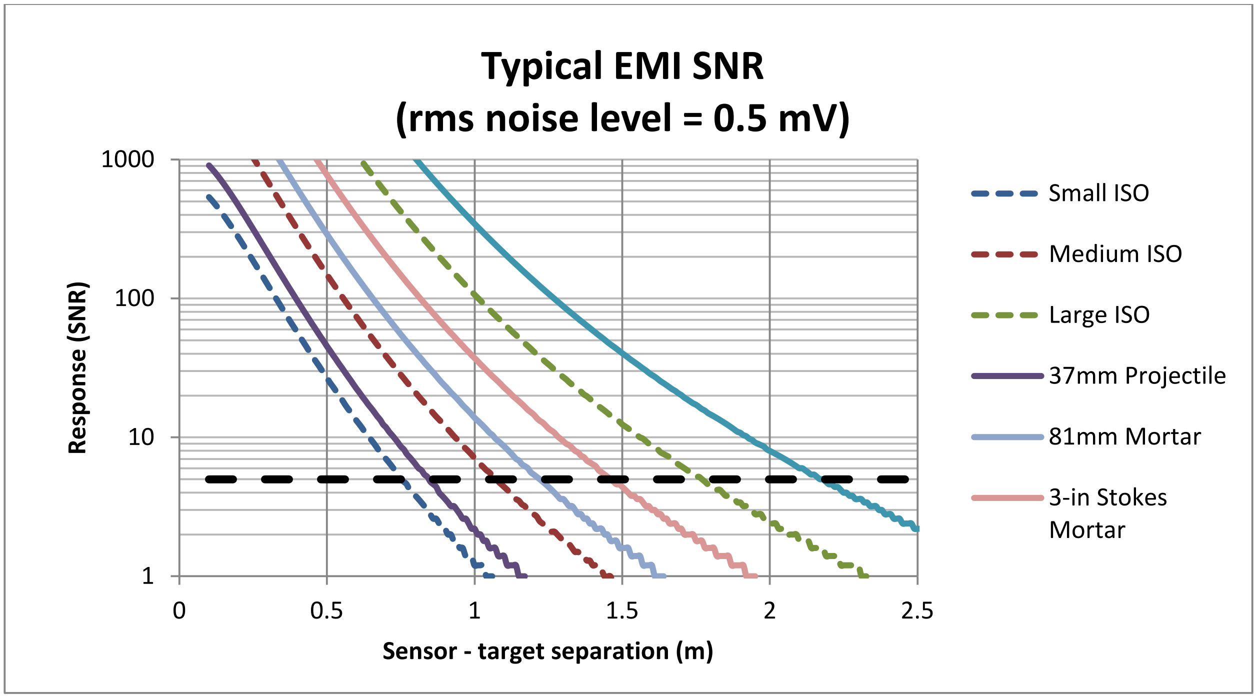


Figure 1. *Typical Signal to Noise Ratio (SNR) performance achieved by EMI sensors.*

Geometrics G-882

The G-882 is an optically pumped cesium vapor instrument that measures the intensity of the earth's magnetic field in nanoTeslas (nT). This instrument can be used to detect localized distortions of the Earth's magnetic field caused by ferrous metallic objects. Response amplitudes are predictable for given ordnance type (size), orientation and sensor-target separation distance. Response amplitudes are maximized when the long axis of the object is parallel to the Earth's magnetic field vector, and minimized when the object is oriented normal to the Earth's field. The sensor-target separation distance is the dominant factor because the response amplitude is nominally proportional to $1/r^3$, (where 'r' represents the separation distance). Response amplitudes for a representative range of ordnance, oriented in the least favorable position, are presented as a function of depth on **Figure 2** (data adapted from Bell et al, 2012). The detection threshold presented is given assuming a noise level of 1 nT and a signal to noise ratio (SNR) detection threshold of 5.

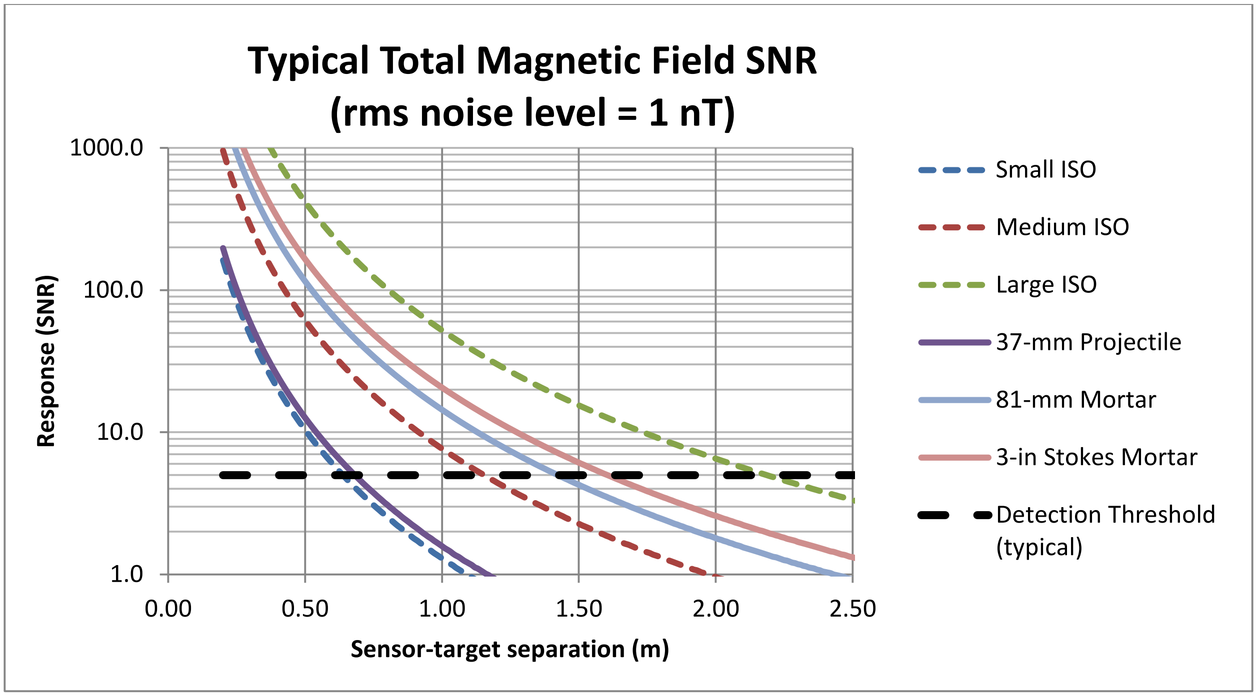


Figure 2. *Total Magnetic Field signal amplitudes for a range of ordnance, assuming a least favorable orientation relative to the Earth's magnetic field. The detection threshold is provided assuming noise levels of 1 nT and SNR of 5. Noise levels will vary from site to site depending upon geology and deployment platform considerations.*

Positioning Equipment

Topside GPS positioning will be accomplished using RTK GPS. RTK GPS instruments are ideal for field-mapping applications with adequate satellite visibility conditions as they provide the highest GPS accuracy possible. Typical RTK GPS accuracies are in the range of 2 to 5 centimeters under optimal field conditions. This accuracy will be reduced in the marine environment due to movement of the boat, waves and underwater currents impacting the DGM sensors and bounce as the sensor attempts to maintain the required height above sea floor.

Data Acquisition, Processing and Reporting

Data Processing

Instrument-specific software will be used for initial data processing, and the output will be imported into Geosoft Oasis Montaj™ for additional processing, graphical display, anomaly selections and QC. All processing steps will be documented. The general processing steps that may be performed on the DGM data include, but are not limited to, the following:

- Positional offset correction
- Sensor bias, background leveling, diurnal corrections and/or standardization adjustment
- Sensor drift removal
- Latency or lag correction
- Geophysical noise identification and removal (spatial, temporal, motional, terrain induced)
- Contour level selection with background shading
- Digital filtering and enhancement (low pass, high pass, band pass, convolution, correlation, non-linear, etc.)

Interpretation/Anomaly Selection

Munitions and explosives of concern (MEC)-experienced data processing geophysicists will use the following criteria for selecting and locating DGM anomalies:

- Identification of an anomaly selection threshold based on background geophysical response
- Lateral extent (plan size) of the area of response
- Three-dimensional shape of the response
- Decay curve or dipole characteristics
- Location of the response with respect to underwater obstructions, potential debris, and sea floor topography
- Potential distortions in the response due to underwater obstructions, potential debris, and sea floor topography

Target Files

The target analysis process culminates in the creation of Microsoft Excel target lists, an example of which is shown as **Figure 3**. The target files are to include:

- Unique anomaly identification numbers
- Transect identification
- Predicted location in Universal Transverse Mercator (UTM) North American Datum 1983 (NAD83) Grid Plane Coordinates in Easting (meters) and Northing (meters), Zone 20N
- Anomaly type identifier
- Response amplitude and units

FIGURE 3
Example MRP Enterprise Target File for Transect Data

ID	GRIDCELLID	X1	Y1	X2	Y2	X3	Y3	X4	Y4	TYPE	AMPLITUDE	UNITS
1	AA-00001	273474.60	3838895.60	0	0	0	0	0	0	1	20.20	mv
2	AA-00002	273473.80	3838893.20	0	0	0	0	0	0	1	8.04	mv
3	AA-00003	273471.00	3838886.00	0	0	0	0	0	0	1	8.85	mv
4	AA-00004	273469.00	3838881.60	0	0	0	0	0	0	1	11.85	mv
5	AA-00005	273462.60	3838867.60	0	0	0	0	0	0	1	27.94	mv

Results Maps

With each target sheet, the DGM contractor will also provide a results map, which will contain the following:

- Client
- Project
- Contractor
- Map Approver
- Date Map was Created
- Scale Bar
- Survey Area and Transect Identification
- Contoured Data
- Color Bar with Data Units Listed

- Index Map
- Target Locations with Identification Numbers
- North Arrow
- Legend
- Title Block

Records Management

All files will be made available for quality assurance (QA) verification during the project to verify that the field and data processing procedures are properly implemented. All raw data files, final processed data files, hard copies, and field notes will be maintained for the duration of the project.

Final Reports, Maps, and Geophysical Mapping Data

All data provided by the DGM SUBCONTRACTOR will be provided via a CH2M HILL-maintained File Transfer Protocol (FTP) or Share Point site. Final reports, maps and DGM data will also be provided on DVD or CD with the final report(s). **Figure 4** shows the folder structure to be used on the FTP or Share Point site.

On a daily basis the contractor will provide each day's raw data files. Raw data is defined as data directly recorded by the data acquisition system, without any modification (or filtering) that changes the originally recorded values from the geophysical or positional sensors.

- Raw data will be provided as American Standard Code for Information Interchange (ASCII) text format so the data files are viewable in text editing software. Proprietary binary format data will be directly converted to text format before delivery.
- Recommended file extensions are ".txt" and ".xyz"; however, other file extensions are acceptable.
- Each delivered raw file will have an informative and unique name. A comprehensive file naming explanation file will be provided on the FTP site.

No later than 3 work days after collection, the SUBCONTRACTOR will provide pre-processed data. The following applies to all pre-processed data deliverables:

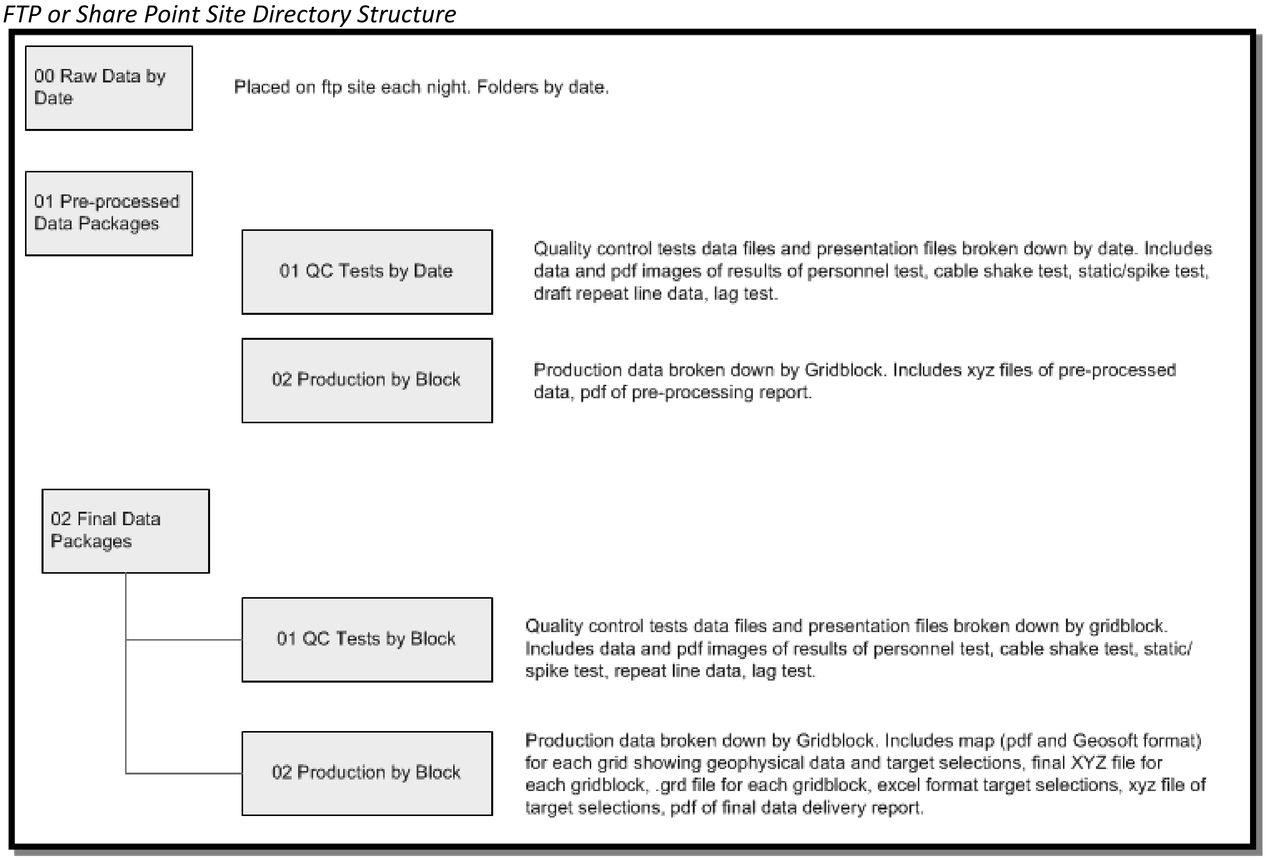
- All pre-processed geophysical data, including all QC tests will be delivered in Geosoft Database (GDB) format or xyz format, readable by Geosoft's Oasis Montaj software package.
- QC test databases and Adobe Acrobat Portable Document Format (PDF) files containing images of QC test results will be provided by date.
- Databases will be delivered in GDB or xyz format, and will include the following minimum channel information:
  - Easting (X) and Northing (Y) coordinates in UTM projection (NAD 83), meters
  - Time (with precision to at least 0.1 s)
  - Raw geophysical data channels
  - Pre-Processed geophysical data channels

No later than 5 work days after collection, the DGM contractor will provide final (processed) data. The following applies to all final (processed) data deliverables.

- All processed geophysical data, including all QC tests will be delivered in GDB or xyz format.
- QC test databases and PDF files containing images of QC test results will be provided by data block.

- Processed production data will be provided broken down by data block.
- A Final Data Delivery Report will be provided with each data block documenting field notes, pre-processing and processing information. Information provided by the report is summarized in **Table 1.**
- Databases will include the following minimum channel information:
  - Easting (X) and Northing (Y) coordinates in UTM projection (NAD 83), meters
  - Time (with precision to at least 0.1 second)
  - Raw geophysical data channels
  - Pre-Processed geophysical data channels
  - Processed geophysical data channels
- Deliverables will include:
  - Geosoft ".map" file for each data block.
  - PDF of Geosoft map for each data block.
  - Geosoft grid ".grd" file for data block showing gridded data from channel used for targeting.
  - Microsoft Excel Target files
  - Geosoft ".xyz" data file and target file
  - Geosoft ".map" mosaic of all processed data to date.
  - PDF mosaic of the Geosoft map of all processed data to date.
- All filenames must include the data block or transect name (as appropriate).

FIGURE 4
FTP or Share Point Site Directory Structure



- A Pre-Processed Data Delivery Report will be provided with each data block documenting field notes and pre-processing information. Information provided by the report is summarized in **Table 1**.

TABLE 1
Processing Documentation Requirements

Information Type	Pre-Processed Data Delivery Report	Final Data Delivery Report	Must be in File Headers
Site ID	X	X	X
Geophysical instrument type used	X	X	
Positioning method used	X	X	
Instrument serial numbers (geophysical and positioning)	X	X	
Coordinate system and unit of measure	X	X	
Grid ID (or other identifier of surveyed area)	X	X	X
Date of data collection	X	X	X
Raw data file names associated with delivery	X	X	
Processed data file names associated with delivery	X	X	
Name of Project Geophysicist	X	X	
Name of Site Geophysicist	X	X	
Name of data processor	X	X	
Data processing software used	X	X	
Despiking method and details	X	X	
Sensor drift removal and details	X	X	
Latency/lag correction and details	X	X	
Sensor bias, background leveling and/or standardization adjustment method and details		X	
Diurnal correction (magnetometer data)	X	X	
Geophysical noise identification and removal (spatial, temporal, motional, terrain induced) and details		X	
Other filtering/processing performed and details		X	
Gridding method		X	
Anomaly selection and decision criteria details		X	
Other processing comments		X	
Date data processing is completed	X	X	
Data delivery date	X	X	
Scanned copy of field notes and field mobile data collection device notes (if applicable)	X		

VI. Quality Control

A description of each basic QC test, its acceptance criteria, and its frequency is provided below and summarized below.

DGM Instruments Quality Control

The DGM system will be field tested to confirm proper operating conditions. Several basic QC tests will be performed by the SUBCONTRACTOR in addition to instrument-specific tests. These tests are also summarized in **Table 2**.

1. **Equipment Warm-up**. The system will be turned on and warmed up for a minimum of 10 minutes prior to use. This test is to demonstrate that the instruments boot properly and that the internal diagnostics routines demonstrate that the necessary sensors (e.g. noise, pitch, roll, etc.) are operating correctly. Equipment warm-up will be performed the first time an instrument is turned on for the day or has been turned off for a sufficient amount of time for the specific instrument to cool down.

2. **Record Topside GPS Positions.** The topside GPS positioning accuracy will be demonstrated by using the topside RTK GPS rover to record the position at a pre-established GPS check point near the survey vessel launch site and comparing this position against the surveyed coordinates prior to embarking for daily survey work. This test will be performed at the beginning of each work day.

3. **Repeat Data.** This test is performed by evaluating repeat data collected over a set of anomalies. The target positions derived from the data will be repeatable to ±2m from the beginning through the end of each day's operation.

TABLE 2
BASIC DGM INSTRUMENTS QUALITY CONTROL

Test	Test Description	Acceptance Criteria	Power On	Beginning of Day	Beginning and End of Day
1	Equipment Warm-up	Minimum of 10 minutes. instruments boot properly and internal diagnostics routines demonstrate that the necessary sensors are operating correctly	X		
2	Record Topside GPS Positions	± 10cm between RTK GPS rover positions and known, surveyed locations		X	
3	Repeat Data	Derived target positions repeatable to within ±2m.			X

Quality Control of DGM Data and Deliverables

QC of geophysical data and data deliverables will be performed at each step of the processing path. This path is presented as **Figure 5**. The QC tests, identified in the Quality Control section of this SOP, that are performed on the system on a daily basis that are checked immediately in the field by the SUBCONTRACTOR and reviewed by the CH2M HILL Project/QC Geophysicist to confirm that the DGM system is functioning properly. Data will not move to the next stage until they have passed the required QC checks.

The following items are among the QC checks performed on the field forms:

- Appropriate fields have been completed
- Field entries are appropriate for work performed
- Back-up hard copies or field book entries are legible
- Data required for geophysical data processors have been entered
- General editorial review (spelling, dates, etc.)

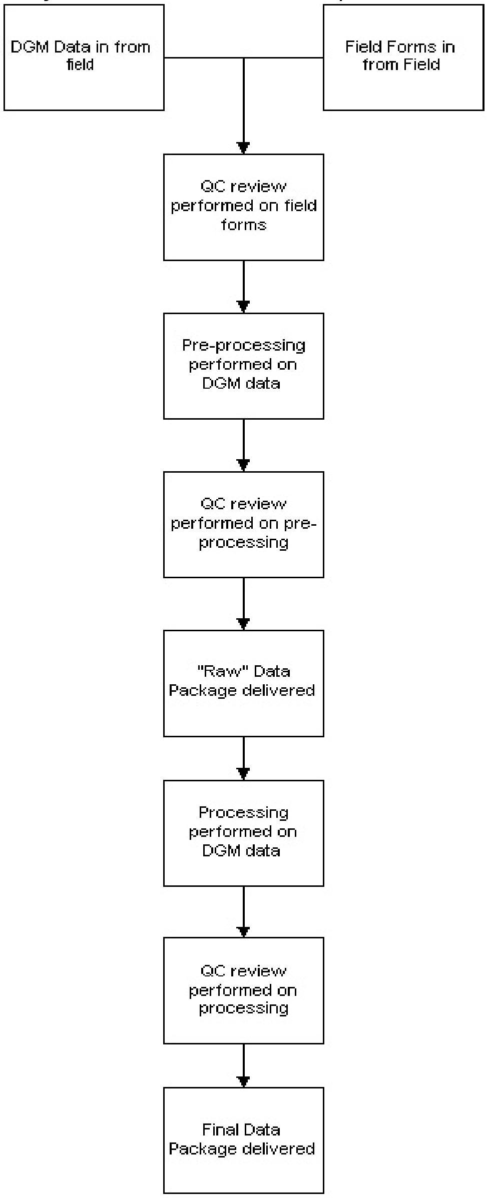
The following items are among the QC checks performed (as applicable to the particular data set) on the "Pre-Processed Data":

- Data are provided in UTM Zone 20N and in units of meters
- Coordinates are correct (i.e. plot in correct locations when loaded into GIS)
- System passes QC tests
- Down line data density is acceptable
- Appropriate file headers have been attached
- Files contain transects stipulated in daily field notes

The following items are among the QC checks performed (or as applicable to the particular data set) on the "Processed Data":

- Latency/Lag correction is appropriate
- Despiking is appropriate
- Leveling is appropriate
- Filtering performed is appropriate
- Line breaking is appropriate
- Anomaly selections are clearly annotated
- Excel target lists of anomalies, anomaly IDs and anomaly type identifier match the results maps

FIGURE 5
QC of DGM Data – Process Flowpath



Corrective Measures

The following are the basic corrective measures to be followed in association with DGM:

- Replacement of sensors if they fail to meet instrument check requirements.
- Re-collection of data if MQOs are not met
- Re-processing DGM data in lieu of re-collection if it is determined that processing error may have resulted in data not meeting MQOs.

VII. References

Nelson, H.H., T. Bell, J. Kingdon, N. Khadr, and D.A. Steinhurst, 2008. *EM61-MK2 Response of Standard Munitions Items*. NRL/MR/6110—08-9155. October.

Nelson, H.H., T. Bell, J. Kingdon, N. Khadr, and D.A. Steinhurst, 2009. *EM61-MK2 Response of Three Munitions Surrogates*. NRL/MR/6110—09-9183. March.

Bell, T.H., N. Khadr, G.R. Harbaugh, and D.A. Steinhurst, 2012. *Magnetometer Response of Commonly Found Munitions Items and Munitions Surrogates*. NRL/MR/6110—12-9385. January.

STANDARD OPERATING PROCEDURES FOR SIDE-SCAN SONAR AND BATHYMETRY MAPPING

Underwater DGM Survey at Area UXO-0003
Naval Weapons Station Yorktown
Yorktown, Virginia

Contract Task Order: WE03

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October 30, 2013

TABLE OF CONTENTS

1. PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide specific procedures and information regarding data collection and equipment to be used for the Side-Scan Sonar (SSS) and Bathymetry (Bathy) surveys at Area UXO-0003, Naval Weapons Station Yorktown (WPNSTA Yorktown), Yorktown, Virginia (the "site").

2. EQUIPMENT AND THEORY

This SOP is applicable for the Edgetech 4125 Dual Frequency Side-Scan Sonar, Odom Echotrac CV Dual-Channel Echo-sounder, Trimble 5700 Real Time Kinematic (RTK) Global Positioning System (GPS), and a Trimble AgGPS FmX integrated navigation system.

Edgetech 4125 Side-Scan Sonar

The 4125 SSS System is a fully digital, simultaneous, dual frequency sonar system designed to identify sub sea contacts and analyze seabed conditions in real time. The 4125 series SSS system consists of three main parts; Tow fish, Topside Processor and Tow Cable. The 4125 Tow fish is towed through the water with transducer arrays on both sides which radiate and receive ultrasonic CHIRP pulses, it also contains the associated digital signal processing electronics. A Windows® based PC or laptop/notebook computer is used to host the Edgetech Discover-4125 application software which provides the user with the means to control the acquisition parameters and display and record the data from the tow fish. The echo data is used to create a two-dimensional image on the monitor along with other information such as depth, heading and position. The 4125P Topside provides an interface between a Notebook computer running EdgeTech's Discover 4125 Sidescan Acquisition software, and a 4125 Towfish. A GPS is interfaced directly with the 4125 SSS to provide position control.

The 4125 Topside Processor is a self-contained, portable unit with all interface and power supply electronics housed within a rugged, waterproof case. A ruggedized Notebook computer completes the Topside Processor package. The data and control interface between the Notebook computer and the Topside interface unit is via TCP/IP protocols via a10/100Mbit 10BaseT Ethernet LAN connection, or optionally, using Wireless LAN connectivity (Note: Only one should be active at any one time). The data and control interface between the Topside Interface unit and the 4125 Towfish is via TCP/IP protocols over 10BaseT Ethernet.

The 4125 SSS will be deployed with a hull mount on a 22-ft ThunderJet jet boat. When fully loaded the boat drafts less than 2 feet in the water. The survey boat is equipped with a 6-liter V8 engine with a high-output alternator and electronic power bus, sufficient to drive the survey operation continuously without the need to charge batteries.

The 4125 SSS operations manual can be found in **Appendix A**. The Quick-Start Guide is presented in **Appendix B**.

Edgetech 4125 Side-Scan Sonar System

22-ft ThunderJet boat on which Side-scan Sonar and Bathymetry Equipment will be deployed

Odom Echotrac CV Echo-Sounder

The Echotrac CV is a hydrographic echo sounder with a networked PC interface. Echo sounding is a type of sonar used to determine the depth of water by transmitting sound pulses into water (bathymetric survey). The time intervals between emission and return of the pulses are recorded, which after post processing are used to determine water depths. The Echotrac CV transceiver units are supplied in a compact rack mount package that is suited to for shipboard installations. The Echotrac CV supports both paper chart creation and electronic logging on a PC. Internal data storage (in .XTF format) allows playback of the analog return signal digitized to full 16-bit resolution. This Echotrac CV contains a dual-channel input, which allows multi-frequency transducers to be used simultaneously. For this work a 200 kiloHertz (kHz), shallow water transducer will be used. Serial data ports on the Echotrac CV can be used to interface the echo sounder to GPS and motion reference units. The Echotrac CV also has an Ethernet port that outputs the 16 bit samples of the acoustic data for further processing or visualization. The Echotrac CV supports a variety of industry standard output formats for use with external data logging systems. The Echotrac CV operations manual can be found in **Appendix C**. The Echotrac eChart software manual can be found in **Appendix D**.

The Echotrac CV will be deployed on the same 22-ft ThunderJet jet boat to be used for the SSS and underwater DGM surveys.

Odom Echotrac CV Echo-Sounder

Trimble 5700 RTK Global Positioning System

RTK GPS receivers will be used to accurately measure the exact position and heading of the boat and the SSS and Bathy equipment. The Trimble 5700 GPS is a 24-channel dual frequency RTK receiver that uses both L1 and L2 satellites. This system operates with a base and rover units; the base sends corrections to the rovers via radio link, thus maintaining a 3cm horizontal accuracy and a 5cm vertical accuracy. For configuration with the SSS and Bathy equipment, the rovers are set to output a GGA National Marine Electronics Association (NMEA) string at 1 Hz. The data acquisition programs for each instrument capture the GPS strings from the rovers to provide geo-location for the sonar and bathymetric data streams. GPS rover antennas will be held in a fixed position above the instruments so that layback calculations are not required.

3. INSTRUMENT STANDARDIZATION

All instruments and sensors will be assembled as specified in their specific User Manuals (see Appendices). Additionally, each instrument will be field tested daily to ensure that the instrument is operating properly (explained in Section 6).

4. DATA ACQUSITION

Data will be collected within an approximate 18 acre area of the York River that encompasses the former Pier R-1 and the R-2 structure at the site (see attached Figure). Currently, no remnants from Pier R-1 are visible; however, pilings may remain below the water level. The R-2 structure is a former small boat landing associated with the Pier. The focus of the surveying will be the area extending approximately 250 feet to all sides of the former Pier R-1 berthing area and the 100 foot offset area surrounding Structure R-2 (as shown in the figure). The purpose of the SSS and Bathy surveys is to identify any bottom obstructions and inaccessible portions in the survey area that may impede or pose a hazard to the equipment to be used for the underwater DGM that will be later performed at the site.

The SSS and Bathy data will be collected simultaneously during the project. The systems will be setup to maximize the resolution of the imagery based on the environmental conditions. 100% of the survey area will be imaged during the surveys. Water and bottom conditions will be evaluated to select operating parameters and survey geometry to provide best possible level of record detail. SSS data will be collected with 100% redundancy to ensure total area coverage. Maximum data sampling rates allowed by the instruments will be used to acquire the highest resolution data. "HYPACK" hydrographic survey software will be used to design the survey line geometry. **Table 1** lists the preliminarily proposed survey parameters, however these parameters may change as the result of site conditions.

Because the survey area is relatively protected from large wave action, and is contiguous and not laterally extensive, special surveying considerations will be used to minimize the extra procedures and equipment required for SSS and Bathy surveys performed in larger, open-water survey areas:

- One day of data collection is scheduled for the project. Data will only be collected on a calm-weather day with no appreciable wave action (less than 1 ft).

- Data will be collected using a constant boat velocity of approximately 3 miles per hour (MPH), precluding the need for velocity-based settling corrections.
- Repeat data will be acquired hourly during the survey to account for tidal variations during data acquisition.

Data will not be collected in heavily vegetated areas that prevent boat propulsion, in extreme shallow water areas (less than 2 feet), or in areas with visible near surface obstructions that prevent safe operation of the equipment.

TABLE 1: PRELIMINARY DATA ACQUISITION PARAMETERS

Parameter	Value
Side-Scan Frequency	900 kHz
Echo-Sounder Frequency	200 kHz
Survey Line Spacing	20 ft
Sensor Altitude	2 ft (approximate)
GPS Offset	0 ft

4.1 NAVIGATION

Navigation is facilitated by the Trimble AgGPS FmX integrated navigation system and the RTK GPS. A base station is setup on a terrestrial control point and differential GPS corrections are sent via radio link to the rover receivers.

The FmX displays virtual survey lines by importing a Geographic Information System (GIS) .shp file. The survey line layout will be designed using the HYPACK software based on the physical conditions at the site and then imported in the FmX. Once the survey lines have been established, the FmX will provide a light bar display to assist the boat operator in guiding the boat along the virtual survey lines. The FmX provides a swath coverage display that shows the boat operator the current survey line and previous lines on which data have already been collected.

4.2 START-UP PROCEDURES

The following steps describe the daily startup procedures prior to data collection:

1. Setup GPS base station
2. Prepare boat (on trailer)
    - Remove rigging safety chains and straps
    - Install drain plugs
    - Engage battery systems
    - Visually inspect all mechanical systems for defects; repair/replace if necessary
    - Inventory boat safety equipment (Personal Flotation Devices [PFDs], fire extinguisher, first aid kit)
    - Turn on all electrical systems
3. Perform land-based system Quality Assurance/Quality Control (QA/QC) tests (Section 6)
4. Test communications equipment (marine radio, mobile phones, walkie-talkie, etc.)
5. Launch boat
6. Prepare boat (in water)
    - Engage primary motor
    - Start and test trolling motor
    - Test all boat electrical systems
    - Test communications equipment (marine radio, mobile phones, walkie-talkie, etc.)
7. Inform Responsible Parties of boat deployment
8. Perform on-water system Quality Assurance/Quality Control (QA/QC) tests (Section 6)
9. Mobilize to survey area

4.3 DATA COLLECTION STEPS

Detailed setup parameters for the instruments can be found in Appendices A – D. Below are the generalized steps used to perform the SSS and Bathy surveys:

1. Turn on instruments, data logging PCs and cooling fans
2. Allow the systems to warm up in water for at least 10 minutes
3. Prepare data acquisition field log. During data collection the system operator will maintain a detailed field log. The log will be used to document all data collection activities.
4. Setup / calibrate instrument data loggers
5. Deploy sonar and bathymetric transducers
6. Measure static draft offset
7. Measure water velocity (bar check)
8. Measure GPS / layback offsets (if necessary)
9. Prepare data files for recording

10. Navigate to appropriate survey line / transect
11. Log data
12. At the end of each transect confirm successful data acquisition and storage, navigation and equipment calibrations and settings

5. DATA STORAGE AND PROCESSING

The SSS and Bathy data are temporarily stored in ruggedized PCs during data collection. At the end of each field day, the data are transferred to a PC workstation for further on-site processing using HYPACK hydrographic survey software. Initial data processing (pre-processing) will be performed by the field team and includes reviewing data for integrity and repeatability.

After the SSS and Bathy surveys are concluded the field crew will demobilize from the site and the data will be analyzed. Identified bottom obstructions will be catalogued in a spreadsheet that provides geographic coordinates for each potential obstruction. Exclusion zones for DGM surveying will be determined from a synthesis of bottom depth and obstruction data. GIS shapefiles will be created from the list of obstructions and exclusion zones for later navigational use during the DGM surveys.

The following is a list of deliverables that will result from the data processing:

- Mosaic image of the SSS data
- Color-coded contour map of the bottom depth data
- Target map showing interpreted bottom obstructions and survey exclusion zones
- SSS bottom obstruction target table including geo-referenced locations and target dimensions

6. QUALITY CONTROL - INSTRUMENTATION

The following quality control (QC) procedures are performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis. Depending on the logistics of the project site these tests may be performed on land prior to boat launch or in water after boat launch.

1. Equipment Warm-up: Minimum 10 minutes
2. Record Sensor Positions: Accuracy of the GPS will be demonstrated by operating the two GPS antennas over a known control point. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which the GPS antennas are held and the displayed positions. The sensor position test will be conducted at the beginning of the survey operation for each workday. Maximum position error for successful completion of the test is 10 cm.

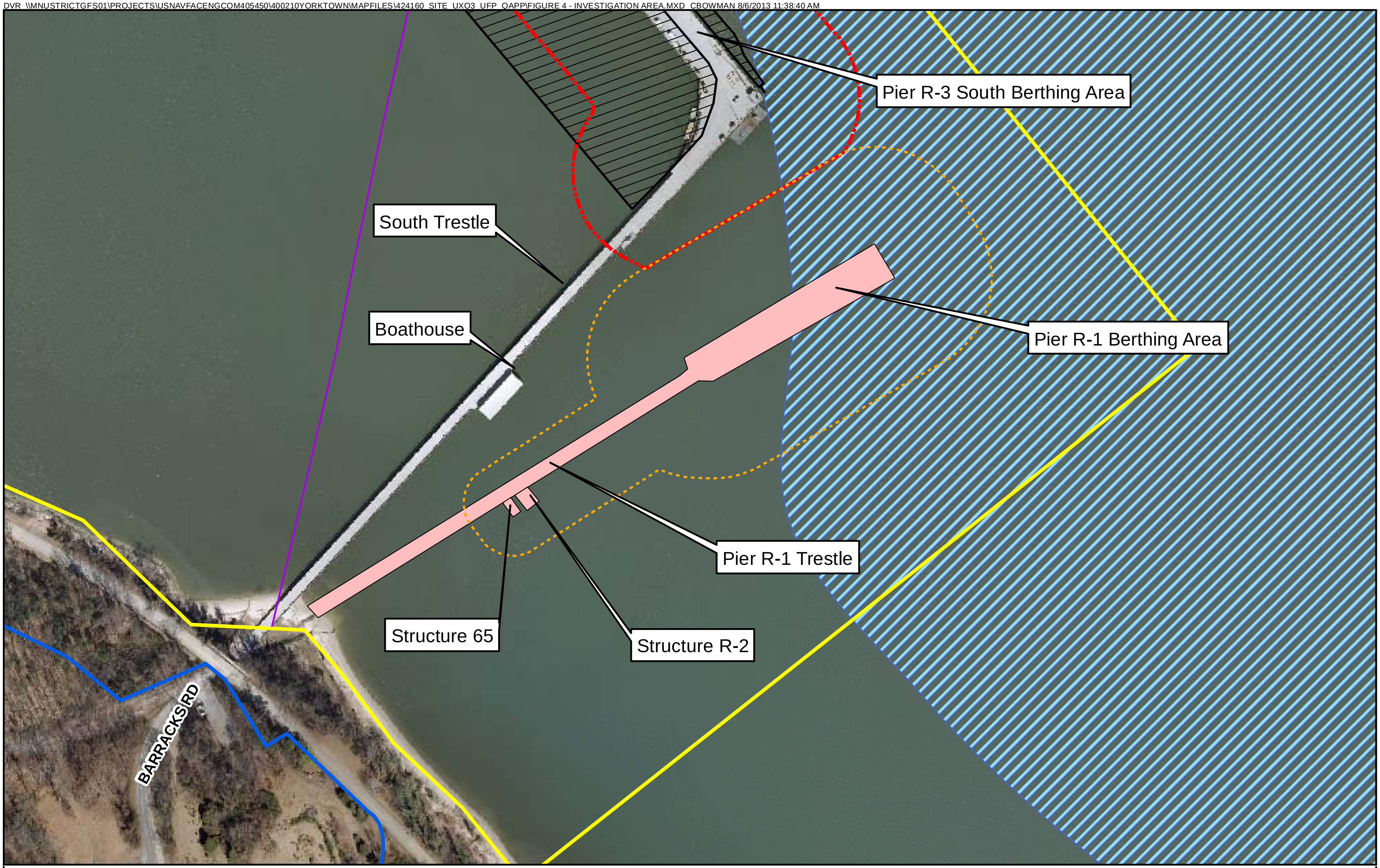
3. <u>Rub Test</u>: Prior to deploying the SSS towfish in the water the port and starboard transducers of the towfish will be tested. The system operator will start the SSS system software and monitor the "waterfall" display of each transducer while another crew member briskly moves his/her fingers across transducer surfaces. If the SSS is operating properly a distinctive "streaking" signature will be observed in the waterfall display, as shown in the picture below. This test is an observed qualitative test of basic system functionality; therefore no digital data will be recorded.

4. <u>Bar Check / Velocity Calibration</u>: Prior to data collection the echo sounder will be calibrated to compensate for the local differences for the speed of sound in water, which changes based on factors such as salinity and temperature. The test involves placing a steel plate / bar underneath the depth transducer at two fixed depths and recording the travel time of the transducer pulses to determine the sound velocity. The test is automated by the control software of the Odom Echotrac CV system. The testing procedure is described in detail in Section 3.2.3 of the software manual (Appendix D). The test will be performed on the water with the boat held in a fixed position. The echo sounder velocity calibration will be conducted at the beginning of survey operations for each workday.

5. Sonar Positioning Test: The sonar positioning test will provide daily evidence of the SSS system response and positioning repeatability. Daily a single line of data will be collected to image a known, fixed-position target object such as a pier piling. The data will be collected with a horizontal offset from the object of approximately 80% of the maximum range of the sonar. The accuracy of the data positioning will be assessed by calculating the difference between the known location of the target object (as measured with an RTK GPS) and the position of the object as calculated by the sonar processing and analysis software. The sonar position test will be conducted at the beginning of the survey operation for each workday. Maximum position error for successful completion of the test is 1 meter.

FIGURES

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\400210YORKTOWN\MAPFILES\424160_SITE_UXO3_UFP_QAPP\FIGURE 4 - INVESTIGATION AREA.MXD CBOWMAN 8/6/2013 11:38:40 AM



Legend

- Approximate SI Investigation Area
- Area Recommended for SI once munitions loading operations have ceased
- Former Dredged Area
- Yorktown Base Boundary
- UXO 3 Boundary
- Location of former pier known as Pier R-1 (submerged pilings remain)
- York River Main Channel
- Sewer Utility (Submerged)

Note:
The investigation area boundary may be adjusted in the field based upon site conditions encountered during the investigation.

N W E S

0 175 350 Feet

Imagery: 2010

Figure 3
Investigation Area
UXO 3 SI MEC-QAPP
WPNSTA Yorktown
Yorktown, Virginia

CH2MHILL.

APPENDIX A

Edgetech 4125 Side-Scan Sonar Operating Notes

4125

DUAL FREQUENCY
SIDE SCAN SONAR

USER'S HARDWARE MANUAL

990-4125MAN-1000 Revision B: April 2010

Email: info@EdgeTech.com
Web: http://www.EdgeTech.com

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WARNING

OPERATION IN AIR

Do not operate the system with Transmitters enabled (Pinging) while the towfish is in air for extended periods. The system may be enabled to transmit while in air for test purposes, as an audible clicking may be heard by persons with good hearing (young ears). Such testing should be limited to 5 minutes or less. This system transmits high power into the transducers, which can become quite hot if operated in air for extended periods. Damage to the transducers is possible.

ELECTROSTATICS

This equipment contains static sensitive devices that are extremely sensitive to static electrical charges, which may be developed on the body and the clothing. Extreme care should be taken when handling these devices both in and out of the circuit board. Normal handling precautions involve the use of anti-static protection materials and grounding straps for personnel.

RFI

This equipment generates, uses, and can radiate radio frequency energy, and if not installed properly may cause interference to radio communications. It has not been tested to compliance to the appropriate FCC rules designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area may cause interference, in which case the user, at his own expense, will be required to take whatever measures needed to correct the interference. It is the user’s responsibility to verify that the system complies with the applicable FCC emission limits.

LINE VOLTAGES

Operation with improper line voltage could cause serious damage to the equipment.

CONTENTS

CONTENTS

To our customers:

Thank you for purchasing one of our products. At EdgeTech it is our policy to provide high quality, cost-effective products and support services that meet or exceed your requirements, to deliver them on time and to continuously look for ways to improve. We all take pride in the products we manufacture.

We want you to be entirely satisfied with your equipment. The information in this manual will get you started. It tells you what you need to get your equipment up and running, and introduces it's many features.

We always enjoy hearing from people who use our products. Your experience with our products is an invaluable source of information that we can use to continuously improve what we manufacture. We encourage you to contact or visit us to discuss any issues whatsoever that relate to our products or your application.

The Employees of EdgeTech

1 INTRODUCTION

The Side Scan Sonar System is designed primarily for search operations to identify sub sea contacts and analyze seabed conditions in real time by towing the Tow fish through the water.

The 4125 Side Scan Sonar System is a fully digital, simultaneous, dual frequency sonar system. The 4125 series side scan sonar system consists of three main parts; Tow fish, Topside Processor and Tow Cable. The 4125 Tow fish is towed through the water with transducer arrays on both sides which radiate and receive ultrasonic CHIRP pulses, it also contains the associated digital signal processing electronics. A Windows® based PC or laptop/notebook computer is used to host the Edgetech Discover-4125 application software which provides the user with the means to control the acquisition parameters and display and record the data from the tow fish. The echo data is used to create a 2-D image on the monitor along with other information such as depth, heading and position. The 4125P Topside provides an interface between a Notebook computer running EdgeTech's Discover 4125 Sidescan Acquisition software, and a 4125 Towfish. The end user need only supply a source of GPS data and either AC or DC power to complete the acquisition package.

The 4125 Topside Processor is a self-contained, portable unit with all interface and power supply electronics housed within a rugged, waterproof (when the lid is closed) Storm Case™. There is space inside the closed unit to accommodate an EdgeTech supplied Notebook computer which completes the Topside Processor package.

The data and control interface between the Notebook computer and the Topside interface unit is via TCP/IP protocols via a10/100Mbit 10BaseT Ethernet LAN connection, or optionally, using Wireless LAN connectivity (Note: Only one should be active at any one time). The data and control interface between the Topside Interface unit and the 4125 Towfish is via TCP/IP protocols over 10BaseT ethernet.

The characteristics and capabilities of the system are explained in this manual.

2 INSTALLATION

The 4125 series system comprises the following major components:

- 4125 series Tow Fish
- 4125 Topside Interface.
- 50 meter Tow cable (standard)

PRODUCT SPECIFICATIONS

Topside Interface:

Size	39 cm D x 49 mm W x 19 mm H (15.2 in x 19.2 in x 7.3 in)
Weight	13.2 kg (29.0 lbs.) w/ laptop 10 kg (22.0 lbs.) w/o laptop
Construction	High-impact structural polypropylene
Color	Black
Sealing	Watertight cover O-ring seal, w/purge valve

Power requirements:

DC Input voltage	12 to 24 VDC 72 watts operating 4.3/6 (9peak) Amps at 12 VDC (Idle/Operating) 2.4/3.3 Amps at 24 VDC
AC Input	120/240 VAC 72-110 watts (Auto-ranging) 0.6/1.1 Amps at 120 VAC (Idle / Operating) 0.3/0.56Amps at 240 VAC

Environment:

Temperature range:	
Operating:	-40°C to+40°C (-40°F to 104°F) (shade conditions)
Storage:	-20°C to 60°C (-4°F to 140°F)
Relative humidity:	
Operating:	0 to 80% (non-condensing)
Non-operating:	0 to 100%

Tow-Fish Interface:

Data Input:	TCP/IP-Ethernet, 10/100BaseT.
Tow fish Voltage:	+70 VDC, @1 amp max

4125/Laptop Processor Interfaces:

1. Sonar Data & Control via 10/100BaseT Ethernet
2. Navigation input: USB direct or via RS232 serial port

Laptop Specifications:

Due to continuous product evolution in this area a firm specification cannot be provided. The nominal specification for the EdgeTech supplied laptop is:

Notebook computer	:
Operating System	: Windows XP
Processor	: Pentium M 730, 2.4 GHz
Memory	: 2 Gbytes
Hard drive	: 160 GBytes
Screen size	: 15.4” - 1280 x 800 typical
Wireless	: Intel® Centrino™

Supplied Components:

4125 Portable Processor case with integral Interface electronics
Laptop processor with DISCOVER 4125 Side Scan Sonar acquisition software
4125 series Tow fish
50 meter tow cable
System Recovery Disk
AC power cable
DC Power
Ethernet interface cables
Consumables spares Kit
Manuals

Tow Fish specifications:

(Dual Frequency – 400/900 kHz or 600/1600 kHz)

Material	Stainless Steel Construction
Tow Body dimensions	96 mm (3.75 in) OD, 980 mm (39 in) Length
Weight	15.4 Kg (34 Lbs) in air (Optional weight available for deep operation)
Operating Depth	200 meters max.
Tow Speed	1-8 knots
Safety shear pin	420 Kg (930 Lbs)
Input power	DC 70V, 50 watts maximum
Data link interface	Ethernet, 10Mbit/s
Beam width 400 kHz	Horizontal, 0.46°, All Sidelobes < -36dB Vertical, 50°
Beam width 900 kHz	Horizontal, 0.28°, All sidelobes < -36dB

	Vertical – 50°
Beam width 600 kHz	Horizontal, 0.33°, All sidelobes < -36dB
	Vertical – 50°
Beam width 1600 kHz	Horizontal, 0.20°, All sidelobes < -36dB
	Vertical – 50°

Motion Sensor (OS5000):

Heading Information:

Accuracy	1.0° RMS
Resolution	0.1°
Tilt Information:	0.1°
Range	Full Range

Navigation Interfaces:

Serial input	RS232, NMEA0183

Depth Sensor:

Accuracy	0.5% of depth (when calibrated for 0 m)
Working Depths	0 to 200meters
Tolerance	>200m

Tow Cable Specification:

Breaking Load	1200lbs
Conductors	6, 2 x 18g & 2 x twisted pairs
Maximum Length	150 meters.

MAIN SYSTEM COMPONENT DESCRIPTIONS

2.1.1 4125 TOPSIDE

The 4125 Portable Topside Processor provides an interface between a laptop computer running EdgeTech's DISCOVER 4125 Side Scan Sonar acquisition software, and a Model 4125 series Tow fish. The end user need only supply a source of GPS data and either AC or DC power to complete the acquisition package. The complete system with the 4125-P topside and 4125 series tow fish is the Model 4125 Side Scan Sonar System.

This unit is a self contained, portable unit with all interface and power supply electronics housed within a rugged, waterproof (when the lid is closed) Storm ® case. There is space inside the closed unit to accommodate an EdgeTech supplied laptop personal computer.

2.1.2 4125 PORTABLE PROCESSOR CASE

The processor case supplied is based on the Hardigg Storm® case series, and provides a waterproof enclosure of the 4125 Tow fish power supply and interface electronics. The power, Tow fish and Ethernet cable connectors are mounted on a recessed, waterproof panel, with LED indicators and On/OFF switch.

Figure 1: 4125 Topside Processor

2.1.3 LAPTOP PROCESSOR:

The laptop style processor is used to run EdgeTech's Discover 4125 Side Scan Sonar software acquisition package. This provides control, storage and display of the tow fish data. The data is presented on a color waterfall display and is stored in XTF or JSF formats on a hard disk.

A user supplied GPS with NMEA interface strings is required for positioning data.

2.1.4 AC POWER CABLE:

The supplied 2 meter AC power cable, shown in Figure 8, is used to connect the unit to a source of AC power. The source may be 50/60Hz and either 120 or 240 volts (nominal).

2.1.5 ETHERNET INTERFACE CABLE:

Used to connect 4125-P Topside to Laptop running DISCOVER sonar program.

Sends data commands to Topside and Tow Fish, receives sonar data from Tow Fish.

2.1.6 DC POWER CABLE:

Used to supply DC power for the unit; white wire (red clamp) is Positive, Black wire (black clamp) is Negative (Typically for battery powered installations, 12 OR 24V).

2.2.7. TOW FISH:

The 4125 series tow fish is a hydro-dynamically stable towed body, which contains the transducers and electronics necessary to generate and receive the side scan sonar signals, and communicate with the topside unit. It comes standard in a compact lightweight stainless steel pressure housing rated to 200 meters It is equipped with stabilizing fins for hydrodynamic balance. The fish weighs 15 Kg (34 Lbs) and can easily be carried and deployed by one person.

Identical but separate, port and starboard transducers are mounted along the side of the tow fish.

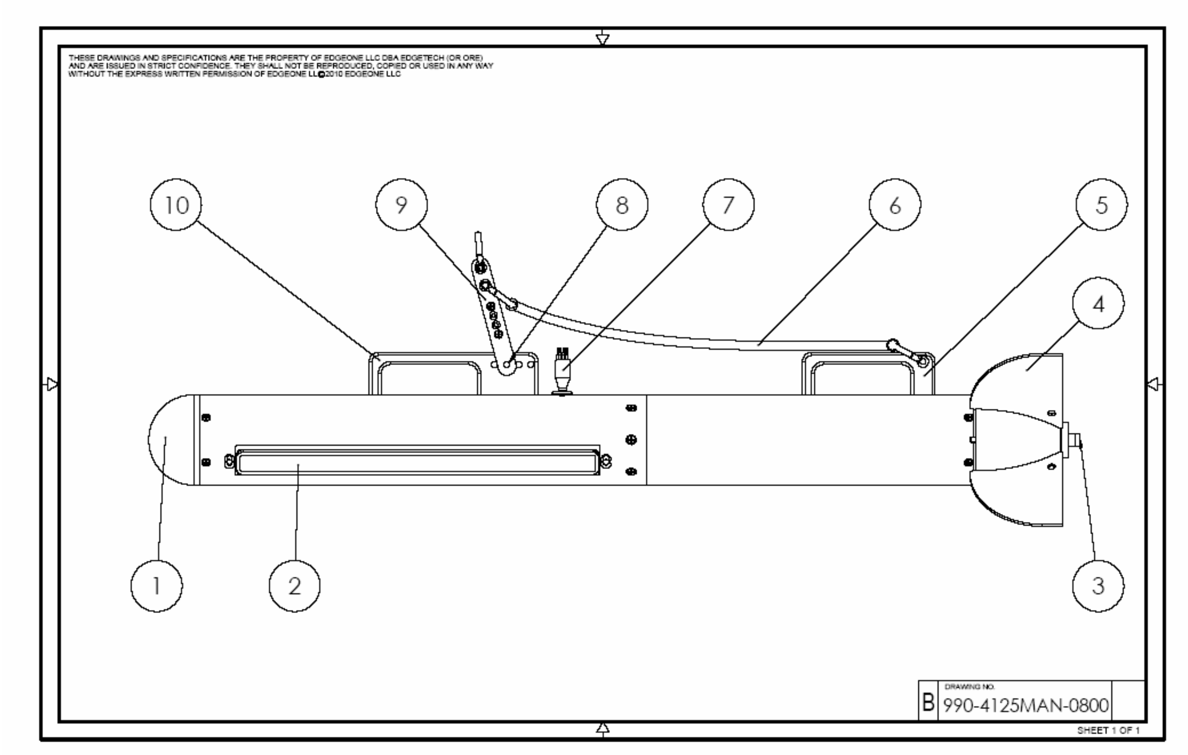


Figure 2: 4125 Tow fish

(1) Fish Nose

(2) Side Scan Sonar Transducer (x2)

(3) Tail Fin Locking Bolt

(4) Tail Fin (x4)

(5) Rear Handle

(6) Safety Wire

(7) Tow Cable Connector

(8) Safety Shear Pin

(9) Tow Arm

(10) Front Handle

2.1.7 SYSTEM CABLES:

Figure 3: Interface cables

Figure 4: 50 meter Tow cable

1. DC Input 12-24 VDC cable.
2. Ethernet Data I/O cable.
3. AC Input 120/240 VAC.
4. 50 meter Tow Cable.

3 SYSTEM SET-UP

The image below shows the entire connection of your 4125 system. You can find 4 waterproof interface connectors on the side of 4125 Topside Interface unit. The names of the components to be connected are labeled above of each connector. The size and or type of connectors is different for each to ensure not making the wrong connection. If you align the projection and the slot of the connectors you can connect them together and fasten them by turning the locking sleeve.

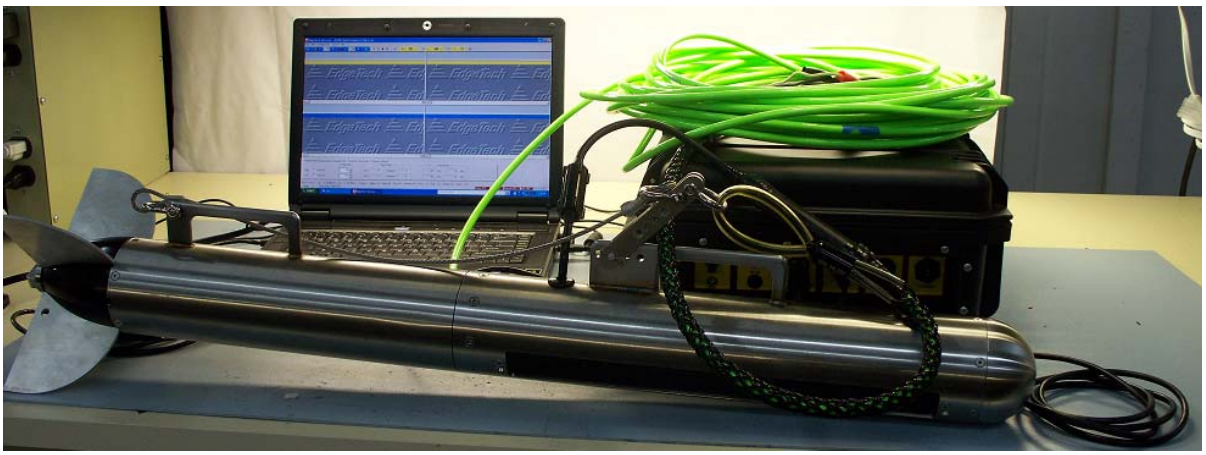


Figure 6: System Interconnection

Figure 8: Software security/Tow Fish interface

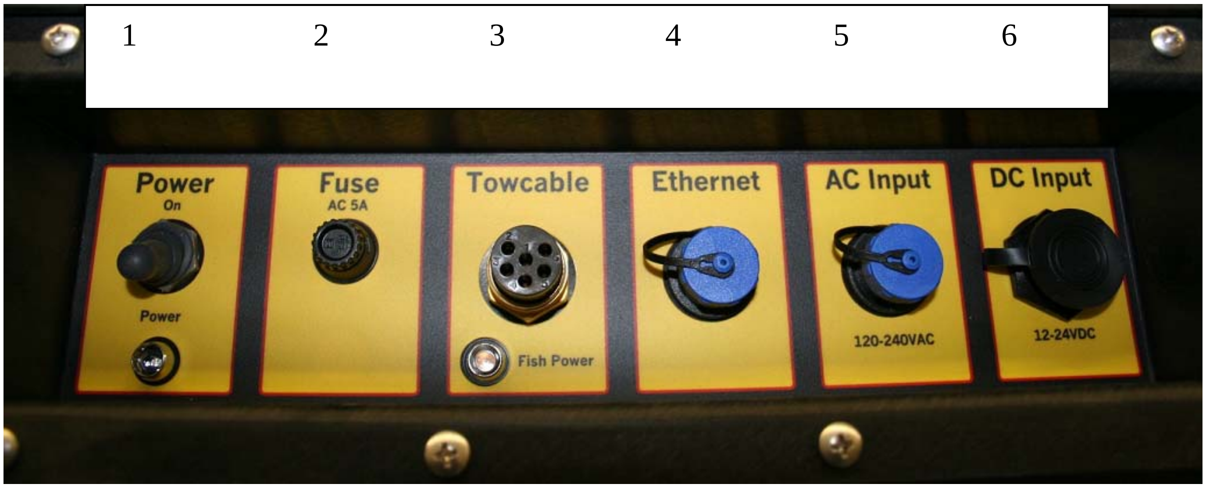


Figure 4: 4125 Connector Box

1. Power On/Off switch.
2. 1 amp Ac fuse.
3. Tow Cable plug.
4. Ethernet Data I/O
5. AC Input 120/240 VAC
6. DC Input 12-24 VDC

SYSTEM CABLE CONNECTIONS

3.1.1 INSTALLATION

Check that the unit power is turned OFF.

Connect the Topside Interface to a source of AC and/or DC power using either the DC cable or the AC power cable. (Note, Either one or both may connected at any one time, the unit will auto switch in the event of one failing)

Connect the Topside via the Towcable connection to the Towfish using the supplied direct cable connection.

For detailed cable drawings, refer to Section 6.

Connect the Notebook to the Topside Interface unit using the 10BaseT direct Ethernet cable. Note: The Ethernet cable may be extended up to 100 feet using a Category 5 Ethernet patch cable and an RJ45 joining connector. A crossover or direct cable may be used.

Operate the ON/OFF switch to the ON position (UP).

(NOTE: The switch operates in both the AC and DC power input modes.)

Observe the Front Panel LEDs. The desired LED status for normal operation should be:

Topside Power (GREEN)	= ON
Fish Power (RED)	= ON

3.1.2 LED DIAGNOSTICS

GREEN LED - Power Indicator:

This LED will be ON if AC or DC power is applied and the Power Switch is ON. If this will not light, with the power switch on check the Fuse.

RED LED – Tow cable power Indicator:

This red LED indicates that power is being drawn by the connected towfish. If this is solid ON this indicates normal condition.

If this LED is OFF, it indicates no power is being drawn and the most likely cause is a disconnected towfish or faulty tow cable.

If this Led is FLASHING, it indicates an over current condition has occurred. Check cable for shorts or water ingress.

3.1.3 ETHERNET CONNECTIONS

The Topside unit provides a transparent TCP/IP connection to the 4125 Towfish.

EdgeTech assigns fixed TCP/IP addresses for all the 4125 Towfish, and reserves TCP/IP address 192.9.0.101 for the towfish.

ALL 4125 Towfish will have IP address = 192.9.0.101.

Any Notebook (or Desktop) computer intended to connect via the Topside unit to the 4125 Towfish must therefore use a network adapter with a TCP/IP address 192.9.0.xxx where xxx is in the range 1 to 100. EdgeTech Factory defaults for EdgeTech Notebook (or Desktop) computers are 192.9.0.100 for Wireless Networking and 192.9.0.99 for the Ethernet LAN adapter.

Ethernet LAN Connection Setup

The Ethernet LAN connection is made using a physical wired connection via the supplied Ethernet cable. This cable provides a standard RJ-45 Ethernet plug for direct connection to the RJ-45 LAN jack a Notebook (or Desktop) computer. The Topside unit auto-senses straight and crossover Ethernet cables, and 10 or 100Mbit/s connections. The Laptop's LAN adapter can therefore be set to AutoSense for Lan speed and duplex settings, but MUST have the TCP/IP address set to 192.9.0.xxx, where xxx is between 1 to 255, but NOT 101.

NOTE: If very long Cat 5 cables are to be sued to extend the reach of the Laptop/Desktop PC to the Interface unit (> 10m) EdgeTech recommends setting the Network Adapter to 10Mbit/s, Full Duplex.

The following steps should be taken on the Notebook (or Desktop) computer to use the Ethernet LAN connection:

- Disable Wireless Networking: Locate Wireless Networking on Windows Desktop or the System Tray, then click it and Disable it, OR, if there is a switch on the Noteboook, turn OFF the Wireless Networking functionality on the Notebook computer .

- Insert the RJ-45 plug of the supplied Ethernet cable into the RJ-45 LAN jack of the Notebook (or Desktop) computer.
- Enable the Ethernet LAN: Locate the Ethernet LAN on Windows Desktop or the System Tray, then click and Enable it.

Troubleshooting

If the Ethernet LAN does not indicate "Connected" status in the Local Area Network Properties Box, check all hardware connections, LAN IP address and make sure that the Ethernet LAN is Enabled, and that the Topside unit is powered on.

Wireless Networking Connection

The Wireless Networking connection is made using the wireless networking capability of the Notebook computer.

The following steps should be taken on the Notebook computer to use the Wireless Networking connection:

- Disable the Ethernet LAN: Locate the Ethernet LAN on Windows Desktop or the System Tray, then click and Disable it, OR simply unplug the Ethernet cable from the Notebook computer's RJ-45 jack.
- Enable Wireless Networking: Locate Wireless Networking on Windows Desktop or the System Tray, then click and Enable it, AND if there is a switch, turn ON the Wireless Networking functionality on the Notebook .

Troubleshooting

The Wireless Networking should indicate a valid connection to the **"sonarlink"** wireless network within 30 seconds. If not, make sure that the Ethernet LAN is Disabled, that Wireless Networking is Enabled (and turned on), and that the 4125 Topside is powered on. If problems with this link persist, refer to Section **3.1.3**

TOW FISH ASSEMBLY

Remove 4125 fish (part #1 on Figure 9) from case.

Insert Fins (#3) into Fin Slots on the 4125 Tail Cone (#2).

Insert Tail Cone with Fins Assembly from previous step into the Towfish Body (#1) as shown.

Insert Tail Fin Locking Bolt (#4) with specified urethane washer (#5) and tighten into Towfish Body (#1).

Check that Fins are inserted properly, with the shear point engaging on the Towfish Body (see Figure 10).

When inserted correctly the fins will align at 45 degrees off vertical/horizontal dimensions.

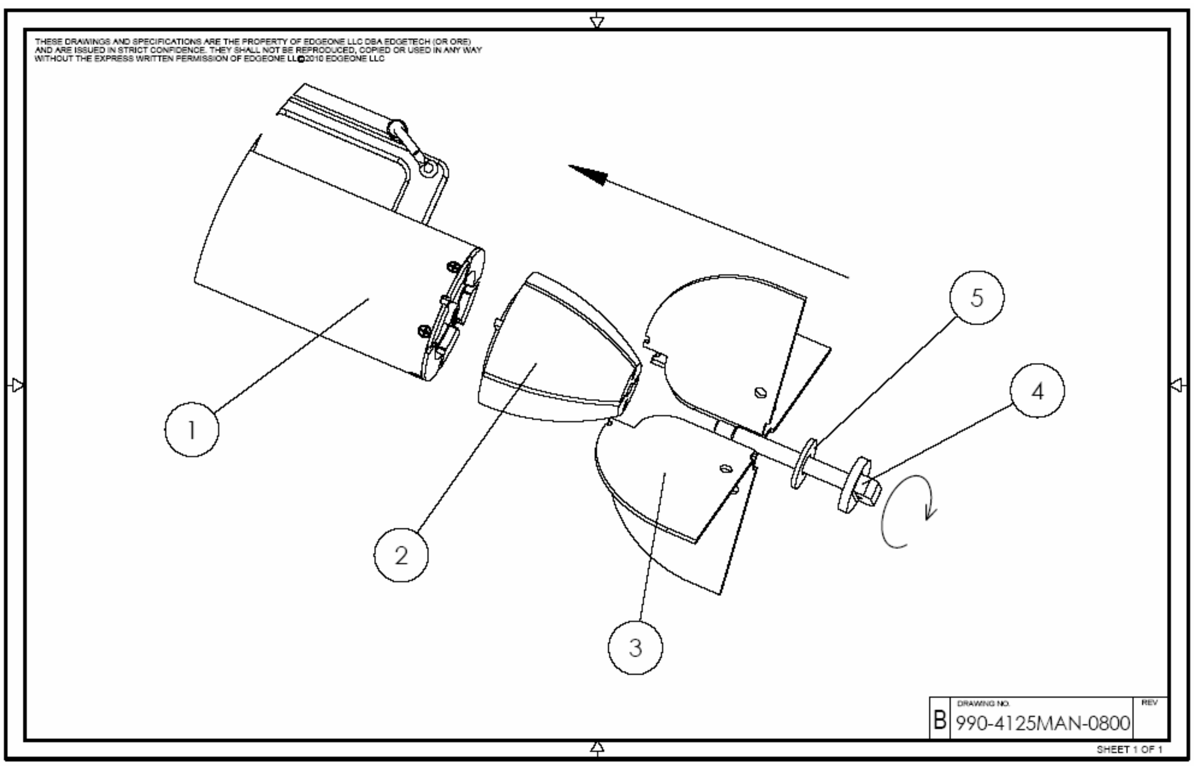


Figure 9: Tail and Fins Assembly

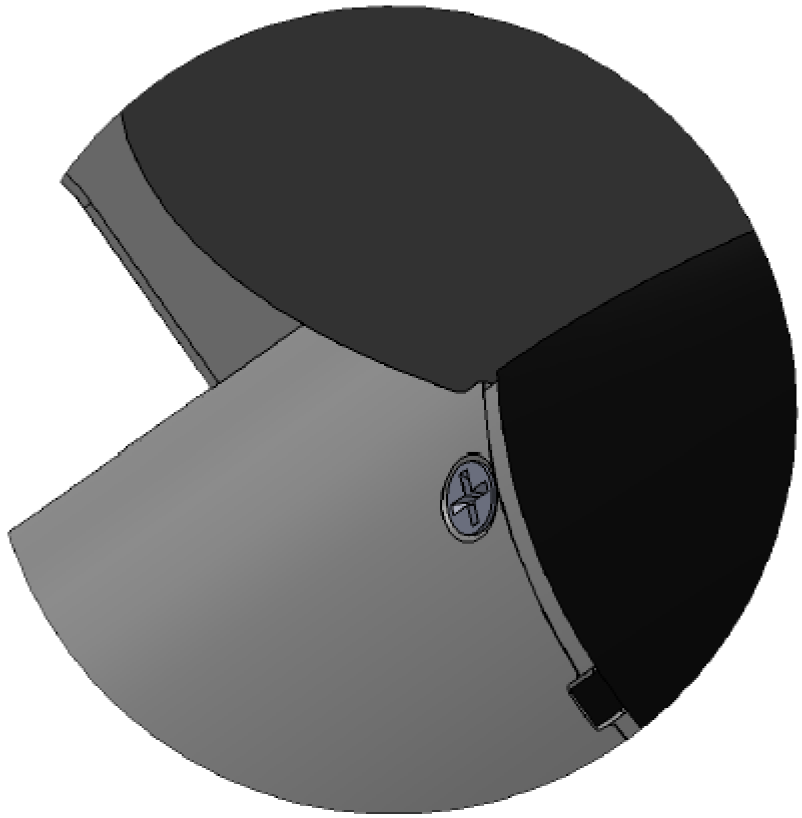
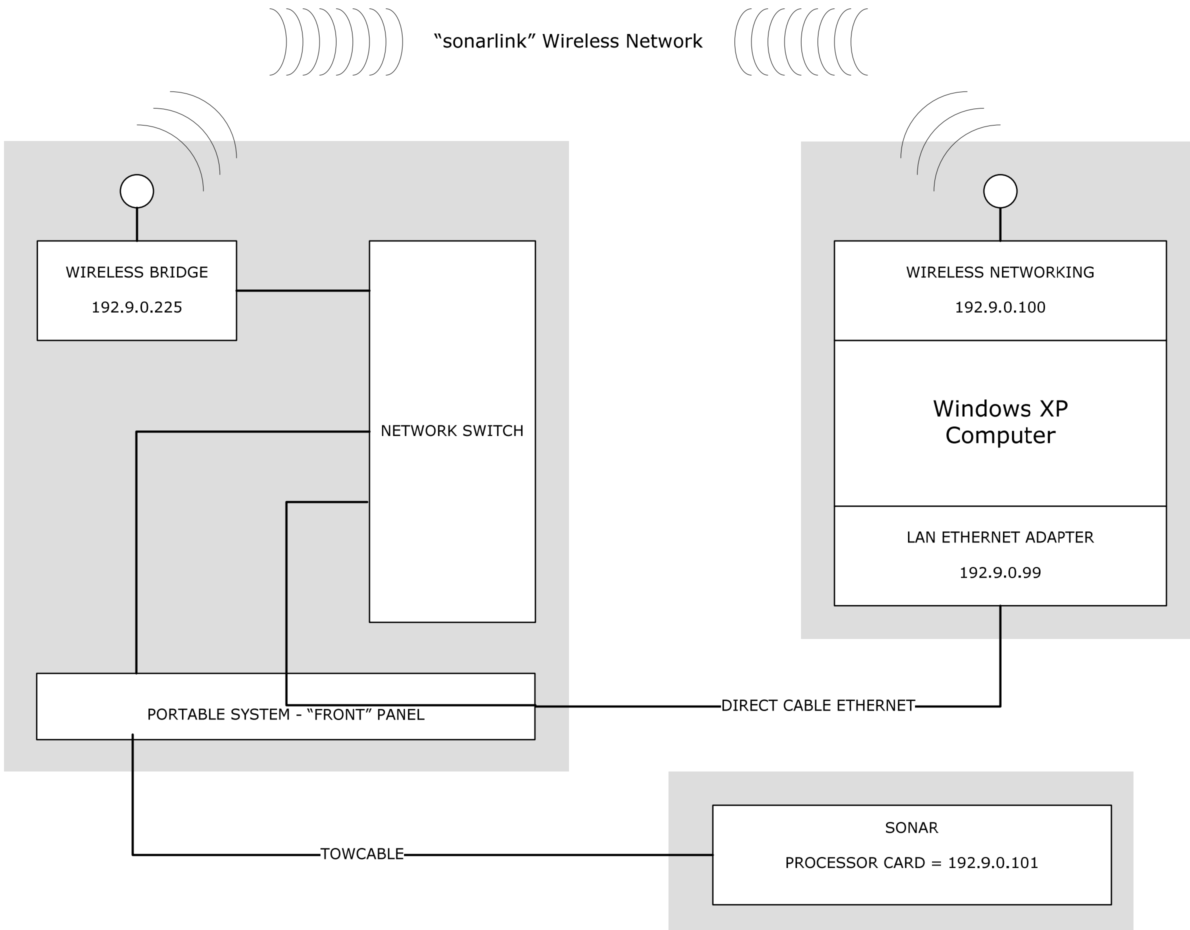


Figure 10: Properly Seated Tail Fin

3.2. System Startup:

After all connections have been made, the system is ready to be turned on and the operating system and SSS Software started. See 4125 Software manual for operation details.

4 4125 NETWORK CONFIGUATION



Notebook (or Desktop) Computer

Wireless Networking

The IP Address for Wireless Networking is fixed at 192.9.0.100, and should not be changed.

Ethernet LAN

The IP Address for Ethernet LAN is fixed at 192.9.0.99, and should not be changed.

The Ethernet LAN can be configured for Auto or 100Mbit/s link speed for short (8m/25ft) cables. For longer cables EdgeTech recommends a setting of 10Mbit/s, Half Duplex mode.

4125P Topside

The TCP/IP Ethernet capable components of the Topside are shown below. The IP Adresses for these components are fixed and should not be changed.

DESCRIPTION	COMPONENT	IP ADDRESS	CAPABILITY
Wireless Bridge	Linksys WET11 or equivalent	192.9.0.225	Ping, HTML

4200-FS Towfish

The TCP/IP Ethernet capable components of the 4200-FS Towfish are shown below. The IP Addresses for these components are fixed and should not be changed.

DESCRIPTION	COMPONENT	IP ADDRESS	CAPABILITY
Processor Card	P700	192.9.0.101	Ping, Remote Desktop

5 QUICK GUIDE

1. Set up your side scan sonar system operation computer and 4125 interface control unit at a secure place.

Connect all cabling, Tow cable, safety grip and shackle securely tightened and seized with a tie wrap or stainless steel wire, power cable, Ethernet I/O cable, GPS input.

Note: Apply a small amount of silicone grease to the Tow Cable connectors prior to connecting to towfish.

2. Assemble the tail fins on tow fish's tail and fasten them with the tail cone bolt, attach twine to fins and rear handle to retain these in the event of impact.

3. Points to be considered for deployment of Tow fish; location of propeller of the ship, expected turning direction during deployment, location of cable holder.

Note: (Cable: Take care not to step on cable, keep away from sharp objects and heat sources. Bending the cable with its radius less than 125 mm may cause damage to cable, do not bend the tow cable sharply)

5. Slow or stop the survey platform and prepare to lower the Tow fish into the water, use two ropes to stabilize the fish when lowering into the water if necessary.

6. Start the system and check that the GPS signal is good and DISCOVER is running with a "net on" indication. Check that data recording path is correctly setup .

8. Perform pre-deployment test.

Rub each transducer, port and starboard one at a time an observe streaks on DISCOVER SS waterfall display.

Check compass heading pitch and roll data is present in the status bar in DISCOVER.

9. After recovery, always wash your Tow fish and cable with fresh water. Coat connector terminals with silicon grease.

MAINTENANCE AND TROUBLESHOOTING

SYSTEM MAINTENANCE

5.1.1 PERIODIC MAINTENANCE OF TOW FISH

Maintenance of 4125 Series tow fish must be done after each use. The first thing to be done after operation and recovery is to wash with fresh water and inspect the fish. Also the condition of cable and connectors should be inspected. Re-lubricate wet connectors lightly with a small amount of silicone grease.

5.1.2 CLEANING

The 4125 topside requires minimal maintenance. Periodically lubricate of tow cable connector and inspect the other connectors.

After operation and recovery of the tow fish, wash and inspect as follows:

1. Stainless steel used for tow fish is manufactured from non-corrosive 316- Stainless steel. Wash the tow fish with fresh water after every use to remove all foreign material from the surface or inside of tow fish and wash it together with connector parts and bolts.

2. Inspect left and right transducers. Wash them with fresh water and a very mild detergent if transducers have any oily residue, using soft cloth.

3. Inspect fins for warping and replace if necessary.

Note: Never use harsh chemical detergents on transducers

4. Inspect the tow cable for cuts or scratches. After connector is detached from tow fish, clean pins and socket with alcohol and coat silicon to prevent adhesion of foreign material and damage caused by corrosion.

5. Inspect shear pin and replace if worn or damaged.

6. Dry tow body in the shade and store it in the case.

5.1.3 DISASSEMBLING OF THE TOW FISH

The 4125 Tow fish is divided into four major parts - Nose, Towbody, Transducers and Tail. Disassembling of 4125 electronics bottle is to be done by a qualified Edgetech service technician. To clean mud or sand from inside Tow Fish, you can remove nose part from body and flush inside of tow body with fresh water.

5.1.4 FISH RE-ARMING

When the safety link (shear pin) trips, the tow fish must be rearmed with the appropriate plastic shear pin. Spare shear and cotter pins are in the spares kit.

Do not replace the plastic shear pin with a metallic one unless it is a dire emergency. A metal pin may not shear if the tow fish hangs on a snag. This may result in losing the tow fish if the tow cable separates.

When the cable connector on the tow fish arm pulls out during recovery from a snag, it causes the cable voltage to be exposed to seawater. Immediately turn off the tow fish power when this occurs to prevent electrolysis on the connector pins. Always check the female tow cable connector for any evidence of burning prior to rearming the fish. If so, the tow cable may have to be re-terminated.

Use a light coating of silicone grease every time the marine connectors separate. Do not pack the female connector with grease unless it is to be stored away for a long period. Clean out the female connector pins of any grease prior to use. Failure to do this will cause a hydraulic lock preventing them from being properly mated.

SYSTEM TROUBLESHOOTING

Refer to this chapter to resolve difficulties met during operation, when the Tow Fish is in water, or for preliminary inspection. This chapter will suggest quick solutions to common problems you may have with the Tow Fish, 4125 topside, or how to get help from our Customer Service department.

WARNING: *Before the examination for troubleshooting of equipment the power must be off and cable must be detached.*

5.1.5 TOOLS AND EQUIPMENT FOR FIELD EXAMINATION

- Multi-meter (Multi-Tester)
- Hexagonal wrench
- Screw driver

5.1.6 TROUBLESHOOTING GUIDE

Table 6-1 Trouble starting system.

Symptoms	Reason	Measures
No Power to 4125 topside. Green LED OFF	1. Poor connection of connectors. 2 . No Power Source 3. Check fuse in topside	Inspect the connectors on the topside, fuse condition and power source.

Table 6-2 Trouble in Tow fish Operation

Symptoms	Reason	Measures
Turn System on No sonar data	Check tow cable Check Ethernet data cable	Replace or repair tow cable if damaged. Check Ethernet set-up
Tow fish does not respond to commands, Net OFF condition indicated in Discover	1. Disconnected Ethernet cable. 2. No power to Interface unit 3. Set up problems of Ethernet Port. 4. Incorrect Network setup in Discover- Refer to Discover Users Manual.	1. Verify Cable and Power connections 2. Locate Network Connections in Windows OS. 3. Open the Network Adapter settings 4. Click TCP/IP – Properties, and verify Fixed IP address is 192.9.0.99

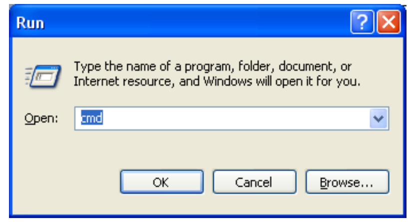
	2. Poor connection between Interface Topside and Tow fish.	5. Click START – Run – and type cmd in the window:  In the dialog that follows, type: Ping 192.9.0.101 <return> If the response is reply…. then the fish connection is good. If the response is :Request timed out, then the fish is not connected or the IP address is misconfigured. If the response is : Hardware error, there is no conneciotn to the topside interface.
	4. Poor electrical contact inside tow fish or Interface Unit	Call Edgetech

Table 6-3 Trouble in Tow fish operation

Symptoms	Reason	Measures
Distortion and noise to the images of Port and Starboard.	Noise/interference from the propulsion of ship, wake disturbance	Check to see if the towfish is in the wake/propeller turbulence.
	Possible interfering signal from echo sounder	Turn off ship's echo sounder.
	Possible fracture of Shear pin	Recover tow fish and inspect for safety pin fracture. If it is damaged, change shear pin.
	Possible fins missing	Replace fins
	Possible adhesion of foreign substances or oil to the port and starboard arrays of tow fish	Recover tow fish and inspect. Remove foreign substances.

Table 6-3 Trouble in Tow fish operation

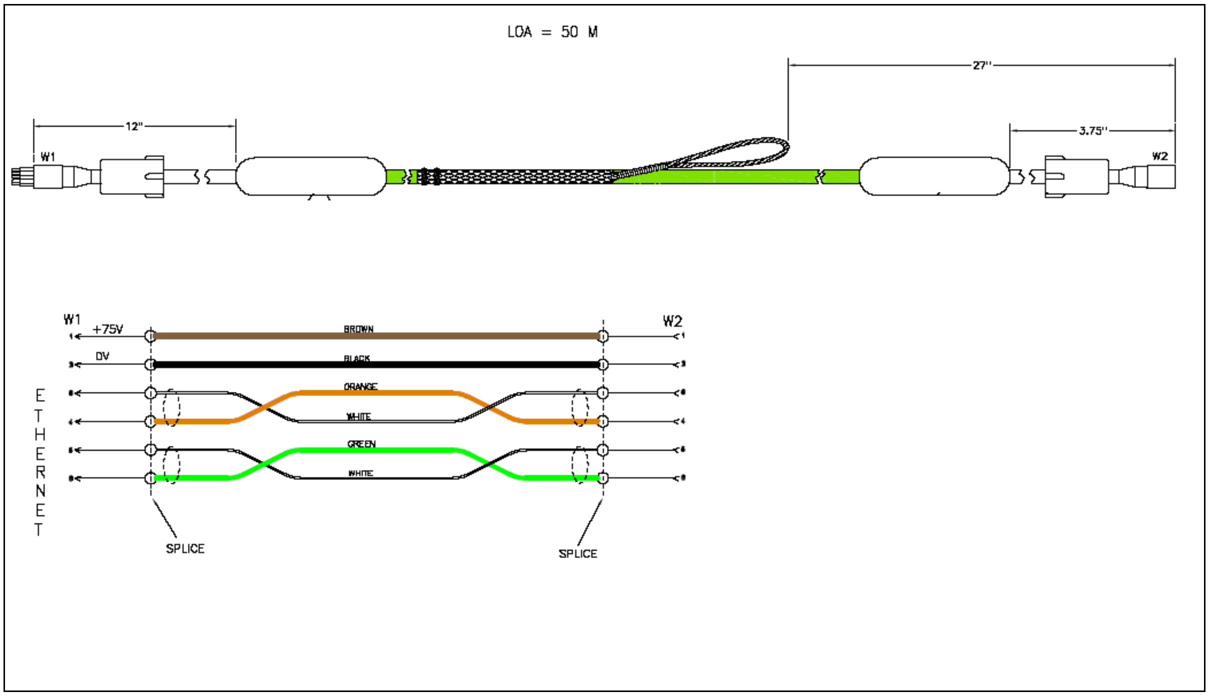
Symptoms	Reason	Measures
Information on navigation and GPS are not displayed on status window or GPS window.	Incorrect connection of GPS and laptop. Incorrect serial port set up of GPS Serial Port.	Inspect if GPS cable is connected to laptop. Use Hyper terminal to check raw Nav string is being input on correct port. If not run DISCOVER set-up program and choose correct com port.
	Obstruction/object above GPS Antenna.	Remove obstruction or objects from above GPS Antenna. 2. Inspect if the antenna of ship is too close to GPS antenna. It may cause poor reception.

5.1.7 CABLE INSPECTION

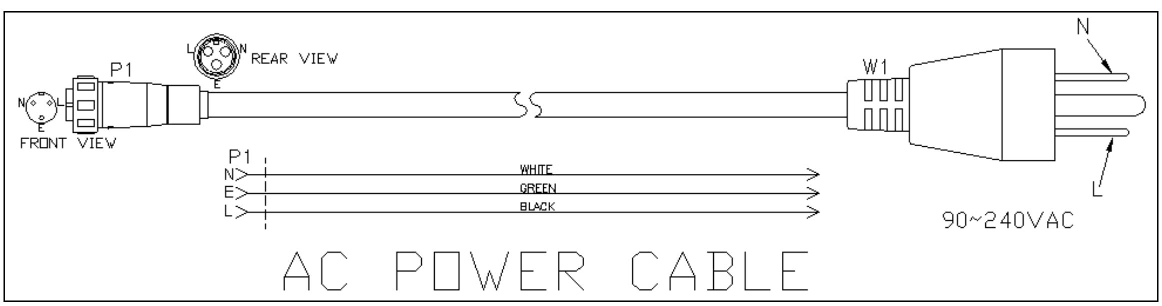
If you think cable or connector has malfunctioned, perform the following three simple cable inspections. Inspect for cable twisting, inspection of external jacket by eye, and simple point to point circuit test.

Inspect whether any part of cable was bent less than minimum allowable value. The minimum bending radius of 4125 tow cable is 6 inches. The cable may suffer damage when the cable is wound or twisted with less than this radius. Also, attention should be paid to not severely twist the cable because it may cause the damage to the molding part of cable and connector. If the tow fish was caught by some object during towing and rotated excessively damage to the connector may have been done. Test cable before using to prevent additional damage.

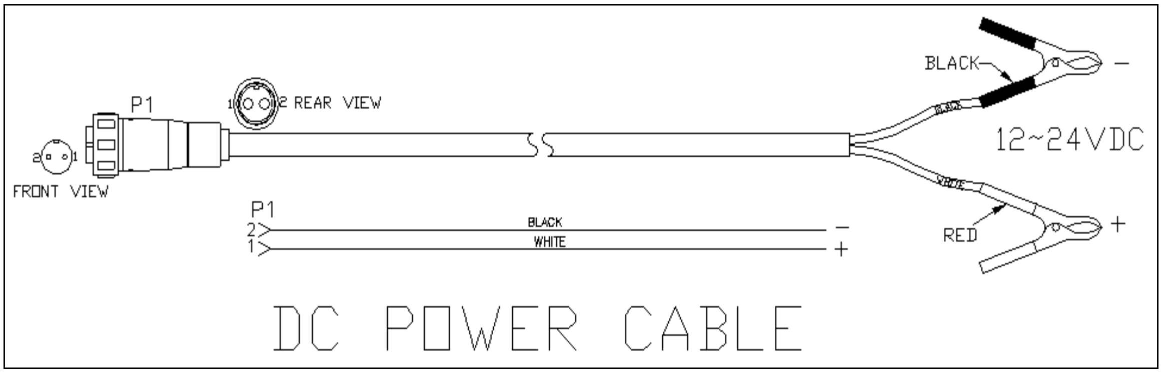
6 DRAWINGS



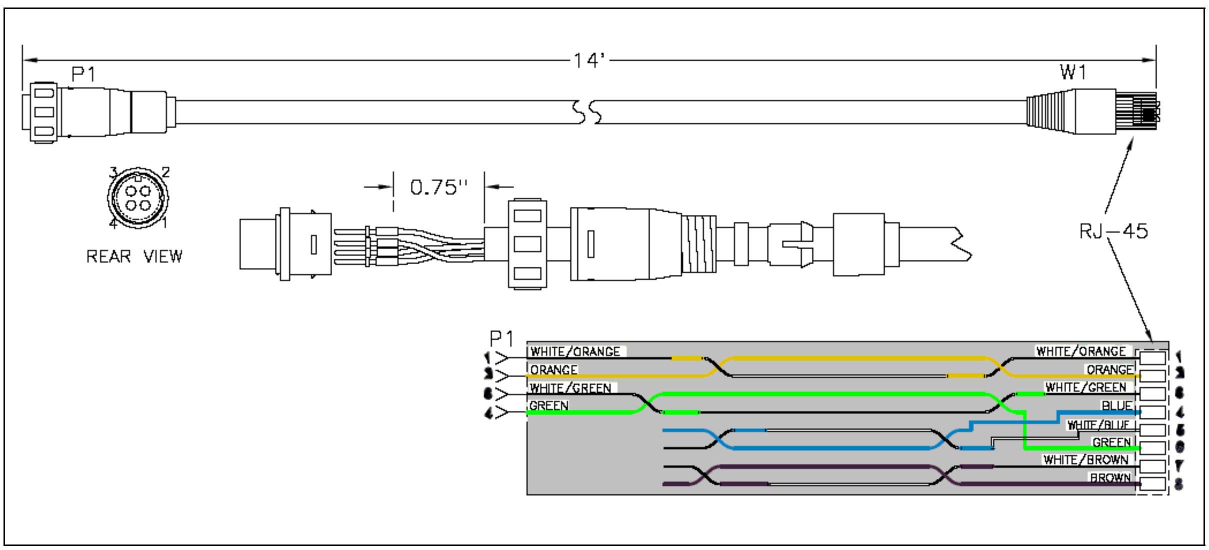
4125 Tow Cable



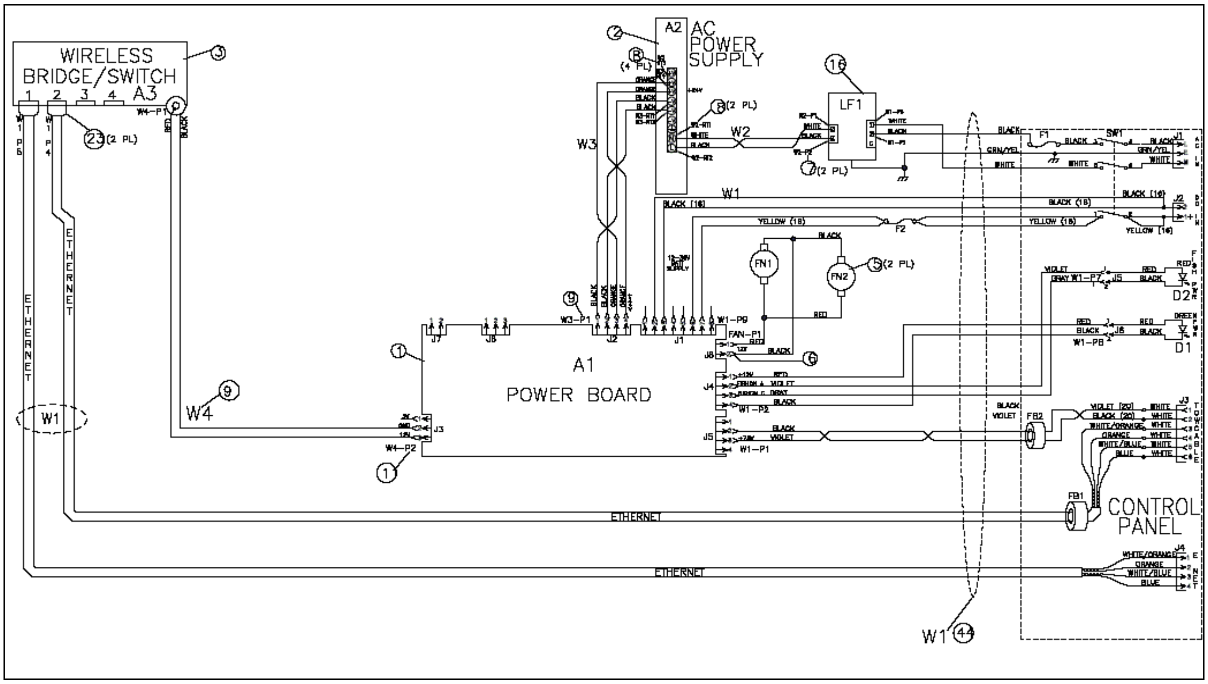
AC Power Cable



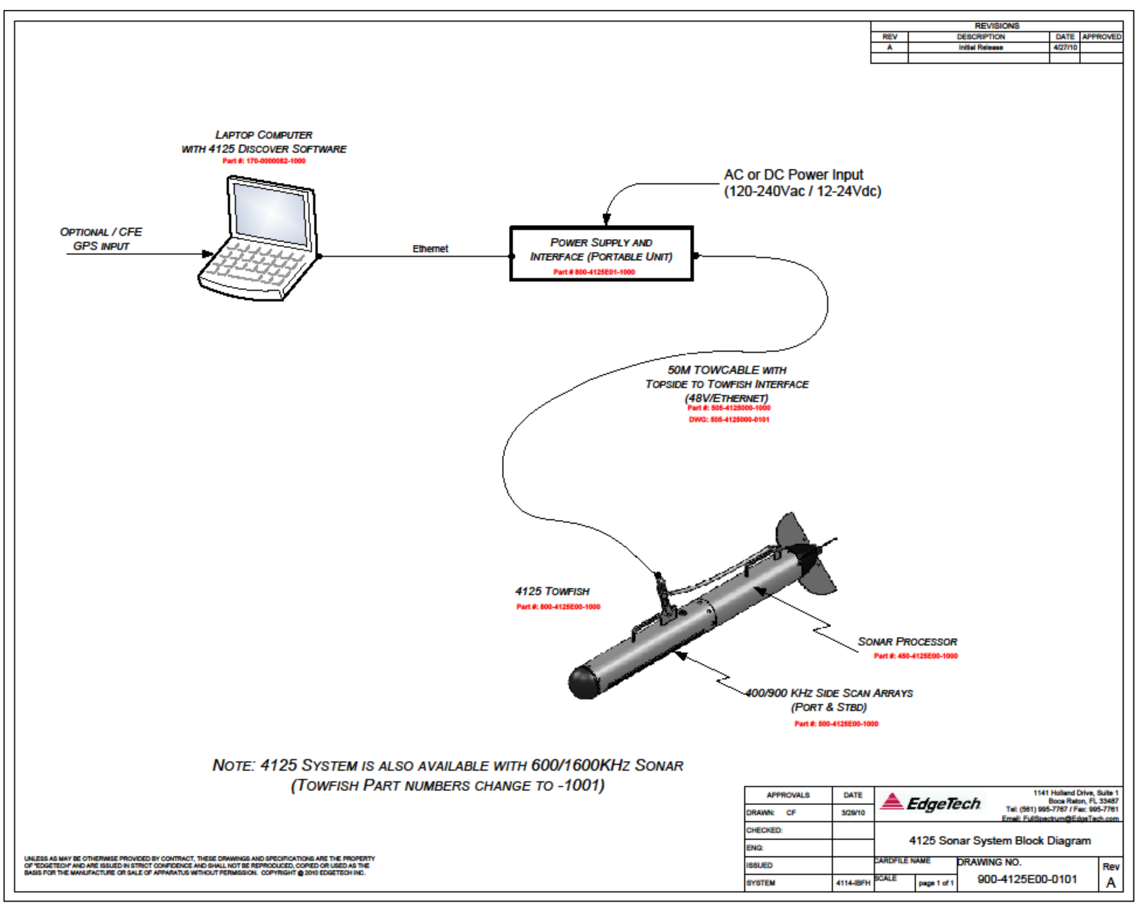
DC Power Cable



Ethernet Data Cable



Topside Interconnect Diagram



7 CABLE LAYBACK AND FISH DEPTH

The plots contained within this document have been generated under the following conditions / assumptions:

- Sea State = 0 (no vessel heave motion)
- Ocean current = 0
- Solutions are for steady state Tow Vessel Speeds (2 to 8 kts, 1 kt increments)
- Cables Examined: Soft Tow Cable (168181)
- Cable lengths 50m to 200m

Ocean currents will be a factor for virtually all cases in which the system is used. By following the simple procedure below the existing plots can be used for predicting the tow fish depth when ocean currents are present (assuming the ocean current is uniform with depth).

Tow Vessel moving into the current:

Tow Fish Relative Speed = Tow Vessel Speed + Ocean Current

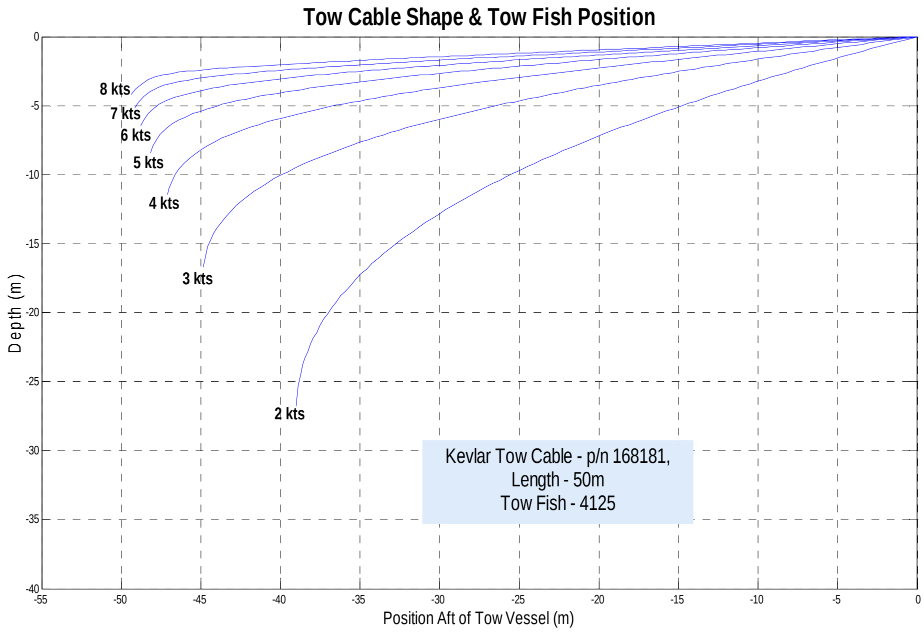
ex: Tow Vessel Speed - 5kts, Ocean Current 1 kt, **->Tow Fish Relative Speed = 6 kts; Use the 6 kts data curve in the graphs listed within**

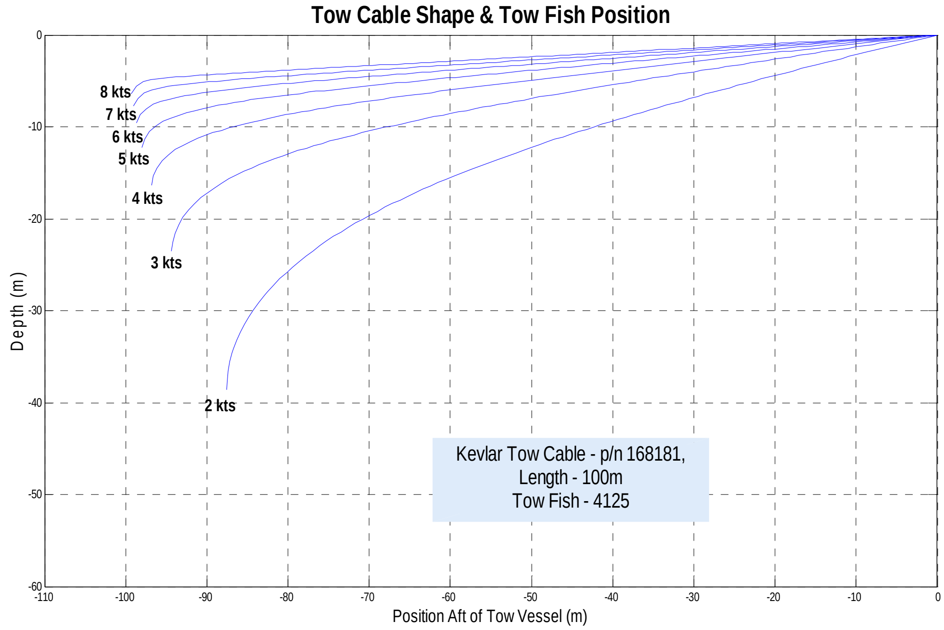
Tow Vessel moving with the current:

Tow Fish Relative Speed = Tow Vessel Speed - Ocean Current

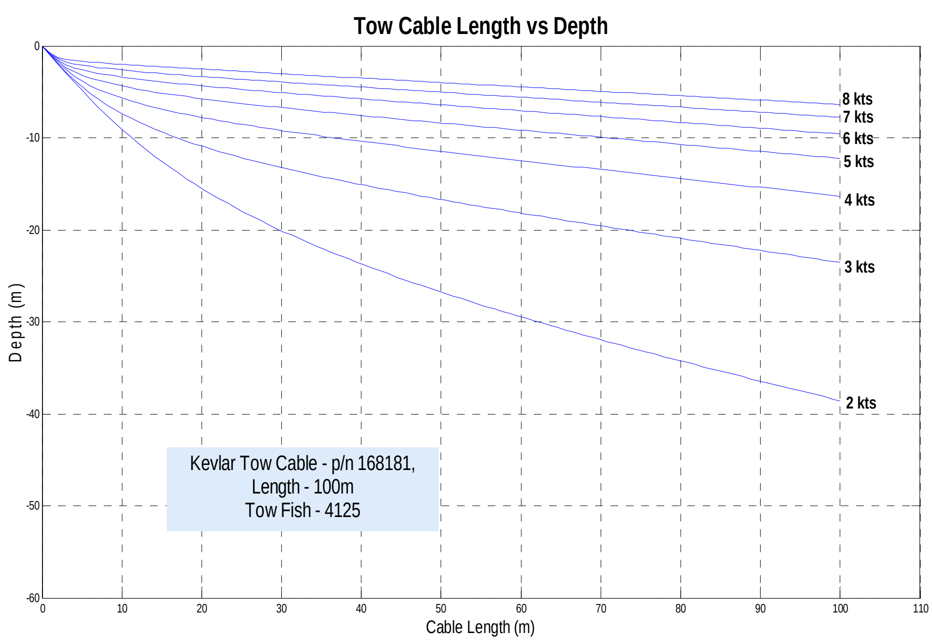
ex: Tow Vessel Speed - 5kts, Ocean Current 1 kt**, ->Tow Fish Relative Speed = 4 kts; Use the 4 kts data curve in the graphs listed within**

The data shown is to support planning purposes only and must not be used to determine or estimate the fish depth in an operational situation.

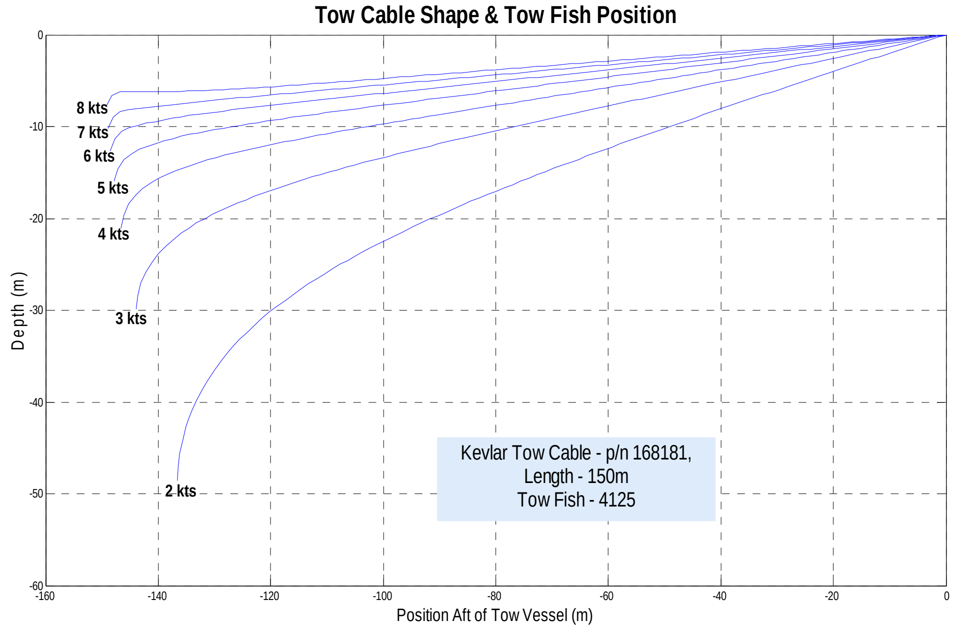

Tow Cable Shape & Tow Fish Position
8 kts
7 kts
6 kts
5 kts
4 kts
3 kts
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 50m
Tow Fish - 4125
Depth (m)
Position Aft of Tow Vessel (m)
0
-5
-10
-15
-20
-25
-30
-35
-40
-55
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0

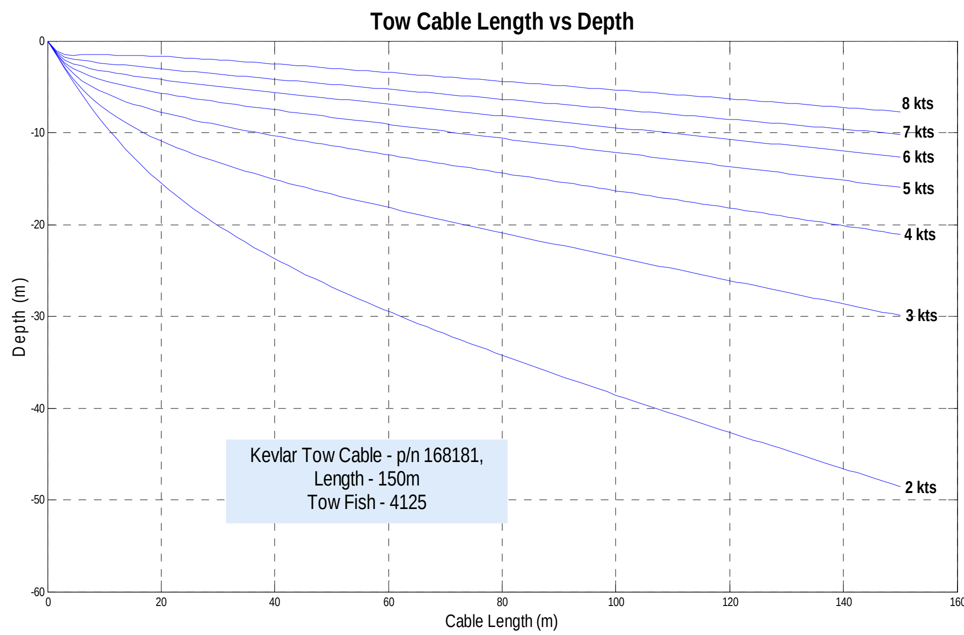


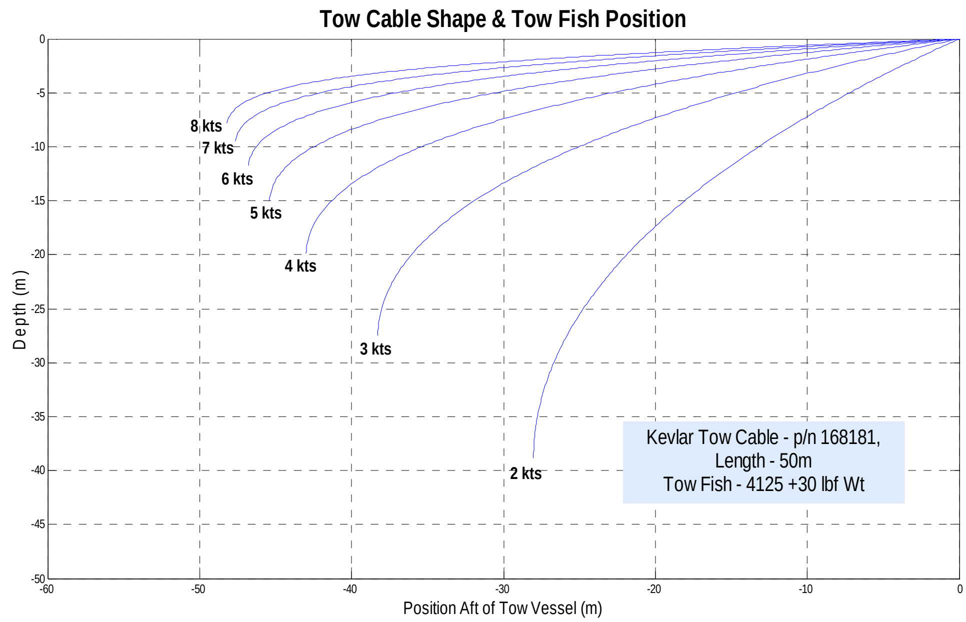
Tow Cable Shape & Tow Fish Position
8 kts
7 kts
6 kts
5 kts
4 kts
3 kts
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 100m
Tow Fish - 4125
Depth (m)
Position Aft of Tow Vessel (m)

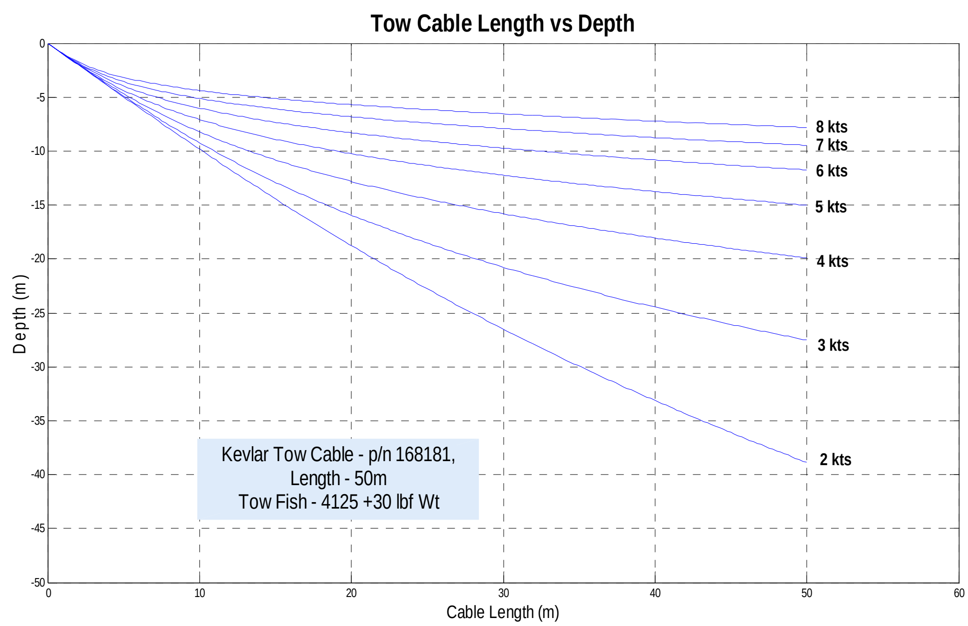


Tow Cable Length vs Depth
8 kts
7 kts
6 kts
5 kts
4 kts
3 kts
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 100m
Tow Fish - 4125
Depth (m)
Cable Length (m)


Tow Cable Shape & Tow Fish Position
Depth (m)
Position Aft of Tow Vessel (m)
8 kts
7 kts
6 kts
5 kts
4 kts
3 kts
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 150m
Tow Fish - 4125
0
-10
-20
-30
-40
-50
-60
-160
-140
-120
-100
-80
-60
-40
-20
0


Tow Cable Length vs Depth
Depth (m)
Cable Length (m)
8 kts
7 kts
6 kts
5 kts
4 kts
3 kts
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 150m
Tow Fish - 4125
0
-10
-20
-30
-40
-50
-60
0
20
40
60
80
100
120
140
160


Tow Cable Shape & Tow Fish Position
Depth (m)
Position Aft of Tow Vessel (m)
8 kts
7 kts
6 kts
5 kts
4 kts
3 kts
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 50m
Tow Fish - 4125 +30 lbf Wt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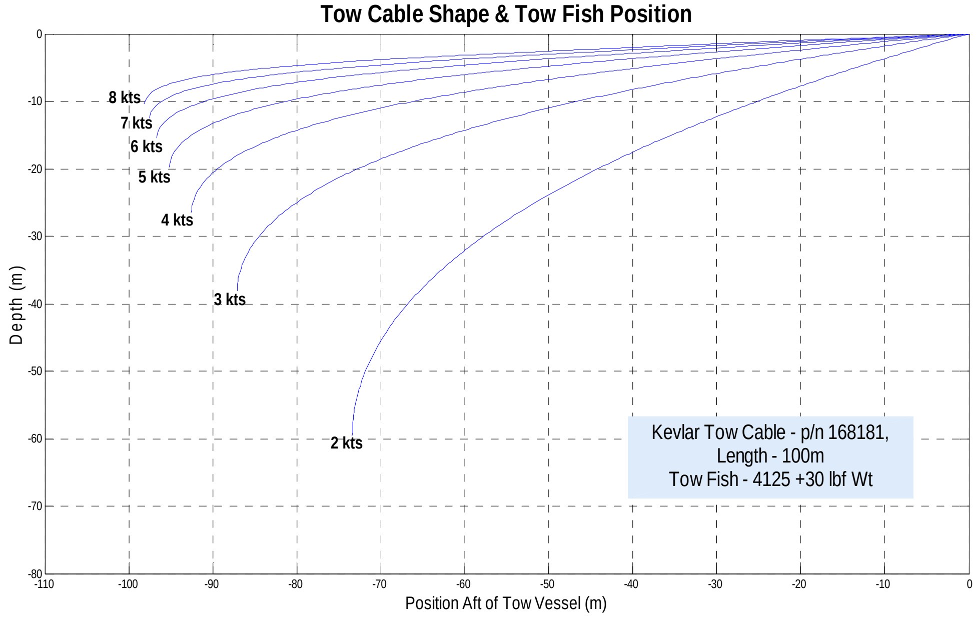
Kevlar Tow Cable - p/n 168181,
Length - 50m
Tow Fish - 4125 +30 lbf Wt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Position Aft of Tow Vessel (m)
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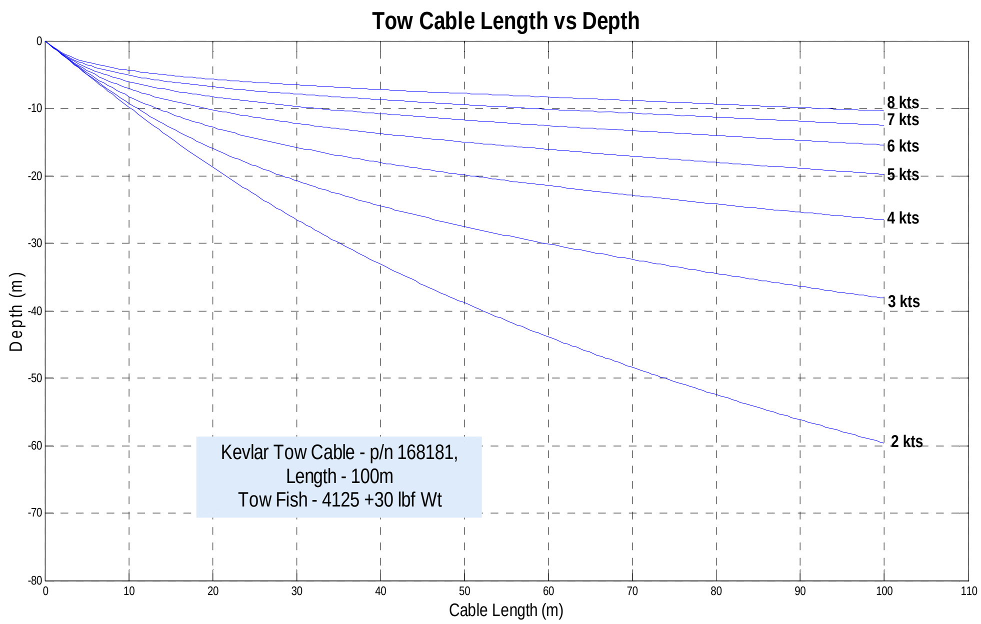
7 kts
6 kts
5 kts
4 kts
3 kts
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 100m
Tow Fish - 4125 +30 lbf Wt


Tow Cable Length vs Depth
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Cable Length (m)
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3 kts
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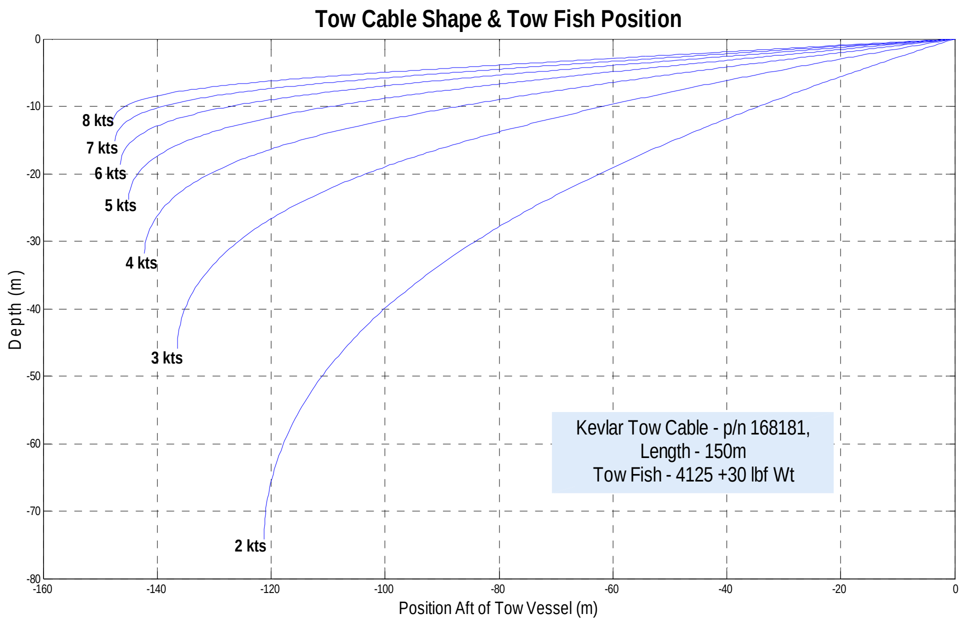
Kevlar Tow Cable - p/n 168181,
Length - 100m
Tow Fish - 4125 +30 lbf Wt


Tow Cable Shape & Tow Fish Position
Depth (m)
Position Aft of Tow Vessel (m)
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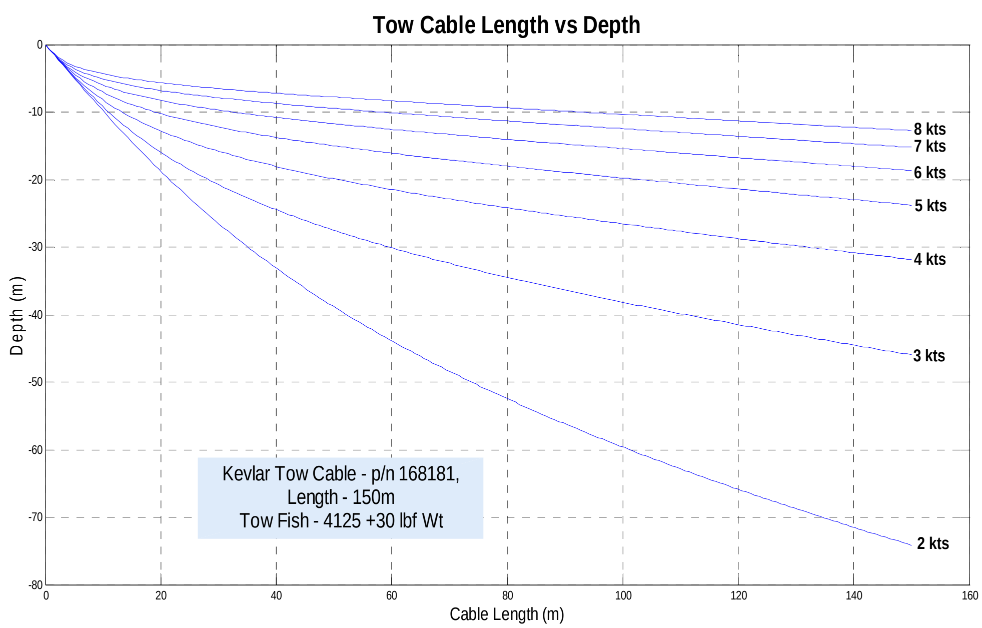
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 150m
Tow Fish - 4125 +30 lbf Wt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7 kts
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4 kts
3 kts
2 kts
Kevlar Tow Cable - p/n 168181,
Length - 150m
Tow Fish - 4125 +30 lbf Wt

Calibrating the Ocean Server compass inside the 4125 series tow fish

Recalibrating the compass requires a flat platform that can be rotated in which the vehicle will remain level and a regular handheld compass. Follow the steps below to calibrate a the compass

1. Move the vehicle outside away from anything that contains metal such as buildings or cars.

2. Setup the platform and make sure that it is level and indicate the compass cardinal points *(0, 90, 180 and 270)* on the platform.

3. Place the tow fish on the platform and remotely connect to the 4125 tow fish using the remote desktop program.

4. Once logged in to the 4125 CPU desktop select **Start**>**Programs**>**Accessories**>**Communications**, and click on **Hyper terminal.** **(There is a shortcut on the 4125 desktop for this)**

5. Next to *Connect Using* select the com port the compass is using *(default com port for the compass is COM 3)* and click the **OK** button.

6. Click the **Restore Defaults** button, next to **Bits per second** select 19200, and click the **OK** button.

Compass com port settings

7. Confirm that data is coming into the HyperTerminal. If no data appears then close the HyperTerminal and restart the process and confirm that the correct com port and setting were chosen.

8. **Calibrating**: Place the Tow fish on the flat platform open the HyperTerminal and hit the **ESC key** then enter an uppercase **C** and slowly rotate the Tow fish 360 degrees or 1 or more full rotations until the incoming characters stop and you see ”…………..” When the rotations are completed click the space bar to stop the Z calibrating.

9. Turn the Tow fish 90 degrees on its side so that the tow arm is now parallel to the ground. Go back to the HyperTerminal window and hit the **ESC key** then enter an uppercase **Z** and slowly rotate the vehicle 1 or more full rotations. At the end of the rotations notice the incoming characters "……" and click the space bar to stop the calibrating.

10. **Soft Iron Calibration**
The above mentioned (C,Z) calibration routines do not compensate for soft iron effects. Soft iron, wires with moving currents and other high permeability materials in the near field cause these. These are generally far weaker than hard iron effects. Choosing a good Tow fish mounting location with distance from soft iron structures should be attempted. Before starting the calibration, you need to have the system with the compass installed and freshly calibrated, (via the <esc>C,<esc>Z commands).

To start the soft iron compensation routine, press the Esc key and then enter the $ key. Select option 2 and follow the screen prompts Align the vehicle to the four cardinal points according to an accurate reference magnetic compass, 0 North, 90 East, 180 South, 270 West in an area free of magnetic disturbance and hit space to continue to the next cardinal point.

After the calibration process is complete, the correction values generated by the process. Realign the vehicle with the cardinal points again and verify the readings are correct. If the vehicle is still not reporting accurate information compared to the known good reference compass you should run through the calibration process again and carefully check each step. In some cases, the magnetic field may be too disturbed for accurate calibration and distance from soft iron is the best solution.

8 CUSTOMER SERVICE

STATEMENT

All equipment manufactured by EdgeTech is warranted against defective components and workmanship for a period of one year.

In order to be able to serve you faster, please address any concerns related to the 4125 System to the plant in West Wareham, Massachusetts.

If the situation requires sending equipment back for repair please refer to the following page for detailed shipping procedures.

Our customer service personnel in both plants enjoy hearing from the people who use our products. Your experience with our products is a valuable source of information that we will use to continuously improve our products. We encourage you to contact or visit us to discuss any issues related to our products.

EdgeTech

info@EdgeTech.com
http://www.EdgeTech.com

4 Little Brook Road
West Wareham, MA 02576
Tel: (508) 291-0057
Fax: (508) 291-0975

RETURNED MATERIAL AUTHORIZATION

It is necessary to obtain a Returned Material Authorization (RMA) number prior to returning any equipment to EdgeTech. This will help EdgeTech in recognizing your equipment when it arrives at our receiving dock, and to assist us in tracking your equipment while it is at our facility. The material should be shipped to the address indicated above.

Please refer to the RMA number on all documents and correspondence as well.

All returned material must be shipped prepaid. **<u>Freight collect shipments will not be accepted.</u>**

The following steps apply only to material being returned from outside the Continental United States. These steps should be followed carefully to prevent delays and additional costs.

1. All shipments must be accompanied by three copies of your proforma invoice, showing the value of the material and the **REASON FOR ITS RETURN.** If the reason is for repair it must be clearly stated in order to come through customs faster and without duties being charged. Whenever possible, please send copies of original export shipping documents with the consignment.
2. If the value of the equipment is over $1000, the following Shipper's oath must be sent with the invoice. This oath can be typed on the invoice, or on a separate letterhead.

   "I, ______________________________, declare that the articles herein specified are the growth, produce, or manufacture of the United States; that they were exported from the United States from the port of _____________________, on or about _______________; that they are returned without having been advanced in value or improved in condition by any process of manufacture or any other means; and that no drawback, or allowance has been paid or admitted hereof."

   Signed ______________________________

3. If there is more than one item per consignment, a packing list must accompany the shipment. It is acceptable to combine the proforma invoice and packing list as long as the contents of each carton are clearly numbered and identified on the invoice.

4. Small items can be shipped prepaid directly to EdgeTech by FedEx, DHL, UPS, Airborne, etc.

5. If the equipment is the property of EdgeTech (formerly EG&G Marine Instruments Division) please insure for full value.

6. Fax one invoice, packing list, and copy of airway bill to EdgeTech upon shipment.

APPENDIX B

Edgetech 4125 Side-Scan Sonar Quick-Start Guide

A981653 REV A

4125 system setup and deployment quick start guide

OPERATION IN AIR

Do not operate the system while the tow fish in air for extended periods. The system may be enabled to transmit while in air for test purposes, as an audible clicking may be heard by persons with good hearing (young ears). Such testing should be limited to 5 minutes or less. This system transmits high power into the transducers, which can become quite hot if operated in air for extended periods. Damage to the transducers and internal electronics is possible.

Top side setup

- Set up your side scan sonar system operation computer and 4125 interface control unit at a secure place.
- Connect AC or DC power cable to power source.
- Connect ETHERNET cable to laptop and 4125 top side.
- Connect GPS to appropriate serial port.
- If wireless connection is going to be used, enable wireless connection in the network settings and disable the LAN connection.
- Connect the tow cable to the top side.

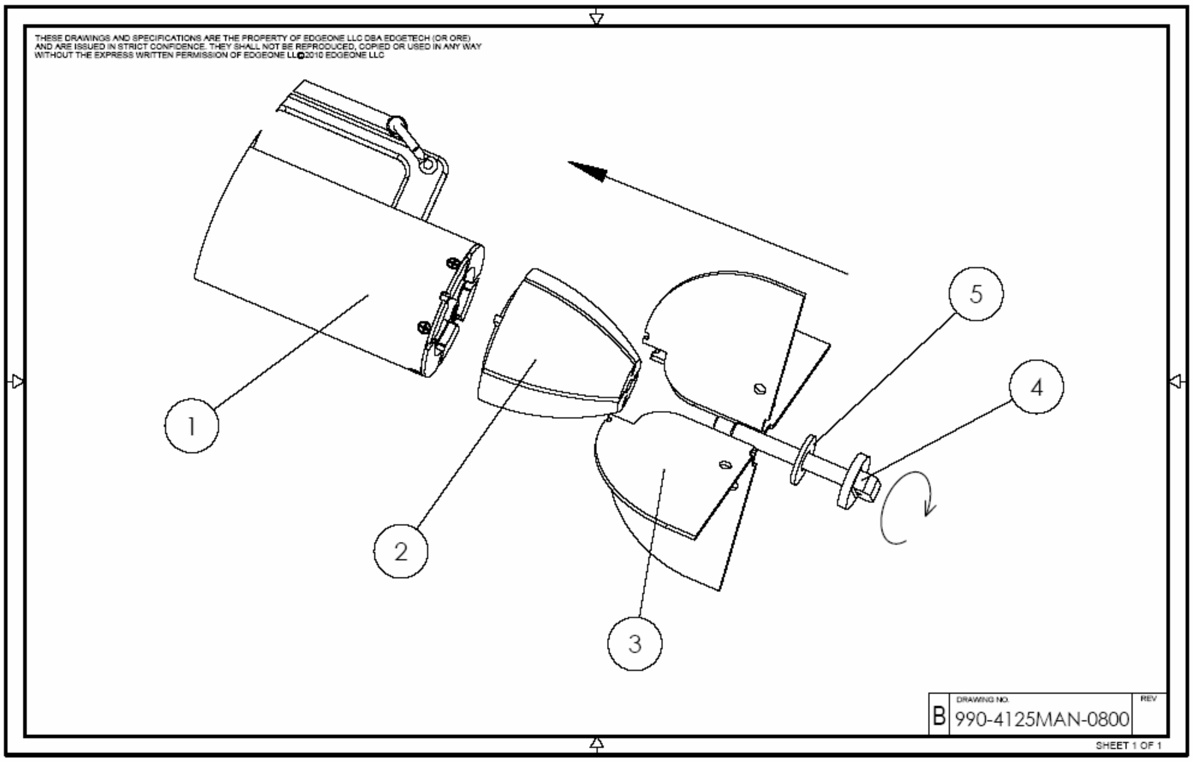
Tow Fish Assembly

- Insert Tail Cone #2 with Fins #3 into the Tow fish Body (#1) as shown.
- Insert Tail Fin Locking Bolt (#4) with specified urethane washer (#5) and tighten into Tow fish Body (#1).

- Check that Fins are inserted properly, with the shear point engaging on the Tow fish Body

  When inserted correctly the fins will align at 45 degrees off vertical/horizontal dimensions.

- Attach supplied line to tail fins and rear handle on tow fish to prevent loss of tail fins due to minor snags or collisions.



- Note: Apply a small amount of silicone grease to the Tow cable connector prior to connecting to tow fish.
- Attach the tow cable to the tow fish main I/O connector and secure locking sleeve.
- Connect tow cable safety grip and shackle to tow arm and securely tightened and seized with a tie wrap or stainless steel wire.

- Attach potted splice to the tow arm with tie wraps to prevent damage to the connector and splice.

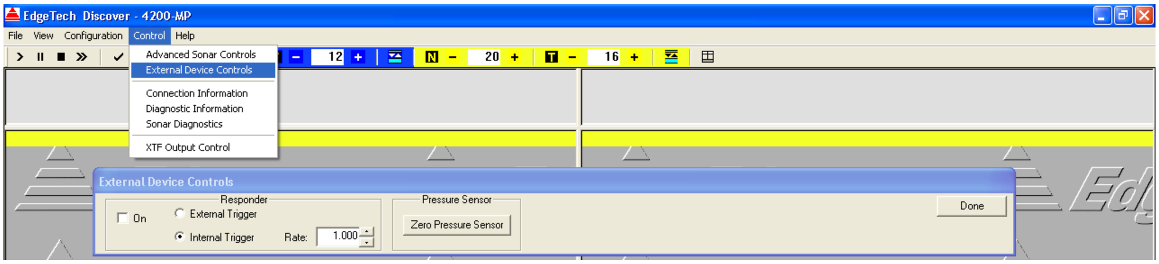
After all connections have been made, the system is ready to be turned on and the SSS Software started. See 4125 Software manual for operation details.

- Turn on the 4125 topside:

Observe that the topside and fish power lights are illuminated and the Link and LAN lights are active. Note: some older topsides have only the power and fish power indicators.

- Start the DISCOVER software program if not already running and wait for the **Net OFF** dialog box to change to **NET ON**. (This indicates that the Top side and tow fish are connected).

  When the LAN connection is made on the ETHERNET 4125 tow fish the LAN light will remain on solid until data is sent over the Ethernet cable between the towfish and the computer. The Link light will flash. (The Telemetry 4125 tow fish the LAN light will remain on solid until data is sent over the Ethernet cable between the towfish and the computer. The Link light will remain on solid when DSL link is made between the topside and the tow fish).
- In the tow fish control dialog check the Transmit boxes for High and Low frequencies and verify the waterfall is scrolling down the screen for both frequencies.
- Set the range for 100 meters for each frequency.
- Click the **N** and **T** buttons on the top of the DISCOVER GUI to set the gains.
- Check that the GPS signal is being displayed in the Status tab. (Refer to the hardware manual for details on serial port setup for navigation input.)
- Zero pressure sensor in the control pull down menu external control dialog box.



External device control dialog.

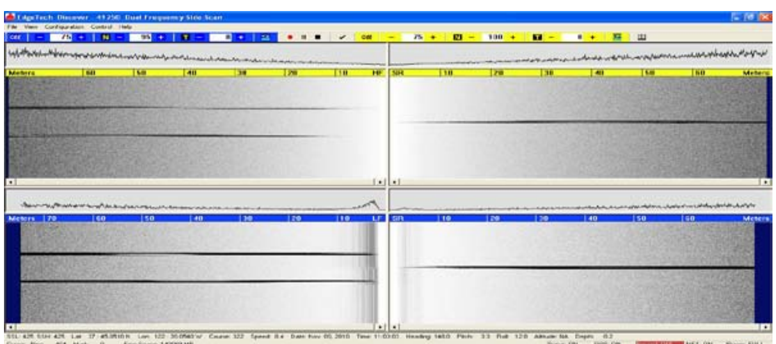
Verify record and playback functions by recording pre-deployment test.

- In the DISK dialog box, name the file in the file record file box and choose the desired path for the file.
- Start recording by clicking the Red button.

Perform pre-deployment test.

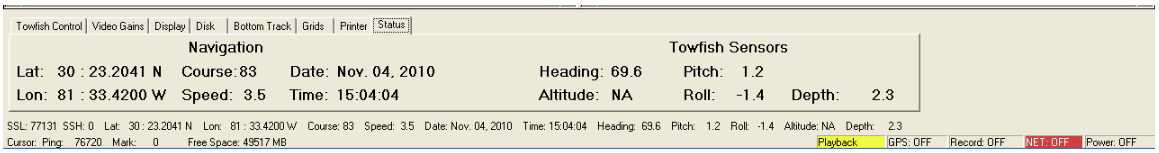
Perform this test while recording to verify record function

- Rub each transducer, port and starboard one at a time briskly an observe streaks on DISCOVER. It should look similar to the screen shot below but will vary depending on how hard the transducers are rubbed.



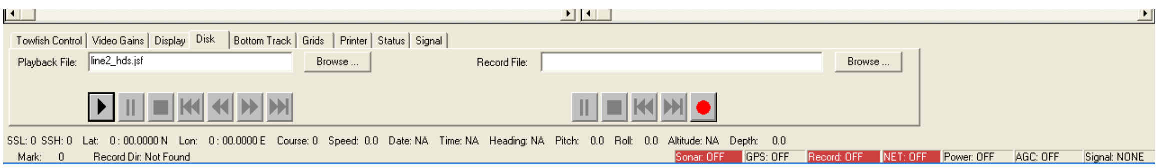
Rub Test

- Check compass heading pitch and roll data is present, pitch and roll the fish and observe the pitch and roll data is changing in the status bar in DISCOVER. Rotate the tow fish 360 degrees and observe the compass data is correct.



Status tab

- After performing the rub test and the check of the HPR sensor click the Black square to stop recording.
- In the DISK tab playback section, click on the browse button and locate the pre-deployment test that was just recorded. Click the play button and playback the file. You should see your pre-deployment test played back.



Record menu

Deployment

Points to be considered for deployment of Tow fish;

- **Location of propeller of the ship. (In shallow water deployments in may be better to deploy from the side of the boat).**
- **Expected turning direction during deployment. When deploying the tow fish from the side of the boat turns should be made so the tow fish swings away from the propeller.**
- **Note: (Cable: Take care not to step on cable, keep away from sharp objects and heat sources.**
- **Bending the cable with its radius less than 5 inches may cause damage to cable, do not bend the tow cable sharply)**

- Vessel should be underway at slow speed or stopped in neutral depending on the situation and conditions (0-2 KNOTS)

- Set the side scan range to 2 to 3 X the water depth.

- Slowly and carefully lower the fish to a safe depth just below the propeller wash (2-3 meters, depending on water depth) is careful not to strike the tow fish against the side of the vessel.

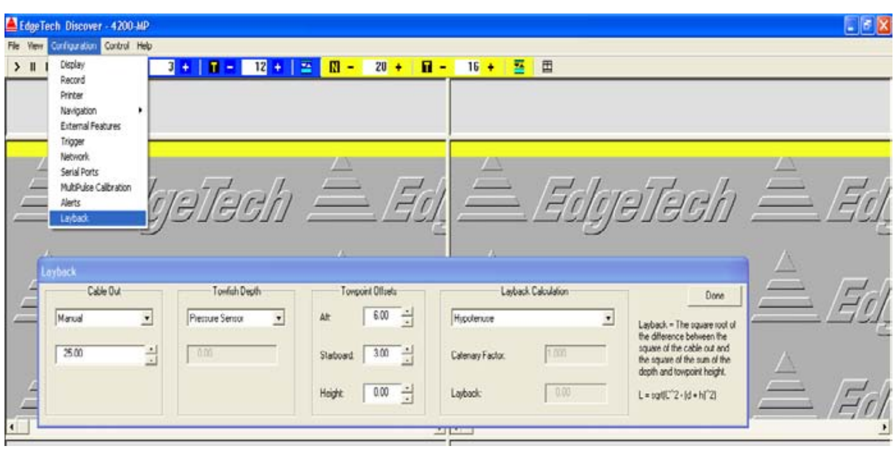
- Observe and detect the first bottom return.

- Normalize the gains and TVG by clicking the N and T buttons for both frequencies and observe the data. Adjust gains manually as needed.

- Once you are sure that you have detected the seafloor carefully lower the fish so that the fish altitude is between 10-15% of the selected range. I.e. if the range is set to 75 meters per side, the tow fish altitude should be between 7.5 and 15 meters off the bottom.

  Note: It is not always possible to achieve 10-15% altitude requirement due to conditions. While this altitude is recommended adequate data can still be obtained by towing the tow fish farther or closer to the seafloor.

- Set the layback variables in the layback dialog boxes.

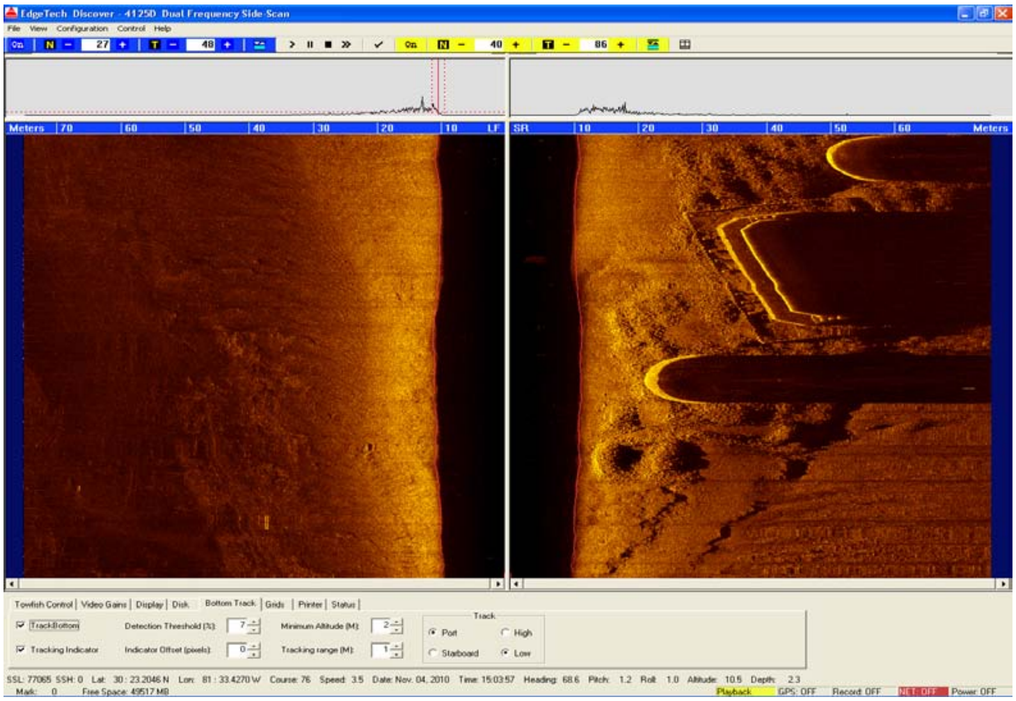


Layback menu

Bottom tracking

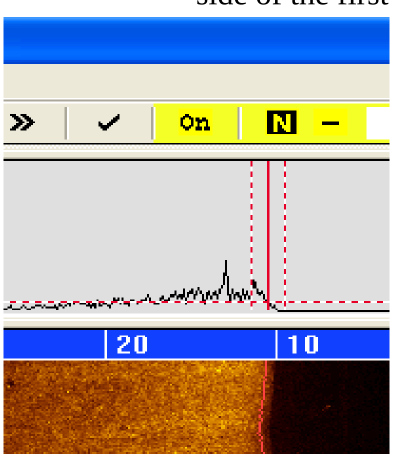
- Check the track bottom and track indicator boxes in the bottom tracking control menu.

- Choose which channel, port or starboard and frequency you wish to track. (It's a good idea to track the side and frequency that has the best return)



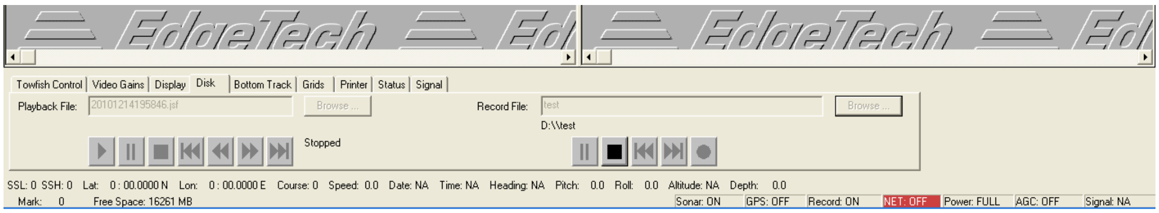
- **SET DETECTION THRESHOLD:** this setting will vary depending on bottom types but a good place to start is about half of the peak signal displayed in the sonar signal amplitude display window.

- **SET TRACKING RANGE [M] [Display, Entry]:** Adjust the width of the tracking window in meters. (Typically you want to track +- 2m either side of the first bottom return.



- Increase the boat speed to the desired survey speed (normally between 3-5 knots) and re-adjust the amount of cable out so that the altitude of the tow fish is correct. (Don't forget to reset the cable out value in the layback settings).

- Go to the DISK menu in the lower control tabs and choose a valid path for your files and give your file a name.



- Click the RED record button.

- Verify the file size is getting larger.

After recovery, always wash your Tow fish and cable with fresh water. Coat connector terminals with silicon grease and install dummy plug in wet end connectors.

4125 SSS quick guide check list

1. Connect power cable to topside and power source for AC or DC .... ☐
2. Connect ETHERNET cable to topside and laptop.. ☐
3. If using wireless connection, enable wireless connection .... ☐
4. Connect GPS to com port 1 .... ☐
5. Connect tow cable to topside.. ☐
6. Install tail fins .... ☐
7. Connect tow cable to tow fish .... ☐
8. Secure shackle to cable grip and seize shackle with wire or zip tie .... ☐
9. Turn on laptop and start DISCOVER software.. ☐
10. Turn on topside power .... ☐
11. Watch for NET off indicator to change to NET on in DISCOVER .... ☐
12. Perform pre-deployment rub test .... ☐
13. Deploy tow fish and start recording... ☐

See manual for full details on setup procedures.

APPENDIX C

Odom Echotrac CV Echo-Sounder Operating Notes

ECHOTRAC CVM

USER MANUAL
Version: 4.04

Odom Hydrographic Systems, Inc.
1450 Seaboard Avenue
Baton Rouge, Louisiana
USA
70810-6261

Telephone: (225) 769-3051 Fax: (225) 766-5122

Email@Odomhydrographic.com
http://www.odomhydrographic.com

Number of pages: 48
Date: May 27, 2008

Revision History

Version	Date	Author	Remarks
0.1	07-01-2003	P. Oostenrijk	Initial version – draft
1.24 b	07-19-2003	P. Oostenrijk	Accepted Beta version
3.0	11-09-2004	P. Oostenrijk	Released version: updated for CV3 and parameter list.
3.01	11-23-2004	P. Oostenrijk	Minor changes to Load Settings
3.08	04-14-2005	P. Oostenrijk	Updated manual for firmware version 3.08 Added section on how to request parameter settings through the serial port.
3.10	08-11-2005	P. Oostenrijk	Added Standby-bit feature
3.20	01-16-2006	P. Oostenrijk	Added UDP port, 8/16 Bit data and Operation time Added support for Asian Language pack Corrected dimensions: 17”x17”x3.5” Added DESO_DDV outputstring Removed Echoalarm for Echotrac CV Removed TVGgainref and Trackinggate for Echotracs.
3.21	02-01-2006	P. Oostenrijk	Test version for new Deso command handling.
3.22	02-28-2006	P. Oostenrijk	New optimized Deso command handling routines. Re-enabled TVGgainref and Trackinggate in Echotrac Control program. Improved annotation handling.
3.23	05-22-2006	P. Oostenrijk	Improved Echotrac Control program network detection interface. Low Frequency pulse width increased to 256. Corrected auto-scaling when draft and index are used. Added support for Echotrac CVM.
3.24	07-17-2006	S. Apsey	Added section in the manual to show how to connect the transducers for different configurations of Echotrac CV/CV3 Added external trigger.
3.25	08-03-2006	P. Oostenrijk	Fixed: Stopping the synchronization process disabled communication with Echotrac. Added compatibility check and warning for Echotrac Control Program version and Echotrac firmware version. If during synchronization a parameter is missing, the parameter name is now displayed. Improved version control in firmware and diagnostic window. Added Echotrac and Subbottom mode. Added Datacheck for GPS and Heave. Depth values are red in case of depth alarm. Added transparency feature on depth monitor window. Added support for CV100. Added Power & Gain control to Depth Monitor window.
3.26	09-07-2006	P. Oostenrijk	Fixed problem with Scale width at 15 feet. Fixed problem with communication when switching to subbottom mode.
3.27	09-22-2006	P. Oostenrijk	Echotrac CVM Maximum and Default values changed. When depth is 0 it is in red. When channel is turned off, “OFF” would also be in red instead of black. Display versions according to boards in Echotrac.
3.28	09-27-2006	P. Oostenrijk	Removed “Accept automated changes” feature.
3.29	05-22-2007	P. Oostenrijk	Added description for Missed Returns on Setup tab. Minor change in Grey Shades description. Updated COM port’s baudrate options to include 38400. Removed chapter Overview Parameters and Settings. This is now refers to the Technical Specification Ethernet Interface

			document.
4.00	02-19-2008	P. Oostenrijk	Updated Odom Title and Logo on cover page. Updated Header and Footer according to new template. Updated the introduction section and listed major changes. Inserted screen capture of new dialog for selecting a sounders on the network. Added Channel signal types and Bandwidth on System Tab. Update the NMEA serial output string formats. Updated uploading firmware and upgrading DSP firmware.
4.01	02-25-2008	P. Oostenrijk	Updated document version to match software/firmware version.
4.02	03-13-2008	P. Oostenrijk	Minor firmware change with model names.
4.03	05-23-2008	P. Oostenrijk	Updated Scale change functionality. Updated CVM channel handling as 1 and 2 instead of 1 and 3.
4.04	05-27-2008	P. Oostenrijk	DBT outputstring changed on pages 54 and 55. Two channels enabled = ‘B’ instead of ‘I’ or ‘M’. If the first depth has an error, ‘e’ is used. If the second depth has an error, ‘o’ is used unless also the first depth as an error. Removed references to Echotrac Control Program. This application has been replaced by Odom eChart.

CONTENTS

1 INTRODUCTION

There are four Echotrac CV units named Echotrac CV100, Echotrac CV200, Echotrac CV300 and Echotrac CVM (Mobile). This document covers the Echotrac CVM and will refer to this unit as "Echotrac CV". This Echotrac CV supports two channels.

The Echotrac CV is a hydrographic echo sounder design incorporating the cutting-edge technology, features and reliability of the Echotrac MKIII, plus the ease and flexibility of operation of a networked Windows® interface. The Echotrac CV transceiver units are supplied in a compact rack mount package that is ideally suited to many shipboard installations. The Echotrac CV supports Chart-functionality in one optional format, a laptop with a full size color LCD as an "electronic chart". A different option, that of operating the unit and collecting data on a networked PC, is also possible. The optional color LCD laptop offers internal data storage (in .XTF format) and playback of the analog return signal digitized to full 16-bit resolution. This Echotrac CV can only contain a Dual channel board. All channels feature a robust design and frequency agility enabling the operator to precisely match the transceiver to almost any existing transducer. Operator selectable TVG curves (10 Log, 20 Log, 30 Log, 40 Log, and Off) serve to optimise the Echotrac for both shallow and deepwater bottom detection tasks and for Sonar imaging. The Echotrac CV features unsurpassed interfacing flexibility, offering 2 serial ports that can be configured to interface with computers and motion reference units. The Echotrac CV also has an Ethernet port that outputs the 16 bit samples of the acoustic data for further processing or visualization. The Echotrac CV also supports a number of output formats that are compatible with most common Echo Sounder strings.

Figure 1: Echotrac CVM

To learn about the features of the Echotrac CV, this document is structured as a step by step manual; covering the Echotrac CV as a product, how to install the software and the equipment, how to use all the different control settings, how to perform certain procedures, how cables are wired to their connectors and troubleshooting.

Some of the major changes as of version 4.00 are:

- Replacement of the Echotrac Control Program with Odom eChart, a graphical data acquisition program. Because the Echotrac Control Program 4.00 will become obsolete, it does not support some of the major changes such as faster synchronization and adapting to the sounder's hardware configuration.
- Faster synchronization due to improved communication protocol.
- Automatic detection of sounder(s) on the network and adapting to the sounder's hardware configuration.

1.1 Purpose
The purpose of this document is to explain the features and operation of the Echotrac CV.

1.2 Scope
The content of this document is focused on the end-user.

1.3 Glossary

DBS	Depth Below Surface
DBT	Dual Bottom Tracking
DGPS	Differential Global Positioning System
DSP	Digital Signal Processor
ETCV	Echotrac CV
NMEA	National Marine Electronics Association
SBT	Single Bottom Tracking
TNC	Threaded Nut Connector
TVG	Time Varied Gain
VDC	Volts Direct Current

1.4 References

[1] Title: Windows Flash Utility: OdomFlash.exe
Author(s): Patrick Oostenrijk
Report no: N/A
Version: 2.2
Date: 2007-02-27

[2] Title: Using Echotrac Ethernet Driver with Hypack
Author(s): Stephen Apsey
Report no: N/A
Version: 1.0
Date: 2006-07-17

[3] Title: Technical Specification Ethernet Interface
Author(s): Patrick Oostenrijk
Report no: N/A
Version: 1.8
Date: 2008-05-28

2 PRODUCT DESCRIPTION

2.1 Specifications

Frequency
- High Band: 100 kHz-1 MHz
- Low Band: 10 kHz-50 kHz

Output Power
- High: 100 kHz – 500 W RMS max 200 kHz – 400 W RMS max, 750 kHz – 200 W RMS max
- Low: 12 kHz – 1kW RMS max, 50 kHz – 750 W RMS max
- Very Low: 3kHz – 4kW (transducer impedance dependant)

Input Power
- 110 or 220 V AC or 24 VDC 50 watts

Resolution
- 0.01m / 0.1 ft.

Accuracy
- 0.01m / 0.10 ft. +/- 0.1% of depth @ 200 kHz
- 0.10m / 0.30 ft. +/- 0.1% of depth @ 33 kHz

Depth Range
- 0.2 – 200m / 0.5 – 600 ft. @ 200 kHz
- 0.5 – 1500m / 1.5 – 4500 ft. @ 33 kHz

Chart Scales
- 5,10,20,40,80,100,200,400,800, 1600 m
- 15,30,60,120,240,300,600,1200, 2400,4800 ft.

Phasing
- Automatic scale change, 10%,20%, 30% overlap or Manual

Sound Velocity
- 1370 – 1700 m/s
- Resolution 1 m/s

Transducer Draft Setting
- 0 – 15m (0 – 50 ft.)

Depth Display
- On control PC.

Clock
- Internal battery backed time, elapsed time, and date clock

Annotation
- Internal – date, time, GPS position
- External – from RS232 port or Ethernet.

Interfaces
- 2 x RS232 serial ports, baud rate selectable 4800-19200.
- Inputs from external computer, motion sensor, sound velocity.
- Outputs to external computer
- Ethernet interface
- Heave – TSS1 and sounder sentence

Blanking
- 0 to full scale

Software
- Echotrac Control supplied
- ChartView display and logging software

Help
The function of each parameter and it's minimum and maximum values can be displayed.

Environmental Operating Conditions
- 0°– 50° C, 5 – 90% relative humidity, Non-condensing

Dimensions
- 53 cm (20.75") H x 44cm (17.25") W x 21.5cm (8.5") D

Weight
- 13.8 kg (31 lbs.)

Options
- One or two acoustic channel.
- Side Scan Transducer – single or dual channel side looking 200 kHz for 340kHz for search and reconnaissance
- Built-in DGPS

2.2 Overview

On the panel of the Echotrac CV are all the connectors for serial communication interfacing, GPS data, Ethernet communication, Transducer signals and power. See below, in Figure 2 for an overview of all the connectors. Each item will be explained in more detail in the following chapters. The panel has LED indicators for Ethernet communication, Transceiver board operation and power.

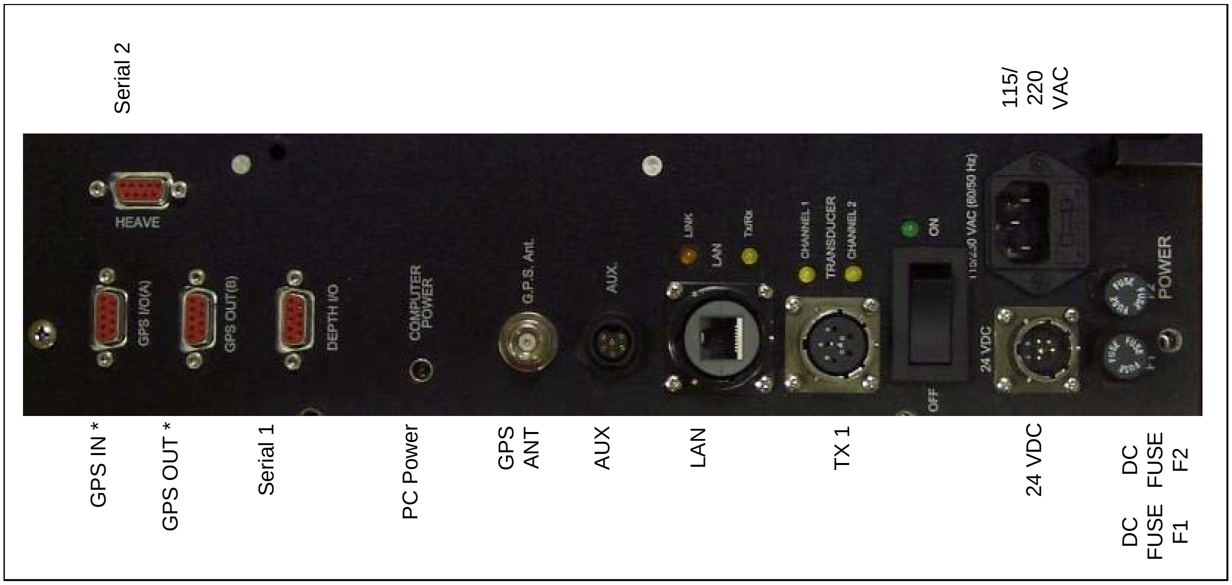


Figure 2: Overview of Echotrac CV

* Important Note: The GPS IN and GPS OUT connectors are only used when there is an internal GPS system built into the Echotrac CV. These two connectors are connected directly to the internal GPS ports A and B to provide external communication with the GPS. The connector labeled GPS IN is used to change the internal GPS settings such as Baudrate etc. The connector labeled GPS OUT is used by the GPS to output the GPS positioning data.

The Echotrac CV is built into a tough, splash proof plastic case for mobility.It is highly recommended that the unit be secured with external 'tie-downs' for rough seas or heavy swells.

2.3 Cabling

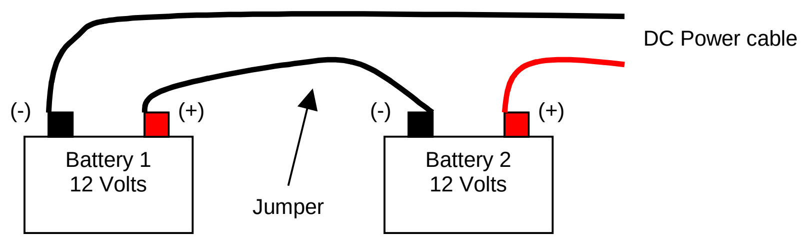
All cabling is via the connectors located on the recessed panel on top of the unit. A view of the connector arrangement is shown in Figure 2. Cable details are given in Appendix A. Care should be taken to route cables using horizontal and vertical runs wherever possible. Avoid paths that run adjacent to transmitter feeder cables or close to heat radiating elements such as steam pipes. For permanent installations, cables should be clamped at regular intervals (1m) along their complete lengths.

2.4 Power connector

The Echotrac CV can be powered by either AC or DC power sources. Switch over between sources is automatic. DC operation requires an input voltage between 18 and 29 VDC (nominal 24 VDC). Average power consumption is approximately 25-30 watts. Frequently, power is derived from two 12 V lead-acid batteries connected in series. These batteries (24V configuration), fully charged, and in good condition, can normally power a unit for a full day without re-charging.
If using an AC source, the unit's internal switcher accommodates either 230 or 110 VAC (50/60Hz) operation without operator intervention. Regardless of the input source (AC or DC), the input power should be well regulated and monitored closely for voltage transients, spikes, etc. Regulated DC supplies should be able to

source a short duration in-rush current spike of approximately 6 amps and an average current load of 3 amps. In the case of "charger" type (unregulated) supplies, the output should be "floated" across a battery load and not connected solely to the echo sounder’s DC input. Details of the power cable are given in Appendix A. Should the DC input voltage polarity be applied in reverse, an audible alarm within the unit will sound regardless of the POWER switch setting. In the event that the input voltage drops below the minimum threshold the unit will automatically shut down.

Setting up two batteries in series (24 Volts DC system)



Using a jumper simply connect the positive post of battery 1 to the negative post on battery 2. Connect the negative lead from the power cable to the negative post on battery 1 and the positive lead to the positive post on battery 2. Always check the voltage with a voltage or multi-meter before connecting the DC power cable to any equipment. Make sure that all the connecting equipment is also turned off before applying the power cables. Otherwise the transients of such a 'jump-start' could damage the equipment.

2.5 Choice of operating frequencies

The Echotrac CV can be configured to use either a combination of a Dual channel board with a High and a Low frequency channel, respectively 100 kHz – 1 MHz and 10 kHz – 50 kHz, or a Dual channel board with two High frequency channels.
Standard transducers are generally available from stock that support the frequency ranges listed on the product description page (See 2.1 Specifications).

2.6 Fuses

For DC operation, both the positive and return lines are protected by fast blow standard glass tube (5-Amp/250 Volts) fuses and are located behind the waterproof twist-lock caps. The two externally accessed fuses are mounted on the rear connector panel. The negative fuse protects the unit from damage resulting from contact with external peripherals that do not share a common return path potential. A 5-amp fuse is included in the AC input connector as well.

2.7 Signal connector TX1

Use signal connector TX1 when you have a single High or Dual Frequency transducer. The signal from the transducer is passed to the Echotrac CV via a standard Odom transducer cable with a twist-lock connector. The twist-lock connector is attached to the Echotrac CV where a connector is labeled "TX1".
See chapter 9: Echotrac CV Cable Connections for cable configurations.

2.8 Serial Ports

Serial 1

The Echotrac CV uses Serial port 1 to output depth data. Using a special Flash Utility program, the port is also used to upgrade the software in the Echotrac CV. Another use of the port is to send commands to the Echotrac CV or request certain parameter settings.

Serial 2

Serial port 2 is used to receive motion sensor data in TSS1 format (heave). This port enables the Echotrac CV to accept data from a motion compensator to apply corrections for the vertical movement caused by swells. The Echotrac CV will only correct the depth for Heave. No corrections are done for Roll and Pitch.

2.9 GPS IN / OUT (for the optional internal GPS only)

The DB9 (RS232) connector labelled “GPS IN” can used to configure the optional internal GPS or enter RTCM corrections to the internal GPS. The DB9 (RS232) connector labeled “GPS OUT” is used to output the GPS data from the optional internal GPS system. On the physical GPS unit these ports would be labelled as ports A and B. The internal GPS system is an optional feature and does not come standard in the Echotrac CV.

2.10 GPS antenna

The GPS antenna for the optional internal GPS can be attached to the TNC connector labeled “GPS antenna”.

2.11 LAN

The LAN port is used by the Echotrac CV to send and receive data on the network. The Echotrac CV can be connected directly to a Hub or a Switch using a regular UTP CAT-5 ethernet cable. A regular cable is also known as a ‘straight’ UTP cable. When the Echotrac is connected directly to a computer, a so-called ‘cross-over’ UTP cable must be used. When a computer is directly connected to the Echotrac CV using a crossover cable, the operating system on the computer may take 2-3 minutes before the computer has accepted a valid IP address. To prevent this delay, you can assign the computer a static IP address or use a Hub/Switch.

2.12 AUX

The auxiliary port is used for acquiring the analog signal from the Echotrac CV.

2.13 EXT. REC (CV2 / CV3)

The External Recorder port is used to connect the optional external printer. This is only available on the Echotrac CV2 and CV3.

2.14 Power switch

The power switch in the ON position will power-up the internal circuitry. In the OFF position it will power-down the internal circuitry.

2.14.1 Power-OFF

The main power switching circuitry is open in this position. Please note that the Echotrac CV switches automatically between AC and DC operation when an appropriate source of power is applied to the unit. Should both AC and 24VDC be applied to the unit at the same time, then the Echotrac will automatically favour the 24VDC supply.

2.14.2 Power-ON

On "power-up", the unit performs a Self-test to check system memory and also tests the Non-volatile RAM battery voltage. If there was a problem with the Non-volatile RAM, the factory defaults will be loaded. The unit then enters the sounding mode and begins data acquisition.

2.14.3 STANDBY

The main power circuitry is energized, drawing current from the mains and providing regulated DC voltages to all internal modules.
The unit is no longer in the sounding mode when it is in the standby position. However, the Parameter Entry System is enabled.

2.15 Power indicator

When the Echotrac CV is turned on, a green LED will be on to indicate that the internal systems have powered up successfully. The green LED is located next to the power switch.

2.16 Ethernet indicators

The TX indicator on the Echotrac CV indicates whether or not the data is transmitted on the Ethernet port. The frequency at which the TX indicator flickers also indicates whether the Echotrac CV is outputting data at a slow or fast pace.
The Link indicator on the Echotrac CV indicates that it recognizes the presence of a network. If the receiving end of the ethernet cable is connected to a computer or a hub/switch that is not powered on, the link light will not be on.

2.17 Transmit indicators

The Channel indicators on the Echotrac CV indicate whether that particular Transducer is firing or not. The frequency at which the Channel indicator flickers also indicates whether the Transducer is firing at a slow or fast pace. The other Channel indicators work in the same way.

3 INSTALLATION

This section contains the information necessary to install the Echotrac Control Software, power-up and connect the Echotrac CV. The installation procedure consists of a number of steps. Each step corresponds to a specific chapter. It is recommended that these steps (chapter 3.1, 3.2 and 3.3) for the installation procedure be followed in this order. See also the quick start procedure in Appendix B.

3.1 Software installation

The minimum requirements for a personal computer to install and run only the Echotrac Control software are:

- Windows 98
- Pentium-I, running at 200 MHz
- 32 Mb of internal memory
- 10 Mb of free space on the harddrive
- One COM-port

The Echotrac control program is fully tested on the following Operating Systems:

- Windows 98
- Windows 2000
- Windows XP
- Windows NT

Note: Windows ME is not supported.
Note: A minimum of two COM-ports are needed to run: one port to receive serial data from the Echotrac and communicate with the Echotrac, and one port to receive GPS. This is an example of a situation when ethernet cannot be used.

The software that is shipped with the unit can be installed on the personal computer by executing the program called SETUP.EXE. This program will install the Echotrac Control software in the Program Files directory. During the setup process it is possible that Windows will ask if you wish to keep certain files on the computer that are older or newer than the ones being installed. By default it is advised to keep the files that are currently on the computer to avoid any conflicts or problems with other programs. If during the setup process, the setup program cannot find the files on your computer that it needs to install the Echotrac CV, the missing file(s) will be copied onto the hard drive.

3.2 Setting up the equipment

The Echotrac CV is a lightweight unit designed for portability. An interconnection diagram is shown in Figure 3. Care should be taken to route cables using horizontal and vertical runs wherever possible. Avoid paths that run adjacent to transmitter feeder cables or close to heat radiating elements such as steam pipes. For permanent installations, cables should be clamped at regular intervals (3 feet or 1 meter) along their complete lengths.

The Echotrac CV requires either an input voltage between: +18 and +29 VDC (standard) or between 110 and 220 VAC. The unit consumes less than 30 watts of power in normal operation. Power is frequently derived from one or two 12 V lead-acid batteries. Two batteries (24V configuration), fully charged, and in good condition, can normally power a unit for a full day without re-charging. Details of the power cable are given in the chapter 2.4 Power connector and the Appendix .

All cables are attached to the connectors located in the recessed area at the left rear of the unit (See Figure 2 in chapter 2.2). Connections are made through multi-pin “MS” style connectors, between the Echotrac CV, its power source, the transducer and all computer or peripheral devices.

The following Interconnection block diagram shows everything that can be connected to the Echotrac CV. All these peripherals are not required to use the basic functionality of the Echotrac CV.

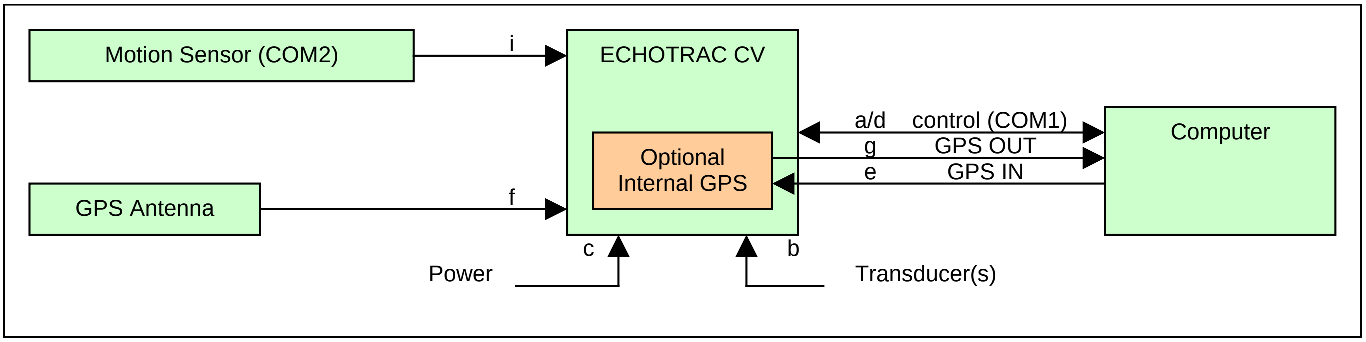


Figure 3: Interconnection block diagram

Before connecting any of the cables, make sure that the computer, the Echotrac CV and other peripherals are turned off. The list below is a sequence of steps for connecting the Echotrac CV with the computer and GPS. If any problems arise, see the Troubleshooting section.

a) Connect the RS232 cable between the computer and the DB9 connector labeled “Serial 1”, if you need to collect depth data through the serial port or need to send command to the Echotrac CV.
b) Connect the cable from the Transducer to the connector on the Echotrac CV labeled “TX1”.
c) Connect the power cable for the Echotrac CV to the connector labeled “POWER”.
d) Connect the UTP ethernet cable to the LAN connector if you want to collect data across a network.

If the optional internal GPS is used, then:
e) Configure the optional internal GPS, using special software, through the connector labeled “GPS IN”.
f) Connect the GPS antenna cable to the connector labeled “GPS antenna”.
g) Connect the RS232 cable between the connector labeled “GPS OUT” with a COM-port on the computer.

If an external peripherals are used, then:
h) Connect the RS232 cable between the motion sensor and the connector labeled “Serial 2”.

3.3 Powering up the equipment

The following sequence must be followed when powering up the equipment:
1. Turn on the personal computer.
2. Turn on the Echotrac CV. After turning the Power Switch from the OFF position to ON, confirm that the power LED, Ethernet Link LED come on. After a few seconds, the Ethernet TX/RX LED and one or both of the Transmit High / Low LEDs should start blinking.
3. Start the Echotrac CV Window Application program.
4. Turn on optional peripherals such as GPS or motion sensor.
5. Depending on water depth and bottom type, set the Tx Power to mid-range (position 6) in the Echotrac control program.
6. Set the RxGAIN to about halfway on the maximum scale.
7. Adjust RxGAIN and TxPOWER to get a clear strong record with few alarms on the displayed depth.

Note: The Echotrac CV should always be turned on before running the Echotrac control program.
Note: Should you feel that a return to the sounder’s default parameter values is called for, then select the Default Reset option in the Echotrac CV Window Application program.

3.4 Configuration and Connection of Echotrac CV and Transducers

Use the Model Number column to identify which Echotrac CV you have by looking at the Serial number sticker on the back of your Echotrac CV. Use the table to determine how to connect your transducers. When configuring the Echotrac CV in the control program make sure the correct frequency is entered for the appropriate transducer by looking at which channel in the control program is controlling each transducer. TX1 and TX2 refer to the transducer connectors on the back of the Echotrac CV

Model Number	Echotrac Model	Channel 1	Channel 2	Channel 3	Notes
ETCVM-A	CVM	High Frequency	Low Frequency		If using separate transducers use adaptor PN# 2311-0011-0000 to connect each transducer.
ETCVM-B	CVM	High Frequency	High Frequency		If using separate transducer use adaptor PN# # 2311-0007-0000 to connect the each transducer.
ETCVM-C	CVM	High Frequency			
ETCVM-D	CVM	Low Frequency			

3.5 Transducer installation

Proper mounting of the transducer is a crucial part of the installation of any "survey" echo sounder. An improperly mounted transducer will result in poor system operation and unacceptable data quality.
Important: See also chapter 5.5 Known problems with Transducer.

In the case of temporary installations, the transducer is often mounted over-the-side. In permanent installations and "pay surveys," hull mounts are generally preferred and often required. In either case, the transducer should be mounted as far below the waterline as possible. In cases where "over the side" mounts are exposed to wave action, ensure that the transducer is mounted far enough below the surface so that it remains well submerged during vessel roll motions.

A preferred mounting location is near the keel of the vessel, in an area where the planing attitude of the hull and the pitch and roll angles of the vessel have the least effect at operating speed. The transducer should be mounted far enough aft of the bow so that bubbles generated by the bow wave will not pass over the face of the unit. Transducers should be located away from sources of turbulence and cavitation bubbles such as propellers, bow thrusters and hull protrusions. Consideration should also be given to sources of mechanical noise generated within the vessel (engines, propellers, pumps, generators, etc.). In some severe cases of mechanically coupled noise, vibration-isolating mounts may be required to mechanically decouple the transducer from the hull.

Transducer mounting can be accomplished in many different ways. The following three chapters show common configurations.

3.5.1 “THROUGH HULL” transducer installation

The top side of the transducer is accessible from inside the vessel while the transducer face is directly exposed to the water. Care should be taken to protect the transducer from damage and turbulence by installing a fairing with a sloping forward edge ahead of the unit. The fairing has the dual effect of both minimizing possible strike damage and smoothing the flow of water over the face of the transducer.

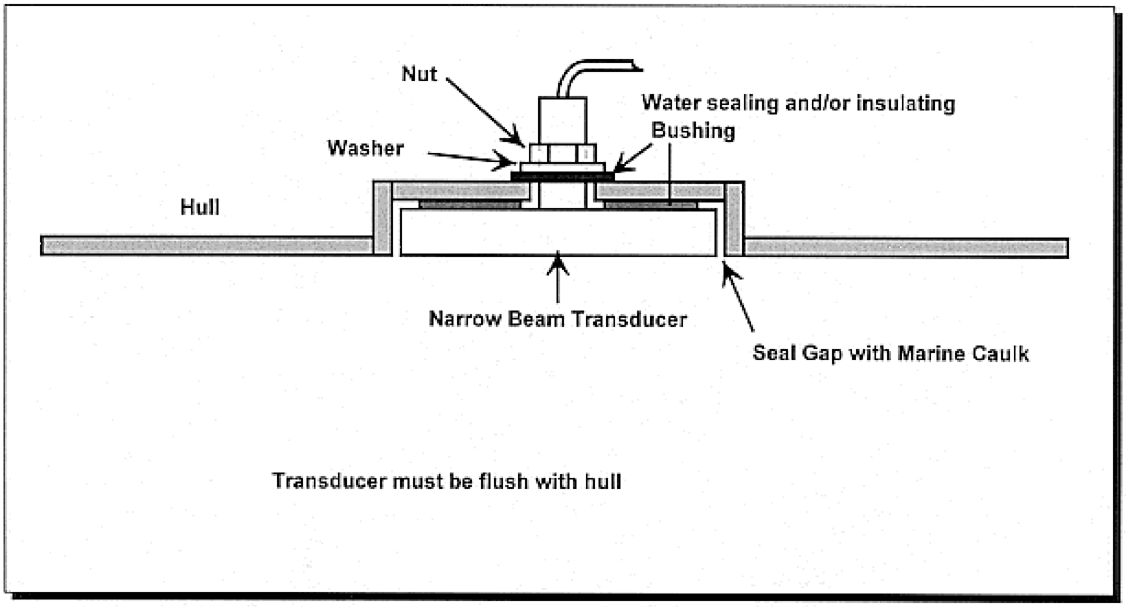
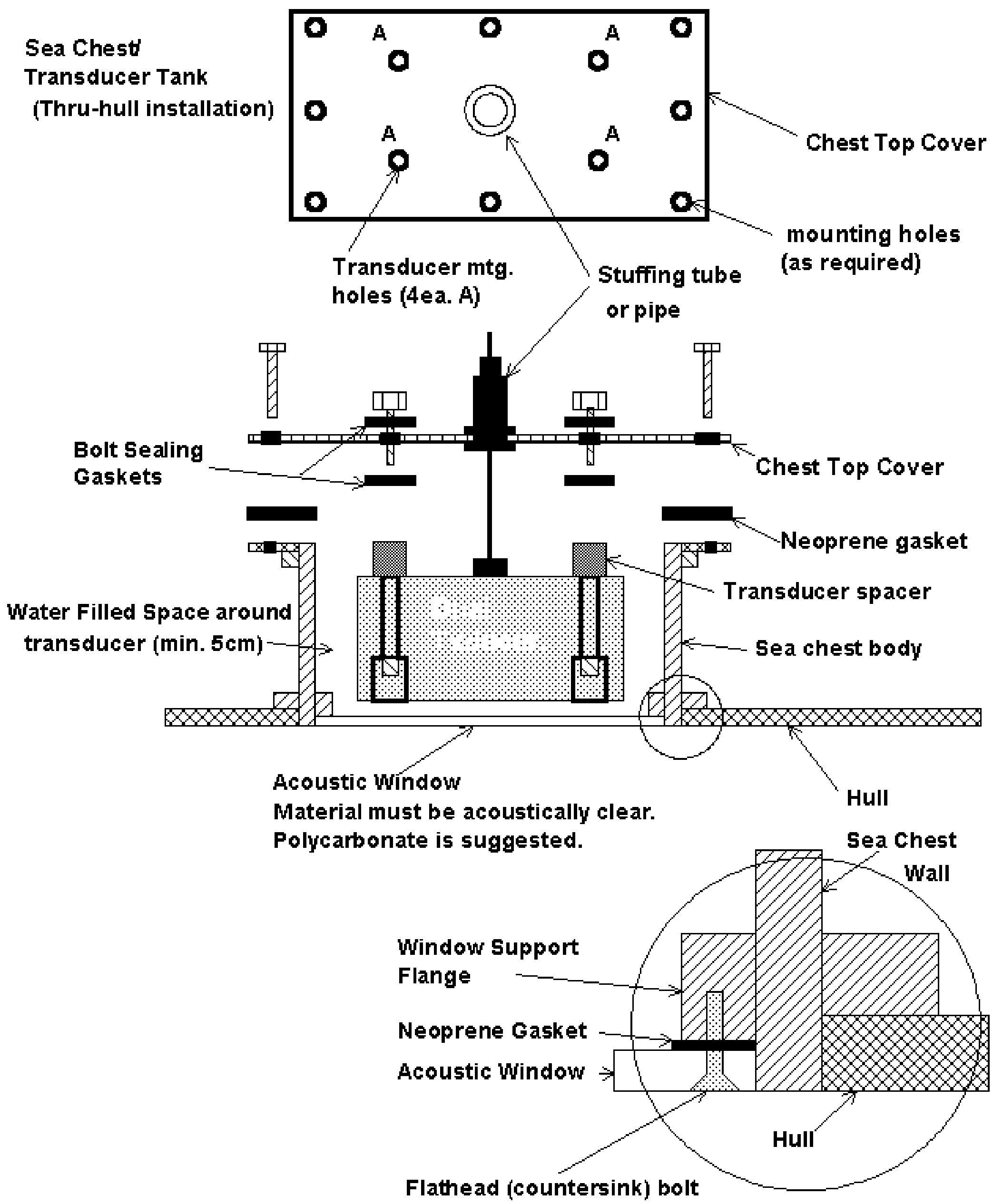


Figure 4: Transducer mounted through the hull

3.5.2 "SEA CHEST" transducer installation

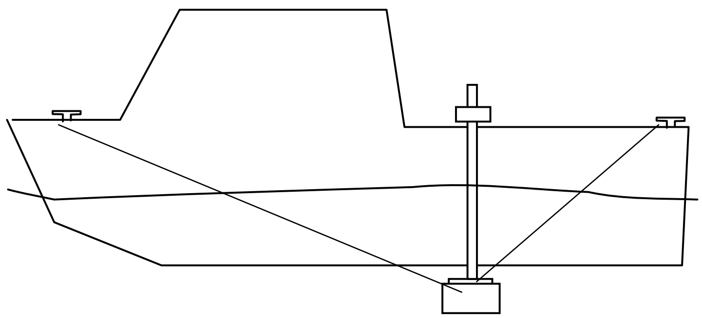
In a "sea chest" mount, a fluid-filled enclosure large enough to contain the entire transducer is attached to the outer hull of the vessel. The outer hull is removed within the area of the chest and replaced with an acoustically clear "window" which is mounted flush with the hull surrounding the chest. Depending on construction, the material selected for the acoustic window, and the draft of the vessel, access can often be gained to the transducer from inside the hull without putting the vessel in dry-dock. In most installations, a water-filled standpipe is incorporated into the "sea chest" design in order to provide hydrostatic pressure equalization. Transducer cables generally leave these assemblies through stuffing tubes, which maintain the watertight integrity of the chest.



3.5.3 "OVER-THE-SIDE" transducer installation

A mount of this type is frequently constructed from a length of pipe. This fixture should be sized to position the transducer well below the waterline and the pipe then fixed to a sturdy support on the vessel. Lines generally are attached at the transducer pipe and tied off fore and aft in order to maintain a stable, horizontal transducer attitude. Care should be taken to assure adequate protection for the transducer cable, particularly at the point where the cable leaves the transducer body.

In all of the above installations, particular care should be taken to assure that the transducer radiating face remains as parallel to the water surface as much as possible while the vessel is moving.



4 OPERATIONAL PROCEDURES

The following sequences are typical operating procedures for the Echotrac. The procedures may vary according to survey requirements and are intended only as a guide. It is assumed that the operator is familiar with the various controls and their associated functions as detailed in the preceding sections of this manual.

4.1 Things to consider when calibrating

1. Calibrate *daily* in an area that is calm; avoid any "rocking" of the vessel.
2. Never use rope or material that might stretch on your calibration bar.
3. Calibration of the CV can be for both frequencies at once.
4. Perform calibration using the shallowest and deepest depths from your area.
5. If you do not have a velocimeter to compute the speed of sound, start with the default speed of the unit. (5000 feet or 1500 meters per second or the speed from the previous day).The echo sounder is calibrated using *draft, index and speed of sound*Measure the *draft* using a survey tape measure
8. Apply *index* for the shallow calibration.
9. Apply *speed of sound* changes for the deeper depths.
10. If the water depth is less than 20 feet (6 meters). As long as your unit is in the average speed of sound range, use only the measured draft and index for calibration. In other words, the speed of sound will have little effect.
11. If the water depth ranges from .5 to 60 feet (18 meters), build a calibration bar that can reach the deepest part of the survey.
12. For depths that exceed 60 feet use a bar that can reach as deep as possible. In areas such as these we recommend that you use a velocimeter as a check.
13. Always document and save your work.
14. *Selecting another tab in the Echotrac Control program exits the calibration functionality.*

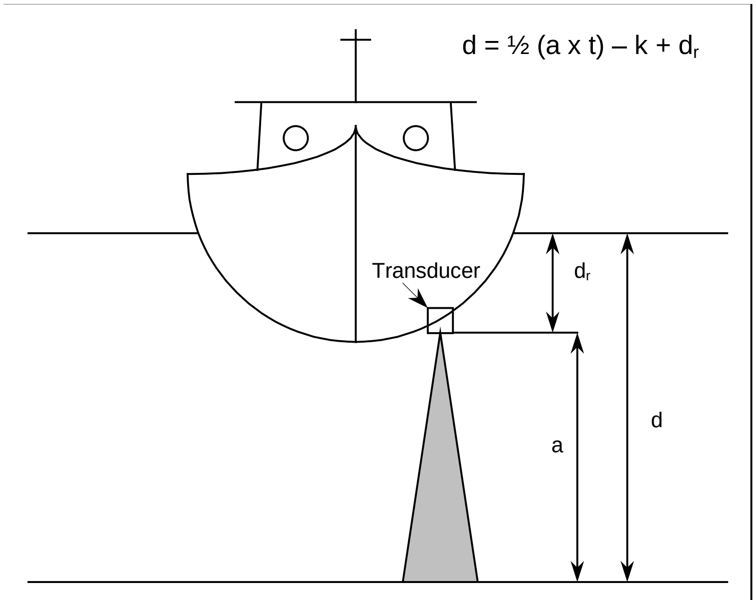
4.2 How to calibrate the Echotrac CV

The principle of echo sounding is based on measuring the time of arrival of an acoustic return (echo) referenced to the time of transmission. The time required for sound to travel from a source (the transducer) to a destination point (the seafloor or bottom) and back can be measured and multiplied by the velocity of sound in water. This provides us with the distance that the pulse has traveled in the water column. Because the transmitted pulse traveled from the transducer to the bottom and back again, the distance must be halved to obtain the true water depth. Furthermore, other factors need to be included into the formula. If the transducer is submersed under water, the distance from the water surface to the transducer, in other words the draft value, must also be accounted for. If the calculated water depth does not exactly match the physically measured water depth, the index value is used as a correction offset. The general depth formula is shown below.

$$d = \frac{v \times t}{2} - k + d_r \quad \Leftrightarrow \quad d = \tfrac{1}{2}(a \times t) - k + d_r$$

Where:

d - Actual depth from water surface to the bottom.
v - Average velocity of sound in the water column.
t - Elapsed time measured from the transducer to the bottom and back to the transducer.
k - Index constant.
d_r - Distance from the referenced water surface to the transducer (draft).



Many users may not be familiar with the parameter “Index” or “k”, although it is likely that they have seen the results of combining transducer draft and index constant into one draft figure. If you have noticed that the measured draft, or the distance from the face of the transducer to the water’s surface is not the same as the draft value entered into the sounder, then you have seen the result of lumping both together. This phenomenon is most evident when using dual frequency transducers where both high and low elements are in the same housing. Often, the draft values are very different for the two frequencies if no adjustable “k” parameter is incorporated. The difference in “k” or electronic delay between a 200 kHz element and a 24 kHz array is substantial, and is the reason behind the difference between the two “Calculated Drafts”.

Once the “k” value is determined, it will not change until either the sounder or the transducer is changed. *The Index parameter should be adjusted to make the measured draft and the calculated draft equal.*

Since the accuracy of measuring the depth depends on the value used for the velocity of sound in water (along with the other factors shown above), it is important that a realistic value for sound velocity is used. In water, velocity is a function of temperature, salinity and pressure. Therefore, the sound velocity in one area may vary from the sound velocity measured in another area. This means that whichever type of echo sounder is used, it must be calibrated in order to provide the most accurate depth data at a given location.

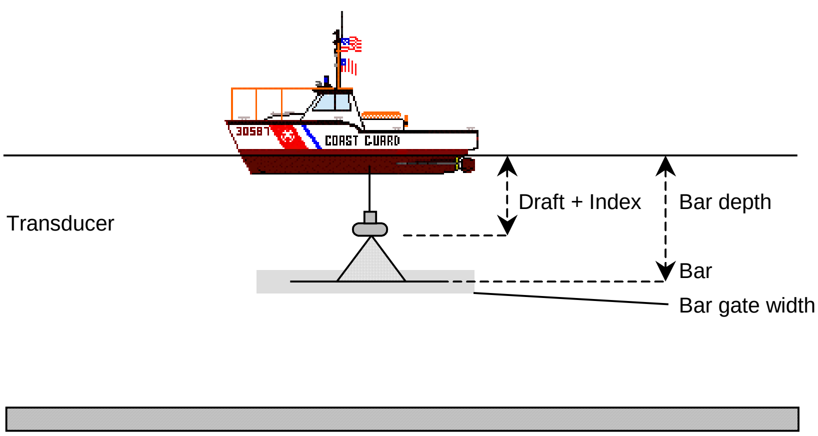
The most common calibration technique is the “Bar-Check” method. This method, when employed properly, has the advantage of determining the sound velocity, draft, and index value. When this method of calibration is used, acoustic sound waves are bounced off a suspended target that is lowered to a known depth between the transducer and the bottom. In this situation it is desirable that the digitizer will see only the Bar (the target) and is unable to lock on to acoustic returns from the bottom. Because the Echotrac CV employs a dynamic tracking gate or window through which the digitizer looks for returns or echoes from the bottom, manual control for the position and width of the gate is necessary. This will force the digitizer to only detect returns from the Bar. See section 4.3 on how to perform a bar-check.

4.3 How to perform a bar check

This section describes an example of how to perform a bar-check.

1. Setup the equipment and start the Echotrac control program.
2. Set the Range at 60 feet. Select the bar-depth (start with a shallow depth, typically 5 feet), bar-width (typically 1 foot), Sound velocity, Draft (measured), Index (start with 0), End-of-scale and Scale width. The Echotrac control program is now in calibration mode because the bar-depth is greater than “0”.
3. Lower the bar into the water column and place it at 5 feet below the water’s surface. The Digitizer in the Echotrac CV will expect to see a target at that 5.00-foot depth while rejecting all other returns (including those from the bottom).
4. Adjust the index to the correct depth.
5. Change the bar depth in the Echotrac control program.
6. Adjust the sound velocity up or down until the digitized depth matches the measured bar depth.
7. Repeat steps 3, 4, 5 and 6 to verify the calibration procedure until your reading matches the depth of the bar.

IMPORTANT:
Adjust the **draft** only when the bar is at the shallowest depth, because this is where the sound velocity has little affect on the calibration.
Adjust the **sound velocity** only when the bar is lowered to greater depths, because this is where the sound velocity becomes pre-dominant.



The figure above shows that the bar is placed under the transducer and kept at a certain measured depth using cables.

4.4 Shallow Water Operation

Set the Transmit power to mid-range, adjust the Receive gain to approximately midrange (this applies to both High and Low frequencies in dual mode) or Auto.

Ensure that the key parameters velocity, channel, draft, and index are correct. Amend any of these parameters as required.

If necessary, slowly adjust the Receive gain controls until the desired quality is obtained and no digitizer alarms are displayed. Adjustment of the Transmit power control may be called for at this point. A balance between Receive gain and Transmit power is generally desired. In many situations AUTO power will satisfy record quality requirements while at other times, where local bottom conditions dictate some variation of the Transmit power/Receive gain ratio, a manual position may work best. Note that the MAX setting on any of the above controls is seldom required.

Should the record show evidence of sporadic noise, which cannot be overcome using the Receive gain controls, and should the digitizer lose lock due to this noise, then several alternatives are available. First, determine whether the digitizer is attempting to lock to a false echo or to the end of the Transmit Pulse. In either of these cases, enter a value for Blanking which is deeper than the false return. This will force the digitizer to lock to the bottom. If the Echotrac is connected to an external computer/data logger, confirm that correct digitized depths are being transferred.

4.5 Deep Water Operation

Please note that deep water operations require a bit more time to accomplish, due to the fact that returns from the bottom are received so much less frequently in deep water

In the ***CHART*** menu select either the ***Auto*** or ***Manual*** scale change.

Select the low frequency channel to Bathymetry.

Set the ***Chart Speed*** to ***AUTO***. Setting the chart to advance one dot row per sounding will improve the appearance of the chart and eliminate the “blocky” appearance of records produced with low ping rates but high chart speeds.

Set the ***RANGE*** value to encompass the greatest depth likely to be encountered. For example: if working in 2,000 meters of water, enter a ***RANGE*** value of at least 2,500.

LF Pulse Width should be set to a value of at least 30. Used in conjunction with the front panel control, ***TX Power***, the pulse width and amplitude determine how much acoustic energy is actually transmitted toward the bottom.

Back in the ***CHART*** menu, set the ***Chart Width*** value to suit the desired resolution. Remember, at a ***Chart Width*** of 1600, each dot represents 1 meter. If you have chosen to work in the ***Manual Scale Change*** (Scale) mode, then set the ***End of Chart*** value to the anticipated depth of the bottom.

Turn ***Blanking On*** by entering a value. A ***Blanking*** value which is a bit shallower than the “Shoalest” depth likely to be encountered, will help screen the digitizer from unwanted “false echoes” in the upper water column.

Begin by noting the position of the ***TX Power*** switch. In most cases of depths over 1,000 meters, the unit should be run at a fairly high power level (6 or greater). Slowly adjust the Receive gain potentiometer to give the desired chart quality and to allow the digitizer to lock to the bottom.

4.6 Using the optional built-in Starlink Invicta DGPS

4.6.1 Introduction

The optional internal DGPS receiver for the Echotrac CV is intended to provide the user with a compact and rugged hydrographic survey tool. With the addition of a data acquisition computer and appropriate software, a complete survey system can be achieved with only two "boxes.". This can be a great advantage in remote or otherwise inaccessible areas where portability, quick mobilization, and ease of operation are important.

As shipped from the factory, the Starlink Invicta 210 DGPS board is configured to use the integral MSK beacon receiver for differential corrections, and to output the GLL string on the COM-port labeled "GPS OUT". The standard configuration can easily be changed using the program GPSMon.exe. The setup program is provided on disk with the unit, and can also be downloaded from Starlink's web site at www.starlinkdgps.com. The program runs on any PC running the Windows operating system. Set up information is exchanged through one of the serial ports on the PC and COM-port labeled "GPS INPUT" of the Echotrac CV. Changes in the configuration do not require the operator to physically access the board.

5 TROUBLESHOOTING

5.1 The Echotrac CV does not seem to be working

If the Echotrac CV does not seem to be working right, follow the steps below to determine the cause.

1. Check if the power LED is on and does not flicker. If it does flicker, see section 5.3.
2. The Echotrac CVs have a Standby bit that is turned on by default. Try the Echotrac Control Program to communicate with the Echotrac CV.
3. Check if all the cables are properly connected and intact. If cables are not properly secured, electrical signals may not be transmitted or received.
4. Make sure you are using the correct COM-port. Windows will display an error message if the port cannot be used or if it is already open/used by another program. Programs or devices that use COM-ports are: Modem, Mouse, Scanners, Printers.
5. Try toggling the COM-port off and on with the Windows application software you are using.
6. Make sure the Echotrac CV is not in Standby mode.
7. A blinking TX LED means that the digitizer is firing, but the data may not be sent out on the COM-port of the Echotrac CV. The Echotrac CV could be in Standby mode.
8. Try powering down the Echotrac CV and powering it back up again. If the Echotrac CV is turned on before the computer, it may interfere with initializing and setting up communication channels.

5.2 The Echotrac CV power LED is off

Try powering the Echotrac CV down and back up again.
If this does not resolve the problem, contact Odom Hydrographic Systems, Inc. for assistance.

5.3 The Echotrac CV power LED is flickering

Reduce the Transmit power. It may be set too high with respect to the water depth.

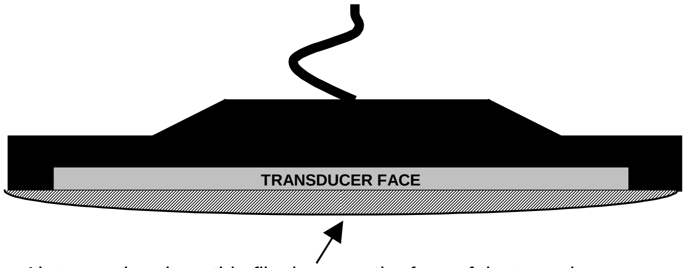
5.4 What are the COM-port settings

The Echotrac CV uses the following default settings for the COM-ports:
9600 baud, 8 data bits, no parity, 1 stop bit.

The COM-port used to interface with the Echotrac CV can be selected on the Communication tab in the Echotrac control program. See also section **Error! Reference source not found.**.

5.5 Known problems with Transducer

Always make sure that the transducer face has been cleaned with mild soap to improve the interface between the transducer and the water. It is sometimes possible for a thin layer of air to be trapped on the face of the transducer. This will result in poor or no signal return from the transducer.



Air trapped under a thin film layer on the face of the transducer.

6 TECHNICAL SPECIFICATIONS

6.1 Computer communications

Due largely to the pervasive presence of PC based data acquisition systems aboard survey vessels, the need has arisen for echo sounders to communicate quickly and easily in a digital format. Two of the most common communications interface formats are RS-232C and RS-422. The COM-ports on the Echotrac CV is capable of sending and receiving data in RS232 only. In its standard configuration, the unit sends ASCII characters at 9600 baud, (8 data bits, 1 start bit, 1 stop bit, no parity) to peripherals or data logging systems at the completion of each sounding cycle. COM-port “Serial 1” is a bi-directional serial port with the capability of accepting input data as well as outputting serial depth information. The following section of this chapter shows an overview of all the output strings and their formats, followed by detailed information about the output string structures.

6.2 Overview Serial Output string formats

COMPORT				CHANNEL			Meters		Feet	
1	2	3	4	CH1	CH2	CH3	Meters		Feet	
Not Heave Out	X	X	Yes	-	-	-	Subtract heave from depth (Applies to CH1, CH2, CH3)		Subtract heave from depth (Applies to CH1, CH2, CH3)	
DESO25	X	X	X	Yes	No	-	DA00001.23 m		DA00001.2 ft	
	X	X	X	No	Yes	-	DB00001.23 m		DB00001.2 ft	
	X	X	X	Yes	Yes	-	DA00001.23 m DB00001.23 m		DA00001.2 ft DB00001.2 ft	
DESODDV	X	X	X	Yes	No	-	DA00001.23 m		DA00001.2 ft	
	X	X	X	No	Yes	-	DB00001.23 m		DB00001.2 ft	
	X	X	X	Yes	Yes	-	DA00001.23 m DB00001.23 m		DA00001.2 ft DB00001.2 ft	
	X	X	X	X	X	-	DH01.23 m (Example: Heave)		-	
	X	X	X	X	X	-	DG01.23 m (Example: Draft)		-	
	X	X	X	X	X	-	CS1234 m/s (Example: Sound velocity)			
NMEA	X	X	X	Yes	No	No	$SDDBS,3.3,f,1.0,M,0.6,F*AB		$SDDBS,3.3,f,1.0,M,0.6,F*AB	
	X	X	X	No	Yes	No	$SDDBS,3.3,f,1.0,M,0.6,F*AB		$SDDBS,3.3,f,1.0,M,0.6,F*AB	
	X	X	X	No	No	Yes	$SDDBS,3.3,f,1.0,M,0.6,F*AB		$SDDBS,3.3,f,1.0,M,0.6,F*AB	
							Normal	Error	Normal	Error
ECHOTRAC SBT	X	X	X	Yes	No	No	_et__12345	_etE_0	_ET__12345	_ETE_0
	X	X	X	No	Yes	No	_et__12345	_etE_0	_ET__12345	_ETE_0
	X	X	X	No	No	Yes	_et__12345	_etE_0	_ET__12345	_ETE_0
							Normal	Error	Normal	Error
ECHOTRAC DBT	X	X	X	Yes	No	No	_et_H_11111	_etEH_0	_ET_H_11111	_ETEH_0
	X	X	X	No	Yes	No	_et_L_22222	_etOL_0	_ET_L_22222	_ETOL_0
	X	X	X	No	No	Yes	-	-	-	-
	X	X	X	Yes	Yes	No	_et_B_11111 22222	_etEB_0_22222 _etOB_11111_0 _etDB_0_0	_ET_B_11111 22222	_ETEB_0_22222 _ETOB_11111_0 _ETDB_0_0
	X	X	X	Yes	No	Yes	_et_B_11111 33333	_etEB_0_33333 _etOB_11111_0	_ET_B_11111 33333	_ETEI_0_33333 _ETOI_11111_0
	X	X	X	No	Yes	Yes	_et_B_22222 33333	_etEB_0_22222 _etOB_33333_0	_ET_B_22222 33333	_ETEM_0_22222 _ETOM_33333_0
	X	X	X	Yes	Yes	Yes	_et_C_11111 22222 33333	_etEC_0_22222_x _etOC_11111_0_x _etFC_11111_0_0 _etGC_0_0_0	_ET_C_11111 22222 33333	_ETEC_0_22222_x _ETOC_11111_0_x _ETFC_11111_0_0 _ETGC_0_0_0
HEAVE OUT							Append heave value to output string			

Priority of channels:
Channel 1 has the highest priority, next Channel 2 and then Channel 3 has the lowest priority.

Therefore, if the depth for all three channels are being output, and all three have errors, then Channel 1 has the highest priority and its error letter will be shown in the output. Not either of the other two channels because they have a lower priority.

Channel and Error overview (for Echotrac DBT only):

Channels in use			Letter
CH1	CH2	CH3	
Yes	-	-	H
Yes	Yes	-	B
-	Yes	-	L
[redacted]			
Yes	-	Yes	B
-	Yes	Yes	B
[redacted]			
Yes	Yes	Yes	C

Channel with depth Error			Letter
CH1	CH2	CH3	
✓ (e)	-	-	E
✓ (e)	✓ (o)	-	D (all)
-	✓ (e)	-	E
[redacted]			
✓ (e)	-	✓ (o)	E
-	✓ (e)	✓ (o)	E
[redacted]			
✓ (e)	✓ (o)	✓ (f)	G (all)

If multiple channels are in use and not all the channels have an error, then priority of the channels determines which letter is displayed to indicate the Error. If all channels are used and all have an Error, a unique letter is used to identify that situation.

6.3 Serial output strings

6.3.1 Echotrac SBT

The Echotrac CV I/O is compatible with the ECHOTRAC I/O, which is the standard serial output string first introduced in the Echotrac DF3200 MKI in 1985. Due to the wide acceptance of this string and the availability of the format in a number of data acquisition systems, the string has been maintained in order to assure continued compatibility.

OUTPUT format

Char. #	**Description**
1	Normally a Space, an "F" Indicates Fix Mark
2	"E" units are in tenths of feet "e" units are in centimeters
3	"T" units are in tenths of feet "t" units are in centimeters
4	Normally a Space, an "E" indicates Error
5	Always a space
6	Depth Data (MSD)
7	Depth Data
8	Depth Data
9	Depth Data
10	Depth Data (LSD)
11	Carriage Return

Please note that characters 2 & 3 are in upper case whenever the **Units** are in tenths of feet, and are in lower case when the units are in centimeters.

Example: <sp>et<sp><sp>DDDDD<CR>

SBT is the default output. With the unit operating in single frequency (High or Low) or dual frequency (High and Low), the SBT string is output until another string is selected in the Communications menu. When ***SBT*** is selected, but the unit is operating in dual frequency, the High frequency depth is output.

6.3.2 Echotrac DBT

Using a single frequency

The following description applies to the selection of ***D****ual* ***B****ottom* ***T****racking* while only one frequency (either high or low) is active.

OUTPUT format

Char. #	**Description "DBT" One Frequency Active**
1	Normally a Space, an "F" Indicates Fix Mark
2	"E" units are in tenths of feet "e" units are in centimeters
3	"T" units are in tenths of feet "t" units are in centimeters
4	Normally a Space, an "E" indicates High Frequency error and an "O" indicates Low Frequency error (missed return)
5	Frequency Indicator "H" = High, "L" = Low
6	Always a space
7	Depth Data (MSD)
8	Depth Data
9	Depth Data
10	Depth Data
11	Depth Data (LSD)
12	Carriage Return

Please note that characters 2 & 3 are in upper case whenever the **Units** are in tenths of feet, and are in lower case when the units are in centimeters.

Example: <sp>ETOL<sp>DDDDD<CR>

Using dual frequencies

The following description applies to the selection of ***D**ual **B**ottom **T**racking* while both frequencies (high and low) are active.

OUTPUT format

Char. #	**Description “DBT” Dual Frequencies Active**
1	Normally a Space, an “F” Indicates Fix Mark
2	“E” units are in tenths of feet “e” units are in centimeters
3	“T” units are in tenths of feet “t” units are in centimeters
4	Normally a Space, an “E” indicates High Frequency error and an “O” indicates Low Frequency error (missed return), “D” indicates High and Low error (missed returns)
5	“B” Frequency Indicator Both High and Low
6	Always a space
7	Depth Data High Frequency (MSD)
8	Depth Data High Frequency
9	Depth Data High Frequency
10	Depth Data High Frequency
11	Depth Data High Frequency (LSD)
12	Always a space
13	Depth Data Low Frequency (MSD)
14	Depth Data Low Frequency
15	Depth Data Low Frequency
16	Depth Data Low Frequency
17	Depth Data Low Frequency (LSD)
18	Carriage Return

Please note that characters 2 & 3 are in upper case whenever the **Units** are in tenths of feet, and are in lower case when the units are in centimeters.

Example: FetDB<sp>DDDDD<sp>DDDDD<CR>

6.3.3 Heave

The following description applies to the selection of the *HEAVE* output string in the Communications Menu while only one frequency (either high or low) is active.

"HEAVE" One Frequency Active		
Character #	***Character***	***Description***
1	<sp>/F	Space/Fix Mark
2,3	et/ET	Centimeter/Foot Units indicator
4	<sp>, E, O	Normally Space, "E" indicates High Frequency error "O" indicates Lo Frequency error (missed return)
5	H, L	Frequency Indicator "H" = High, "L" = Low
6	<sp>	Always Space
7,8,9,10,11	DDDDD	Depth Data
12	+ or -	Heave Direction
13, 14, 15, 16	HHHH	Heave Data (x.xx) Always Centimeter Resolution
17	CR	Carriage Return

Example: <sp>etEH<sp>DDDDD+HHHH<CR>

The following description applies to the selection of *HEAVE* while both frequencies (high and low) are active.

"HEAVE" Two Frequencies Active		
Character #	***Character***	***Description***
1	<sp>/F	Space/Fix Mark
2,3	et/ET	Centimeter/Foot Units indicator
4	<sp>, E, O, D	Normally Space, "E" indicates High Frequency error "O" indicates Lo Frequency error (missed return)
5	B	Frequency Indicator "B" = Both or dual Frequency Operation
6	<sp>	Always Space
7,8,9,10,11	DDDDD	High Frequency Depth Data
12	<sp>	Always Space
13, 14, 15, 16, 17	DDDDD	Low Frequency Depth Data
18	+ or -	Heave Direction
19, 20,21.22	HHHH	Heave Data (x.xx) Always Centimeter Resolution
23	CR	Carriage Return

Example: FET<sp>B<sp><sp><sp>184<sp><sp><sp>193+1234<CR> ;
Fix Mark, Dual Freq., 18.4FT for High, 19.3 for Low, +12.34m heave

6.3.4 DESO25

The following description applies to the selection of *DESO25* while only one frequency (either high or low) is active.

DESO25 One Frequency Active		
Character #	***Character***	***Description***
1	D	Always D
2	A,B	"A" for High Frequency, "B" For Low Frequency
3-10	DDDDDDDD	Depth Data
11	<sp>, f	Space or "f" indicating feet units
12	m, t	"m" indicates meters, "t" indicates feet
13	CR	Carriage Return
14	LF	Line Feed

Example: DB12345.69<SP>m<CR><LF> ; Lo, 12345.69 meters
*<CR><LF> ; Terminator symbol

6.3.5 DESO DDV

The following description applies to the selection of *DESO DDV* while only one frequency (either high or low) is active. Once every 2 seconds, the following two strings will also be output immediately after the DESO 25 outputstring has been output. There are two options: DESO_DDV_C and DESO_DDV_NOC. The former enables chart control through Deso commands. The latter does not allow chart control through Deso commands.

DESO DDV Heave		
Character #	***Character***	***Description***
1	D	Always D
2	G	Always H
3-5	DD	Heave Data
6	.	Period
7-8	DD	Heave Data decimal
9	<sp>	Space
10	m	"m" indicates meters
11	CR	Carriage Return
12	LF	Line Feed

DESO DDV Draft		
Character #	***Character***	***Description***
1	D	Always D
2	G	Always G
3-5	DD	Draft Data
6	.	Period
7-8	DD	Draft Data decimal
9	<sp>	Space
10	m	"m" indicates meters
11	<sp>	Space
12	CR	Carriage Return
13	LF	Line Feed

DESO DDV Sound Velocity		
Character #	***Character***	***Description***
1	C	Always C
2	S	Always S
3-6	DDDD	Sound Velocity Data
9	<sp>	Space
10-12	m/s	“m/s” indicates meters per second
13	CR	Carriage Return
14	LF	Line Feed

Example: DA12345.69<SP>m<CR><LF> ; Hi, 12345.69 meters
DG<SP>0.00<SP>m<SP><CR><LF> ; Draft 0.00 meters
CS1500<SP>m/s<CR><LF> ; Sound Velocity 1500 meters per second
*<CR><LF> ; Terminator symbol

6.3.6 DESO COMMANDS

The following DESO commands are supported when a DESO outputstring is selected:

- TXx…80 characters max…xCL example: TXthis is a test
- VSsxx.xx_m/sCL example: VS+01.23 m/s
- EMxCL example: EM0, EM1, EM2 or EM3
- *CL Terminator command

x = single character
s = sign “-“ or “+”
C = Carriage Return
L = Line Feed
_ = space
_m = units stated as meters [m]
ft = units stated as feet [ft]

6.3.7 NMEA DBS

The following description applies to the selection of *NMEA DBS* when the high frequency is active.

OUTPUT format

Char. #	**Description**
1 – 7	$SDDBS,
	Depth in feet. Single decimal floating point number.
	,f,
	Depth in meters. Single decimal floating point number.
	,M,
	Depth in fathoms. Single decimal floating point number.
	,F*
	8 bit hexadecimal value checksum calculated over the entire string excluding the leading ‘$’
	Carriage return
	Line Feed

Example: $SDDBS,29.1,f,8.9,M,4.8,F*36<CR><LF>

6.4 Serial Data input / Chart annotation

Information that in the past was handwritten on the chart record can be transmitted to the Echotrac via the RS232 return line (ASCII Serial Input). Up to 80 ASCII characters per line can be accommodated.

Event Line (*Fix Mark)*

A single line across the chart is produced by sending HEX 06 (ASCII "ACK" or "Control F"). An event line will be printed across the chart at the end of the current sounding cycle and will not delay or interfere with normal operation of the unit.

Event Annotation

When required, the event line can be annotated with up to 80 characters of information. This is achieved by following the HEX 06 with HEX 01 (ASCII "SOH" or "Control A"). Once the HEX 02 is transmitted, annotation characters can be sent sequentially or with breaks between characters. The ASCII string should be delimited by a HEX 04 (ASCII "EOT" or "Control D"). This will cause the annotation to be printed and will return the ECHOTRAC to normal operation.

** Note: Event annotation must contain at least one character before the HEX 04 delimiter even if it is only a HEX 20 ("space"). Care should also be taken to avoid annotation overrun, which is caused by grouping annotated events so closely together that they obscure the record.

Header Information (*multiple line annotation*):

This type of information would normally be hand-written at the start or end of a survey line and would include information relating to date, time, work area, etc. Using the Heading Information input facility it is possible to have this information printed automatically on a blank section of chart. Each line is still limited to the maximum of 80 characters but there is no limit to the number of lines of annotation.

Header information is sent in the same way as Event Annotation (see above) except that a HEX 0D (ASCII "CR") delimits each line of information. The HEX 04 ("Control D") is transmitted only at the end of the complete header text. The following procedure steps through each phase of the Header Information input:

1 Transmit HEX 01 to request an annotation input.
2 Transmit a line of header information to a maximum of 80 characters.
3 Transmit HEX 0D ("CR") to print the line.
4 Transmit next line of Header Information.
5 Repeat step 3 and 4 as required until all Header Information is sent.
6 After the last "CR", send the HEX 04 delimiter to return ECHOTRAC to normal operation.

(In order to advance blank paper, send the HEX 0D ("CR") as many times as necessary.)

6.5 Serial heave input

The only string the Echotrac CV will accept is the TSS1 string. Below is a description of the string.

TSS1 String		
Character #	***Character***	***Description***
1	:	Start Character
2-3	X	Horizontal acceleration data
4-7	A	Vertical acceleration data
8	<sp>	Space
9	<sp>,-	Space if positive, minus if negative
10-13	H	Heave data
14	Q	Status flag
15	<sp>,-	Space if positive, minus if negative
16-19	R	Roll data
20	<sp>	Space
21	<sp>,-	Space if positive, minus if negative
22-25	P	Pitch data
26	CR	Carriage Return
27	LF	Line Feed

6.6 External Serial Control of Echotrac Parameters

Many of the parameters sent via the LAN port may also be entered via the serial port from an external computer or terminal. The external control feature allows remote input of the operating parameters from data files or through the computer keyboard.

Some restrictions apply to external parameter inputs, which, because of their absolute nature, are only tested against minimum and maximum limits. Echotrac control program changes on the other hand are always processed in a controlled fashion in order to prevent possible system errors. Most often problems arise if the external parameter input is not in the correct multiple for the parameter addressed.

Protocol overview
13 ASCII bytes maximum are necessary to complete a parameter transfer as shown below:
The sequence begins when the Echotrac receives a CONTROL P (ASCII DLE, HEX 10) followed immediately.

<Parameter Number>'Space'<New Value>CR
13 Characters Maximum

Ex: '0' '1' 'SPACE' '1' '4' '6' '4' CR

Protocol format
The Echotrac CV input communication protocol is defined by 13 bytes.

	Header	Parameter #		SPACE	New Value								Delimiter
Byte	1	2	3	4	5	6	7	8	9	10	11	12	13
HEX	0x10 <DLE>	0x00..0xFF	0x00..0xFF	0x20	n	n	n	n	n	n	n	n	0x0D <CR>
DEX	16	0…255	0…255	32	n	n	n	n	n	n	n	n	13

Note:
HEX Hexadecimal
DEC Decimal
DLE Data Link Escape (also known as Control-P)
CR Carriage Return
SPACE This character will be represented by "_" in the examples below.
N The letter "n" represents each single digit of the New Value.
Minimum is 1 digit. Maximum is 8 digits.

Examples:
Bar depth <DLE>08_12<CR> Identifier is 08, value is 12 feet
Index <DLE>07_1500<CR> Identifier is 07, value is 1500 meters

The sequence begins when ECHOTRAC receives a CONTROL P (ASCII DLE, HEX 10) followed immediately by the parameter control string (The parameter number (2 characters) followed by a SPACE (HEX 20) then the parameter value itself (which can be up to 8 characters long) followed by a carriage return). The transfer is then complete and the ECHOTRAC returns to normal operation using the new value. In the above example the VELOCITY identified by the parameter number 08 was changed to a new value of 1464 m/s. The string delimiter (CR) will always terminate the input. Use Control T (HEX 14) to stop the chart and Control R (HEX 12) to restart the chart.

The parameter IDs that you use to send settings are the same as when you request settings. For example, to set the chartspeed you would use a parameter ID '15'.

Querying Parameter settings
To query a setting use the following 6 character sequence: <CTRL+P><Request ID><space><Parameter ID>

The Request ID is a command that the Echotrac recognizes as the command for a parameter value request.The Echotrac CV will then reply with “#CV3,P,”<UNITS><PING NUMBER><PARAMETER ID><VALUE>.
The Units is a single character F or M for Feet or Meters. The ping number is 8 characters, the Parameter ID is 2 characters and the value is 8 characters. Example:
<CTRL+P>86 00
#CV3,P,F000000010000000168

Note: The Serial Parameter Request feature is supported in the following firmware versions only (See table below). Also, as of version 3.06 the ID used to request a parameter value changed from 86 to 187.

Firmware	Request ID
3.01 – 3.05	86
3.06 –	187

See chapter 7 Overview parameters and settings for a table listing all the parameters and their unique identifier.

7 OVERVIEW PARAMETERS AND SETTINGS

An overview of parameters and settings can be found in reference [3].
Any setting that is changed in the control program is automatically sent to the Echotrac.

7.1 External Ethernet Control of Echotrac Parameters

The Echotrac ETHERNET port runs at 10 Mbps and outputs 16 or 8 bit samples of the acoustic data. The ETHERNET port also sends out all parameters . See reference [3] for more details.

8 UPLOADING FIRMWARE

The Echotrac CV has a total of 2 processors, 1 of which can be uploaded with new firmware through the serial ports. The other processor perform low-level tasks and require only infrequent upgrades. The firmware in one module uses a Motorola processor. The Communication CPU is upgradeable through Com 1 on the Echotrac CV. The Motorola processor is the main processor in the system. The firmware on the DSP processor needs to be upgraded by an Odom technician.

This section refers to the Echotrac Control Program, but the sounder can also be controlled by Odom eChart, the serial port or third party applications.

8.1 Upgrading Motorola Processor Firmware

The flash upgrading program will run on computers running Windows 95/98, Win NT, Windows 2000 and Windows XP. The other requirement is that the computer must have an on board serial port number 1 through 4. We have had success using PC Card serial ports but not USB adaptor serial ports.

Care must also be taken to ensure the Echotrac CV does not loose power or that the serial connection becomes disconnected when performing the software upgrade.

The Echotrac must be functioning correctly and all version numbers valid in order for the flash upgrade to work.

1-Install the Odom Flash Utility by Unzipping the OdomFlash.zip file in a directory. After the file is uncompressed, run the setup.exe file to install the program. Follow the instructions.

2-To upgrade the Motorola processors you need the new binary file. The file is named ECV2COM.bin and must be obtained from Odom Hydrographic Systems Inc.. We normally do not put these on our web site, but we can email them to you or they will be sent on a CD disk. Once these files have been obtained put them in a known folder in the computer with the Odom Flash Program.

3-Put the Echotrac CV in Standby mode using the Echotrac Control Program. Go to the Communication Menu in the Echotrac Control Program and set the baud rate of Com1 to 19200.
As a precaution, disconnect any cables that are not required during the flash upgrade procedure such as: Network, GPS and Heave. This will ensure that the Echotrac is not interrupted by external devices during flashing.

4-Connect the serial port of the computer to Com1 on the back panel of the Echotrac.

5-Start the Odom Flash program. Under Select Model, make sure Echotrac CV2 is selected. Under the Bin Folder, click on the Browse button and select the folder that contains the ECV2COM.bin file. Click on the Upload button.

6-Monitor the Flash utility program for messages. Do not interrupt the process.

If the upgrading procedure fails and the Echotrac CV fails to display a version number for one of the modules after cycling the power then the flash chips in that module will need to be replaced with a working set of flash chips.

8.2 Upgrading DSP Firmware

At this moment the firmware for the DSP cannot be upgraded in the field, but can only be upgraded in the office by an Odom technician.

9 ECHOTRAC CV CABLE CONNECTIONS

9.1 Serial 1

Serial 1 is the main communication port to and from the Echotrac. Use this port to receive depth values, send annotation information, change parameters, and to upgrade the firmware.

Connector PN:	Pin Number	Signal Description
DB9 Male	2	Transmitted data from Echotrac
	3	Received data to Echotrac
	5	GND

9.2 Serial 2

Serial 4 is used for interfacing a motion reference sensor to the Echotrac. The Echotrac will read the TSS1 string through this port.

Connector PN:	Pin Number	Signal Description
DB9 Male	3	Data from the motion sensoro the Echotrac MKIII
	5	GND

9.3 GPS In

GPS In is only used when the Echotrac has a built in GPS unit. If the Echotrac has a built in GPS then this is the configuration port for the GPS or can be used to input external RTCM correction to the GPS.

Connector PN:	Pin Number	Signal Description
DB9 Male	2	Transmitted data to the Internal GPS
	3	Received data from the Internal GPS
	5	GND

9.4 GPS Out

GPS Out is only used when the Echotrac has a built in GPS unit. If the Echotrac has a built in GPS then this is the output port for the GPS data.

Connector PN:	Pin Number	Signal Description
DB9 Male	2	Transmitted data to the Internal GPS
	3	Received data from the Internal GPS
	5	GND

9.5 LAN

The LAN connection is the Ethernet port for the Echotrac.

Connector PN:	Pin Number	Signal Description
10BASE-T	1	TX +
	2	TX -
	3	RX +
	6	RX -

9.6 Aux

The Auxiliary port is used for acquiring the analog signal from the Echotrac.

Connector PN:	Pin Number	Signal Description
MS3116J10-6P	A	External Mark Input
	B	External Trigger Input
	C	TxRx or Start Signal
	D	Reply signal for low frequency
	E	Reply signal for high frequency
	F	GND

9.7 TX1

TX1 is the main transducer connection port for the Echotrac. If using Odom Hydrographic Systems, Inc. normal dual frequency transducer or a signal frequency transducer connect the transducer here.

Connector PN:	Pin Number	Signal Description
MS3116J14-5P	A	Shield
	B	High Frequency
	C	Low Frequency
	D	Low Frequency
	E	High Frequency

9.8 DC

The DC connector is used to supply DC input power. The range of the DC power is 18-30 VDC.

Connector PN:	Pin Number	Signal Description
MS3116J12-3S	A	+ 24 Volt DC
	C	GND

9.9 AC

The AC connector is used to supply AC input power. The range of the AC power is 110-230 VAC, 60-50 Hz. The Echotrac MKIII power supply automatically senses the input range and adjusts to it.

9.10 Serial Cable Connections for Echotrac with Built in GPS

The double ended (2-DB9 serial cables) are connected to the following pins of the Echotrac CV serial data connector (FWDR09S). The DB9 connectors are labeled as GPS IN and GPS OUT.

Internal Connections - GPS to the Echotrac CV serial Ports

FWDR09S	DB9 (GPS)
Pin G	Pin 2 (output)
Pin F	Pin 3 (input)
Pin B	Pin 5 (gnd.)
Jumper Pins B&C	DB9 (Echotrac CV)
Pin A	Pin 2 (output)
Pin D	Pin 3 (input)
Pin C	Pin 5 (gnd.)

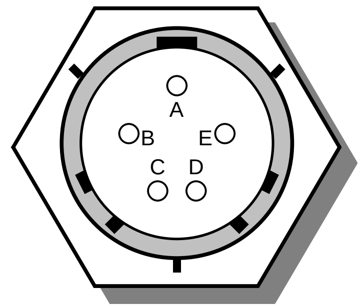
Starlink DB9 Connector (the one on the GPS board)	Signal Name	HT100 Connection
Pin 2	Port A output	FWDR09S Com 1 Pin G
Pin 3	Port A input	FWDR09S Com 1 Pin F
Pin 4	Port B input	FWDR09S Com 2 Pin F
Pin 6	Port B output	FWDR09S Com 2 Pin G
Pin 8	Power	24 Volts on Echotrac CV
Pin 9	GND	GND on Echotrac CV

Appendix A. CABLE CONNECTIONS:

TRANSDUCER Cable Connector (Signal Connector)
P/N: MS3114E14-5S

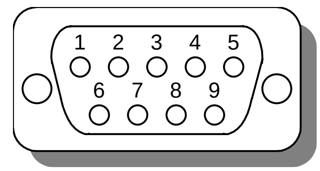
Pin #	Description
A -------------------	Shield
B -------------------	High Frequency
E -------------------	High Frequency
C -------------------	Low Frequency
D -------------------	Low Frequency

Signal Connector



DB9 SERIAL Cable Connectors (Control, Data out, GPS input, GPS output)
P/N: FWDR09S

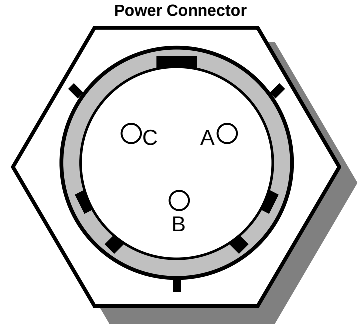
Pin #	Description
2 -------------------	RS-232 Input
3 -------------------	RS-232 Output
5 -------------------	Shield (Signal ground, Common return)



POWER Cable Conn. (DC only)
P/N: MS3114E12-3P

Pin #	Description
A --------------------	+12 or 24 VDC
B --------------------	No Connection
C --------------------	Return

Power Connector



Fuse: 5 amp (DC inputs only)

Standard Transducer Wiring

Transducer Model #	Description	Pin Connections
SM200-10	200kHz 10^{o}	A - Shield B – Signal (Black) E – Signal (White)
SM200-2.75	200kHz 2.75^{o}	A – Shield B – Signal (Black) E – Signal (White)
TM33-20	33kHz 20°	A – Shield C – Signal (Black) D – Signal (White)
HM40-20		A – Shield C – Signal (Black) D – Signal (White)

Appendix B. Quick Start Operating Procedures

ECHOTRAC CV

QUICK START OPERATING PROCEDURES

The **Echotrac CV** is designed to operate with minimal operator input, yet still provide complete flexibility for a wide range of conditions and applications.

1. Ensure that all equipment is powered off before connecting any power or signal cables.
2. Connect the Power, Transducer, Serial and GPS cables (if applicable) to the Echotrac CV.
3. Connect the other ends on the cables to the computer, Data Acquisition Software and GPS (if applicable).
4. Switch the Echotrac CV and computer power from OFF to ON.
   Confirm that the power LED and Ethernet Link LED on the unit come on. After a few seconds, the Ethernet TX/RX LED should start blinking as well as one or both of the Transmit High / Low LEDs. If this does not happen then the Echotrac CV is in Standby Mode. Use the Odom eChart Program to start the Echotrac CV.
5. Check that Odom eChart Windows application software is installed on the computer (see the user manual for instructions)
6. Check that the unit's parameters in the Odom eChart Windows application are correctly set.
7. Select Open Communication from the Control menu in the Odom eChart Windows Application.
8. Set Range to maximum anticipated water depth.
   Depending on water depth and bottom type, set the Tx Power to mid-range (position 6) in Odom eChart.
   Set the RxGAIN to about halfway of the maximum scale.
   Adjust RxGAIN and TxPOWER to get a clear strong record with few alarms on the displayed depth.
9. To reset all parameters to the default values of the most recent startup, choose ETCV Default Settings in the CONTROL MENU of the Odom eChart Windows application.

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APPENDIX D

Odom eChart Software Operating Notes

Odom eChart

USER MANUAL
Version: 0.3

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Number of pages: 25
Date: April 18, 2008

Revision History

Version	Date	Author	Remarks
0.1	12-13-2007	S. Apsey	Initial version – draft
0.2	01-31-2008	R. Byrd	First Edits
0.2	04-18-2008	S. Apsey	Software version 1.1.12 update

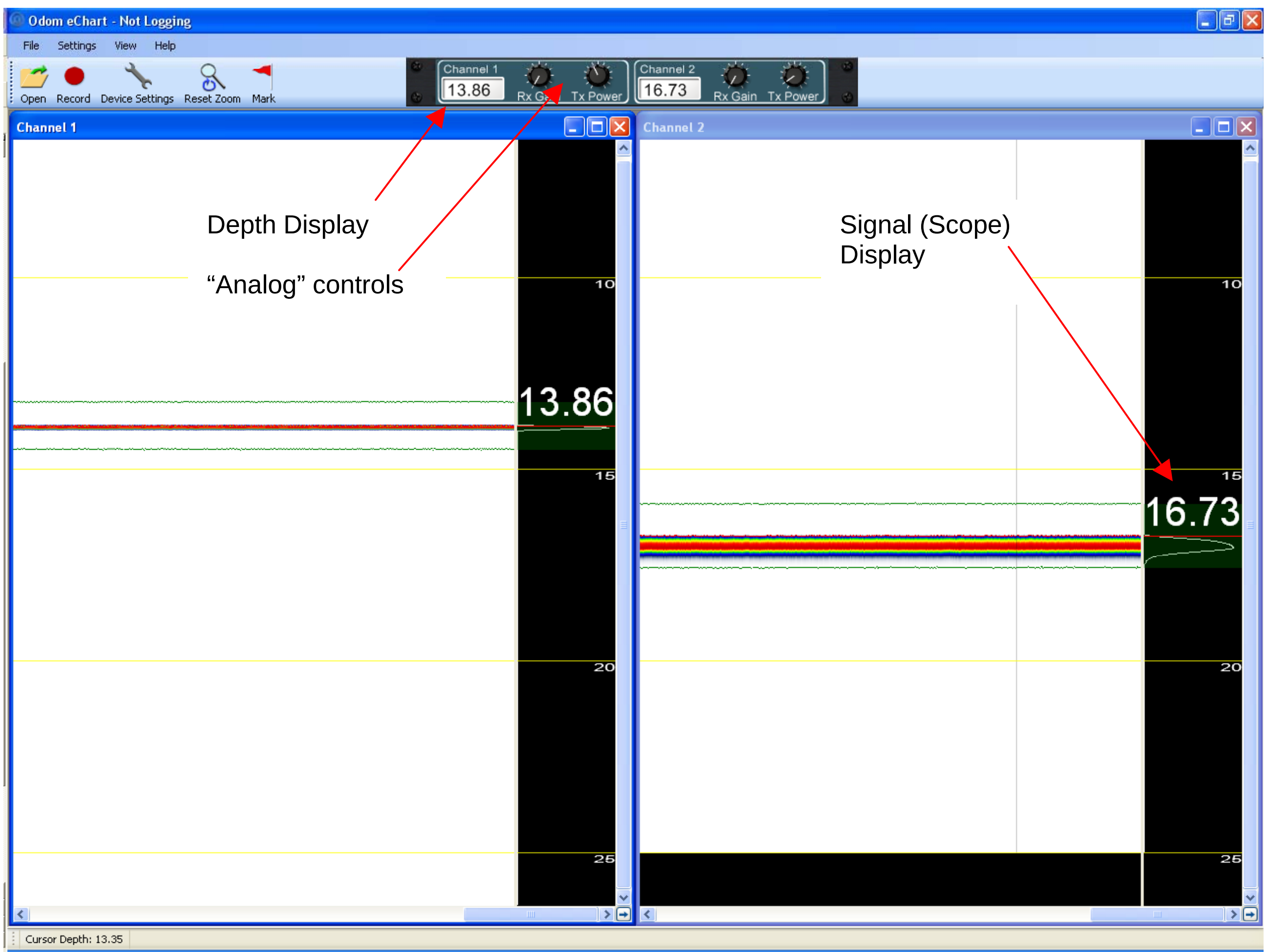
CONTENTS

1 INTRODUCTION

Odom eChart (hereafter referred to as eChart) is a data display and control program for the Echotrac family of hydrographic echo sounders. That family includes the MKIII, Echotrac CV100, Echotrac CV2, Echotrac CV3, and Echotrac CVM echo sounders manufactured by Odom Hydrographic Systems, Inc.. eChart utilizes the Ethernet port available on these units to send commands to and to display and log data from the entire “Echotrac Family” of single beam echo sounders.

The Ethernet data output by these echo sounders are 1600 or 3200 time series of 16bit amplitude values of the water column, digitized each time the sounder transmits a pulse to the transducer. Depending on the Echotrac model, up to 3 channels of data are sampled simultaneously up to maximum repetition rate of 20 times per second. Collection of that amount of data is made possible by the wide bandwidth of the Ethernet link compared to an RS232 link tasked similarly. eChart also allows the operator to replay data that has been logged. The software has zoom in/zoom out functions that allow the operator to view the entire file or a small portion of the file. The operator can also display all of the parameters for any single ping in the data file. eCHart also has printing facilities that utilize standard Windows printers.

1.1 Main eChart Screen



1.2 Purpose

The purpose of this document is to explain the features and operation of eChart software.

1.3 Scope

The scope and content of this document is focused on providing useful information to the end-user.

1.4 Glossary

DGPS	Differential Global Positioning System
NMEA	National Marine Electronics Association
VDC	Volts Direct Current

2 INSTALLATION

2.1 Software Installation

The minimum requirements for a personal computer to install and run only the ES3 software are:

- Windows 2000, XP or Vista
- 512 MB of RAM
- 2 Gigabytes of free hard drive space
- Direct-X 7 compatible video system with 64MB Video memory and current driver
- Pentium-IV, running at 2 GHz
- One Ethernet port

Double-Click the provided setup file to start the installation process. An Install Shield wizard will guide you through the rest of setup process.

3 eCHart MENUS

3.1 File

3.1.1 Open File

The File Open command allows the operator to open files that have been previously recorded. All recorded file are stored in the install_folder\Odom\eChart\Recorded Data folder. Files are stored in a *.dso format which is a proprietary file type. Details of the file specification are available in the Appendix. There is also an icon on the tool tray for this function.

3.1.2 Record

This will start recording files to the install_folder\Odom\eChart\Recorded Data folder. It is important that the operator not change the units of measure as this will produce unpredictable results when playing back the file.

3.1.3 Convert DSO file to XTF

EChart logs all its file to Odom's proprietary DSO file format. This menu item allows the operator to convert these files to XTF(extended Triton Format) for playback and processing with other software packages.

3.1.4 Connect to Sounder/Disconnect from Sounder

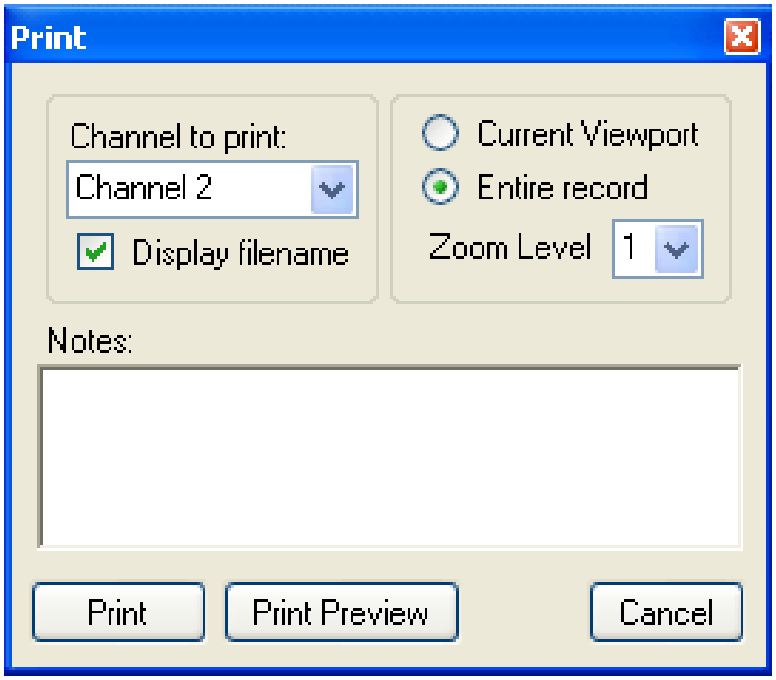
This will connect the eChart software to an Echotrac sounder through the Ethernet port. If connecting directly between the Echotrac and eChart computer ensure a cross over CAT5 cable is used. Make sure the computer has acquired a network connection to the sounder first otherwise a connection cannot be established. There is also an icon on the tool tray for this function.

3.1.5 Save Image…

Save Image will save the current screen to a .bmp file. This is useful for archiving a bar check or some other important feature.

3.1.6 Print…

Allows the operator to print data that has been recorded on a standard Windows printer.

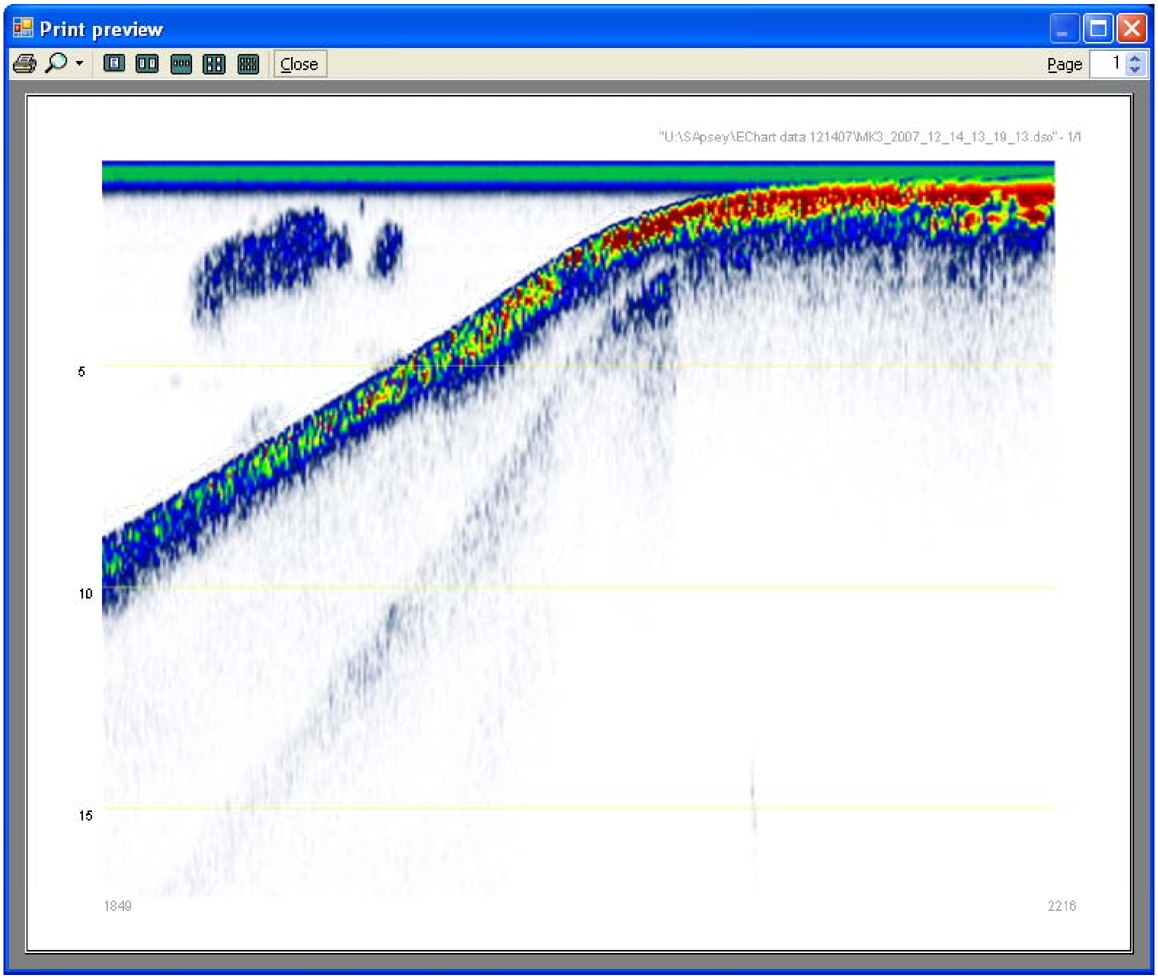


3.1.6.1 Channel to print

Channel to print selects which channel data to print.

3.1.6.2 Current Viewport

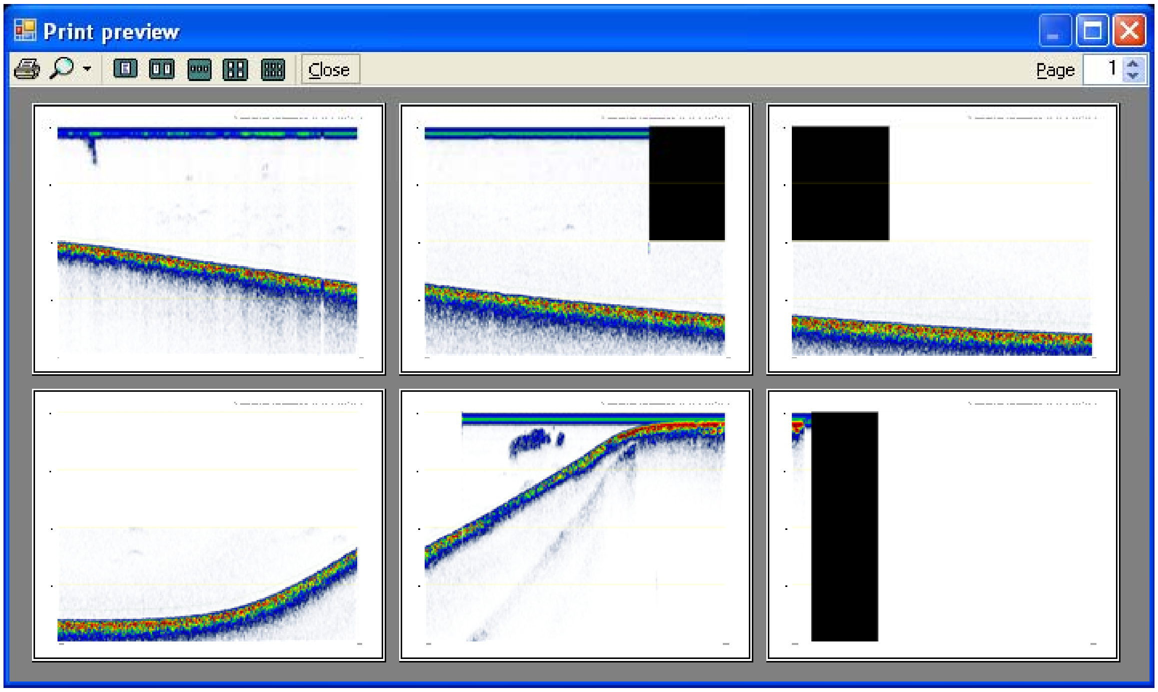
The Current Viewport will print only the current zoom level and data that is displayed on the screen.


Print preview
Close
Page
1
"U:\SApsey\EChart data 121407\MK3_2007_12_14_13_19_13.dso" - 1/1
5
10
15
1849
2216

3.2 Settings

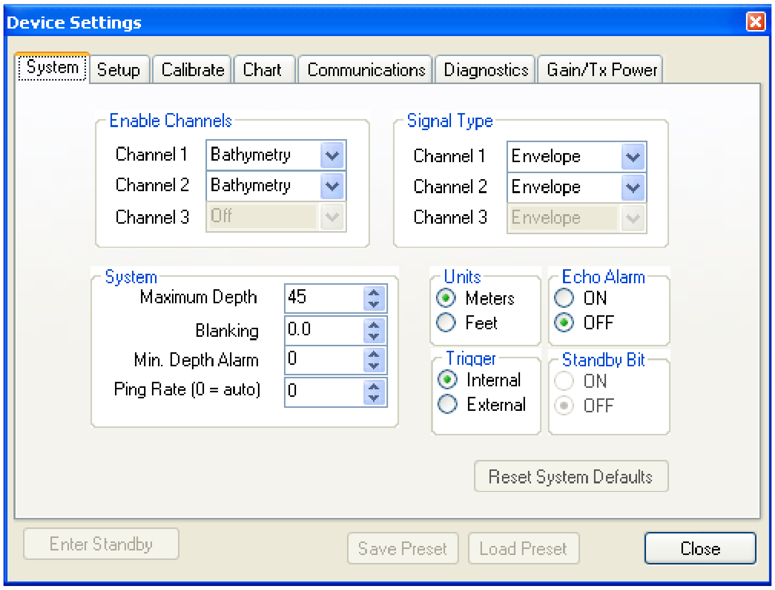
3.2.1.1 Entire Record

The selecting the Entire Record command results in the printing of the record at the Zoom Level selected.



3.2.2 Device Settings…

The Device Settings controls all the parameters for the Echotrac. If the Echotrac model that is connected to eChart does not support a certain feature, that feature will appear “greyed out” and will not be accessible to the operator.

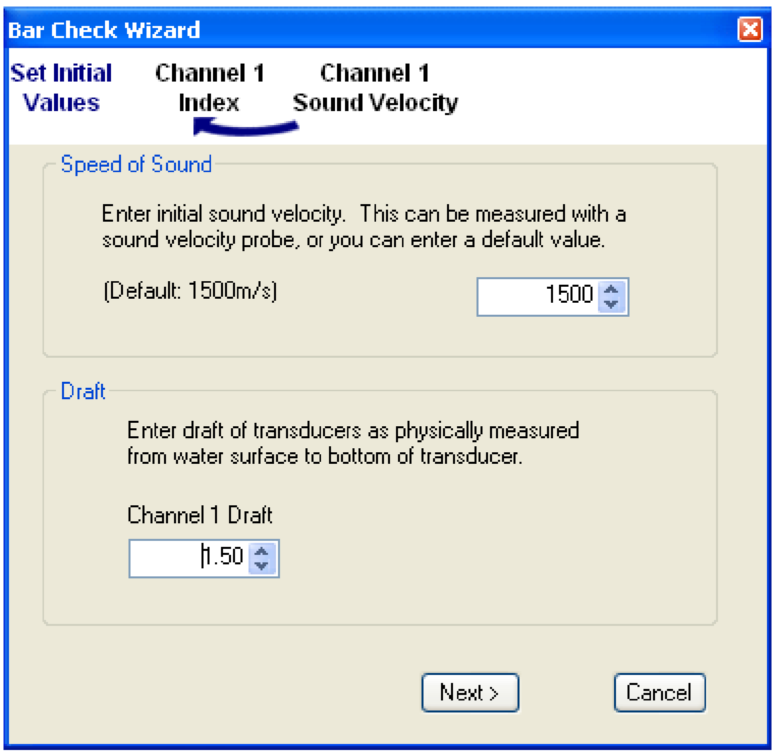


3.2.3 Bar Check…

The bar check is the hydrographic survey industry's most widely accepted method of calibrating single beam echo sounders. The procedure involves deploying a plate or bar that is suspended by cables or chains at accurately measured distances below the transducer. The "Bar Check Wizard" streamlines the bar check procedure for calibration. The result of the Wizard is an echo sounder that is calibrated for draft, sound velocity and index offsets. The Bar Check Wizard also generates a text file containing the values associated with each calibration factor.

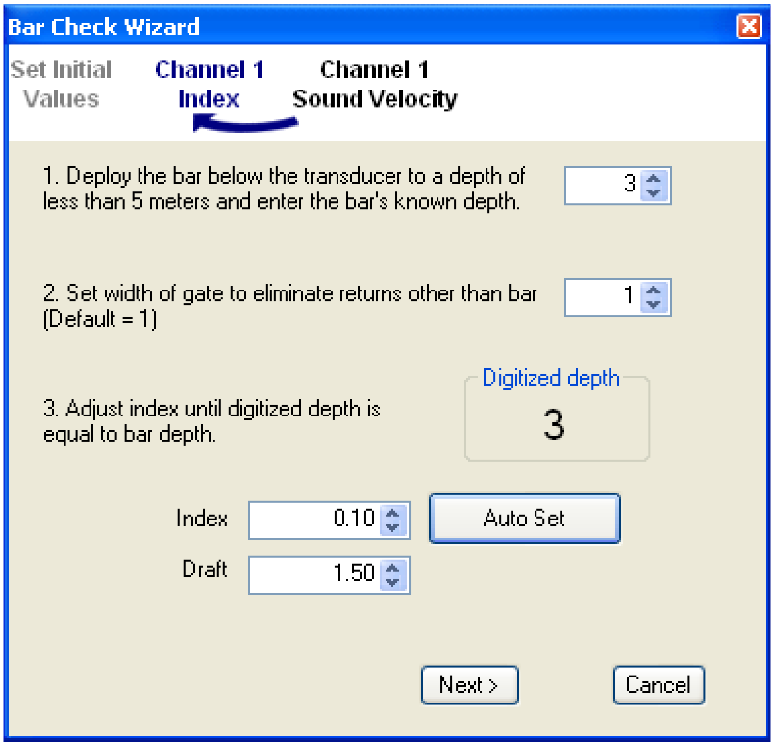
The three parameters the Echotrac needs to determine the depth accurately are Draft, Sound Velocity and Index. Draft is the distance from the water surface to the face of the transducer. Sound Velocity is the average speed of sound in the water column. Index errors are any delays caused by the transducer elements and analog filters in receiver of the echo sounder. Draft and Index errors are best determined when the bar is placed close to the face of the transducer, and sound velocity is best determined when the bar is at its deepest.

Before starting the bar check, make sure the TX Power, RX Gain, Pulse Width, TVG curves, Threshold and Bandwidth parameters are set to values which are appropriate for the survey to be performed. Changing any of these parameters will impact the calibration of the Echotrac as it will any echo sounder.



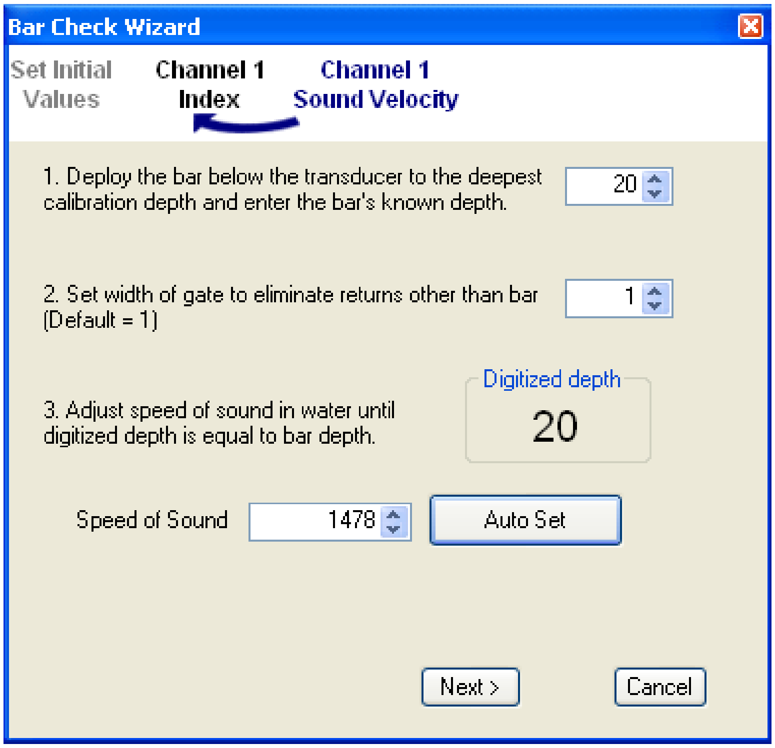
Enter the initial speed of sound. This is usually determined with a sound velocity probe like a Digibar. If a sound velocity probe is not available enter an approximation or leave the default value. The bar check procedure will produce the correct sound velocity as an end result.

Enter the measured draft (how deep the transducer is as measured from the water surface to the transducer face). If the transducer is hull mounted enter the known value. The calibration procedure will determine the exact offset.

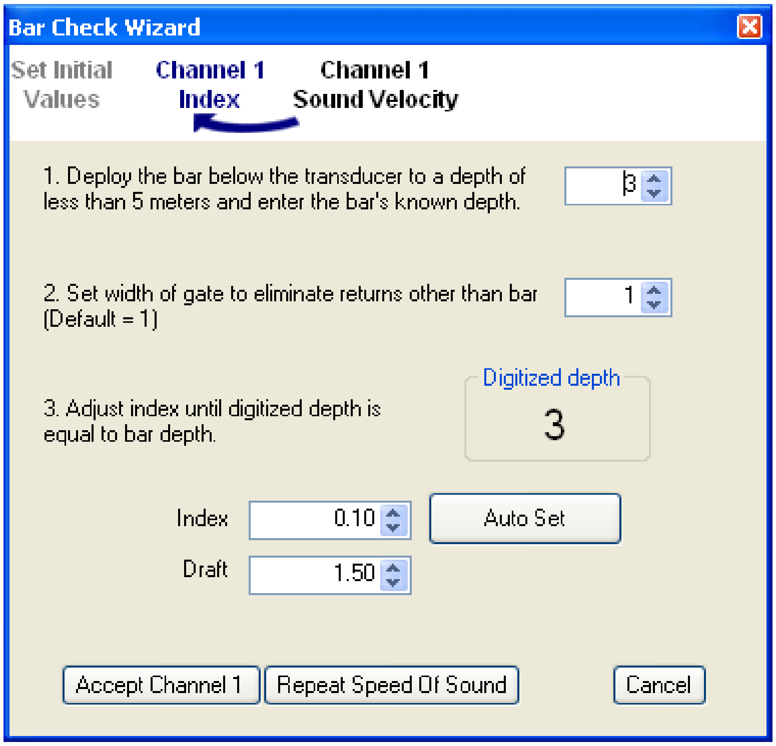


Deploy the bar below the transducer to a shallow depth. Place the bar at least 1 meter (3 feet) below the face of the transducer. Keep the distance between the transducer face and the bar small to eliminate errors in the sound velocity entry. The bar depth and width parameters instruct the Echotrac to only validate signals within this "window" in the water column, eliminating signals from the seabed.

The Digitized depth value displayed is the depth the Echotrac is measuring. Use the chart display to make sure the bar is visible in the record. If the bar is not visible, move the bar around until it is directly under the transducer. In areas with current or wind, this can be a challenge. Once the measurements of the Echotrac on the bar are stable click on the Auto set button. This will set the Index to the appropriate value so the depth from the Echotrac equals the bar.

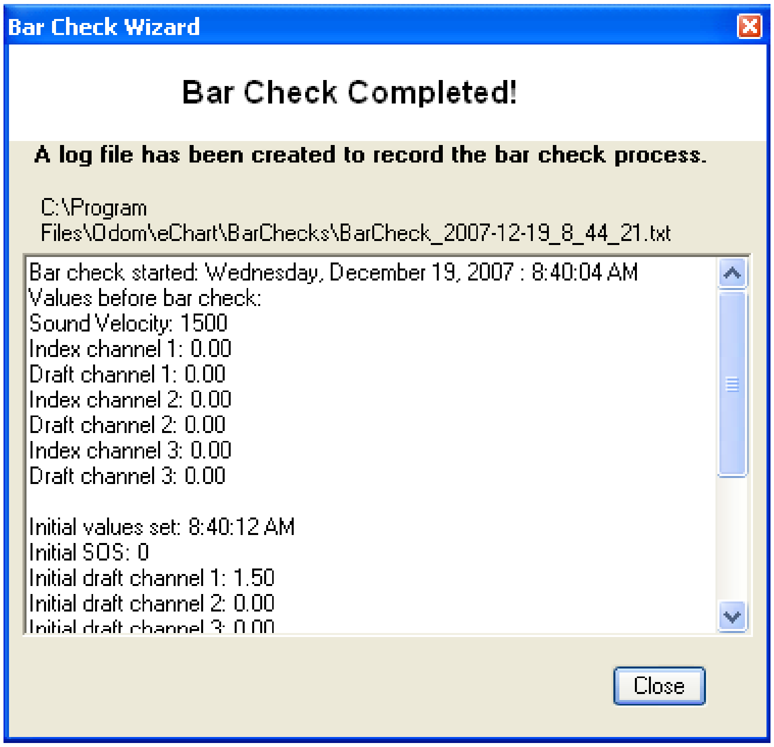


Set the bar to the deepest possible depth and then enter the depth of the bar. Getting the bar directly under the transducer can be a challenge, but it is essential for a good bar check. Once the Echotrac is measuring the bar click on the Auto Set button and the wizard will change the Speed of Sound until the measurement is correct. The sound velocity required to measure the bar depth should agree closely with the sound velocity from the sound velocity probe. If it does not, then there is a problem with either the draft and index measurement or sound velocity calibration. Most often this is caused by improperly accepting the depth of the bar check when the bar is not directly under the transducer.



The next step in the bar check wizard is to confirm the measurement of the shallow water bar check since the measurement might change if the sound velocity initially entered was not accurate. If the measurement agrees with the bar the procedure is finished otherwise keep repeating the shallow water deepwater measurements until both agree. If calibrating more than one channel, Channel one (or the highest frequency channel available) is used to determine the sound velocity. The low channel (s) need only to be employed to arrive at the appropriate draft and index figures for each since the sound velocity is common for all channels.

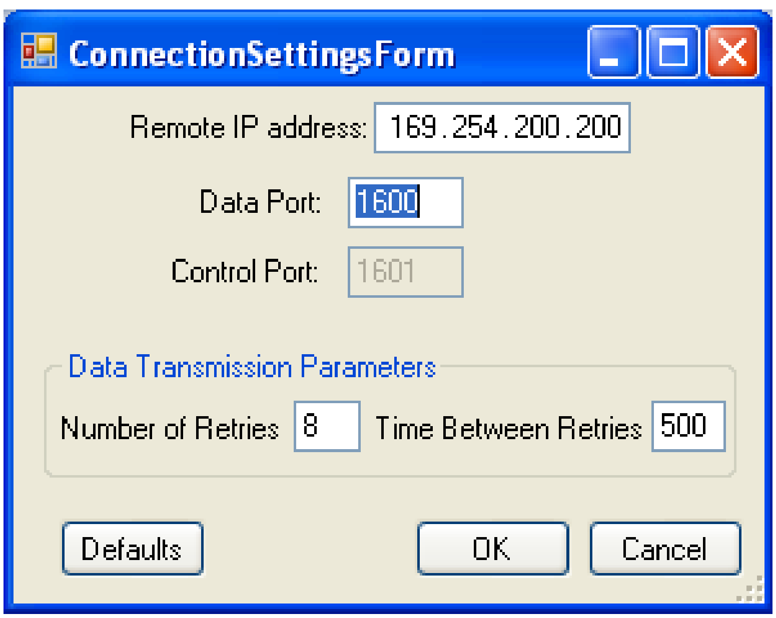
The biggest source of error when bar checking and echo sounder is ensuring the bar is directly under the transducer when accepting the measurement. Do not increase the gain in an attempt to compensate for the bar not being directly under the transducer.



The final step of the bar check wizard is a summary of the parameters changed and a text file is created of the bar check. This file is placed in the install_directory\Odom\BarChecks folder.

3.2.4 Connection Settings…

Allows the operator to set some of the parameters required to connect eChart to the Echotrac. Normally these parameters do not need to be changed.



3.2.4.1 Remote IP address

The Remote IP address is used to fill in the "User Settings Packet". The sounder takes on the Remote IP when it connects. The Echotrac uses UDP/IP and this address is not really necessary, but is used to help when network packets are captured for debugging purposes.

3.2.4.2 Data Port

This is the UDP data port for the Acoustic Data Packet that is output from the Echotrac. The default value is 1600. A reset of the Echotrac will set the sounder to this port number.

3.2.4.3 Control Port

This is the control port for the Echotrac. This port number is always 1 larger than the Data Port of the Echotrac so the only way to change this port number is to change the Data Port.

3.2.4.4 Number of Retries

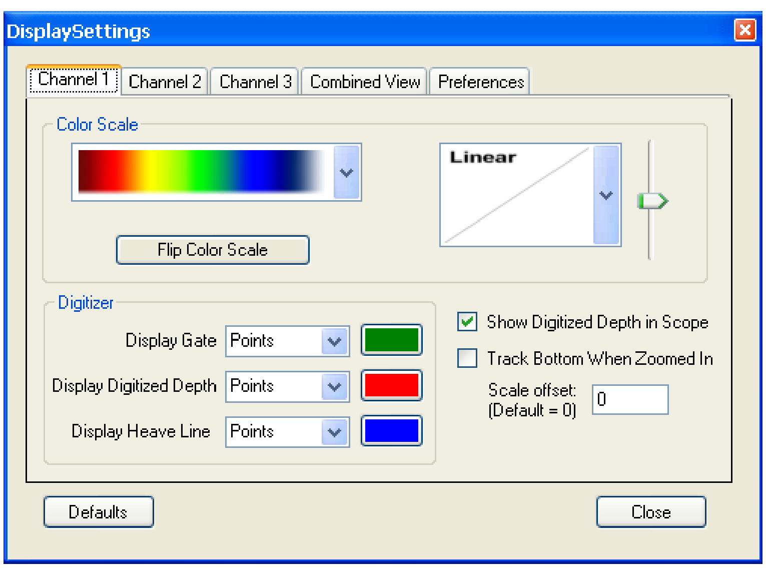
"Number of Retries" refers to the number of times eChart will attempt to connect to the Echotrac before giving up.

3.2.4.5 Time Between Retries

"Time Between Retries" refers to the amount of time between eChart attempts to connect with the Echotrac. If the Echotrac is set to a deep depth range (which dictates a long period of time between "Pings") a longer retry time might be required.

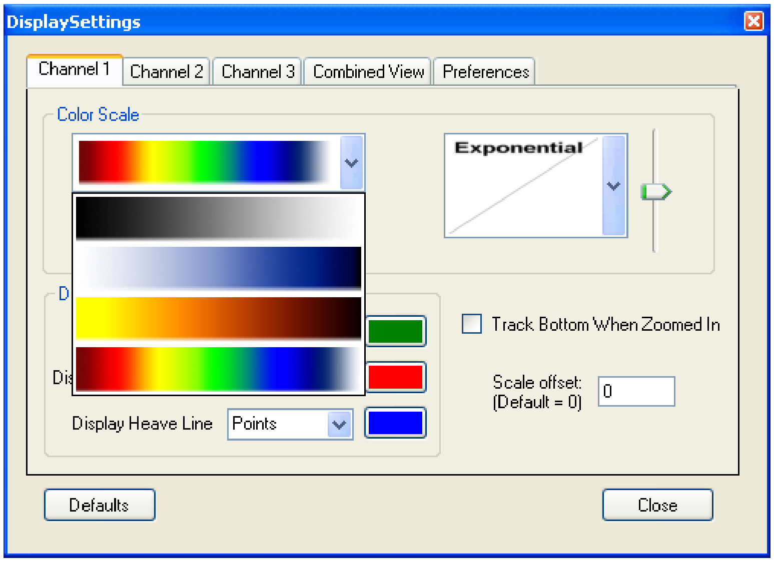
3.2.5 Display…

This menu sets the attributes such as colors and other preferences for each channel. There are up to a maximum of three channels in an Echotrac, so there are three tabs for selecting properties for displaying the data.



3.2.5.1 Color Scale

eChart offers four different color scales. The rainbow color is usually the best for bathymetry data. The grey is the more traditional record and it has a familiar look for both bathymetry or side scan data. Amber is usually the reserved for side scan data. The Linear/Exponential drop down box employs the slider to the right of the box. In the Linear mode the slider affects the linear offset of the color scale. In Exponential mode the slider can add more emphasis to the either the lower amplitude data or higher amplitude data. Exponential mode is good for highlighting objects in side scan data or bring out layers in sub bottom bathymetry data.



3.2.5.2 Digitzer

The Digitizer box lets the operator select which items are displayed on the screen and whether they are displayed using dots or lines and what colors are used.

3.2.5.2.1 Display Tracking Gate

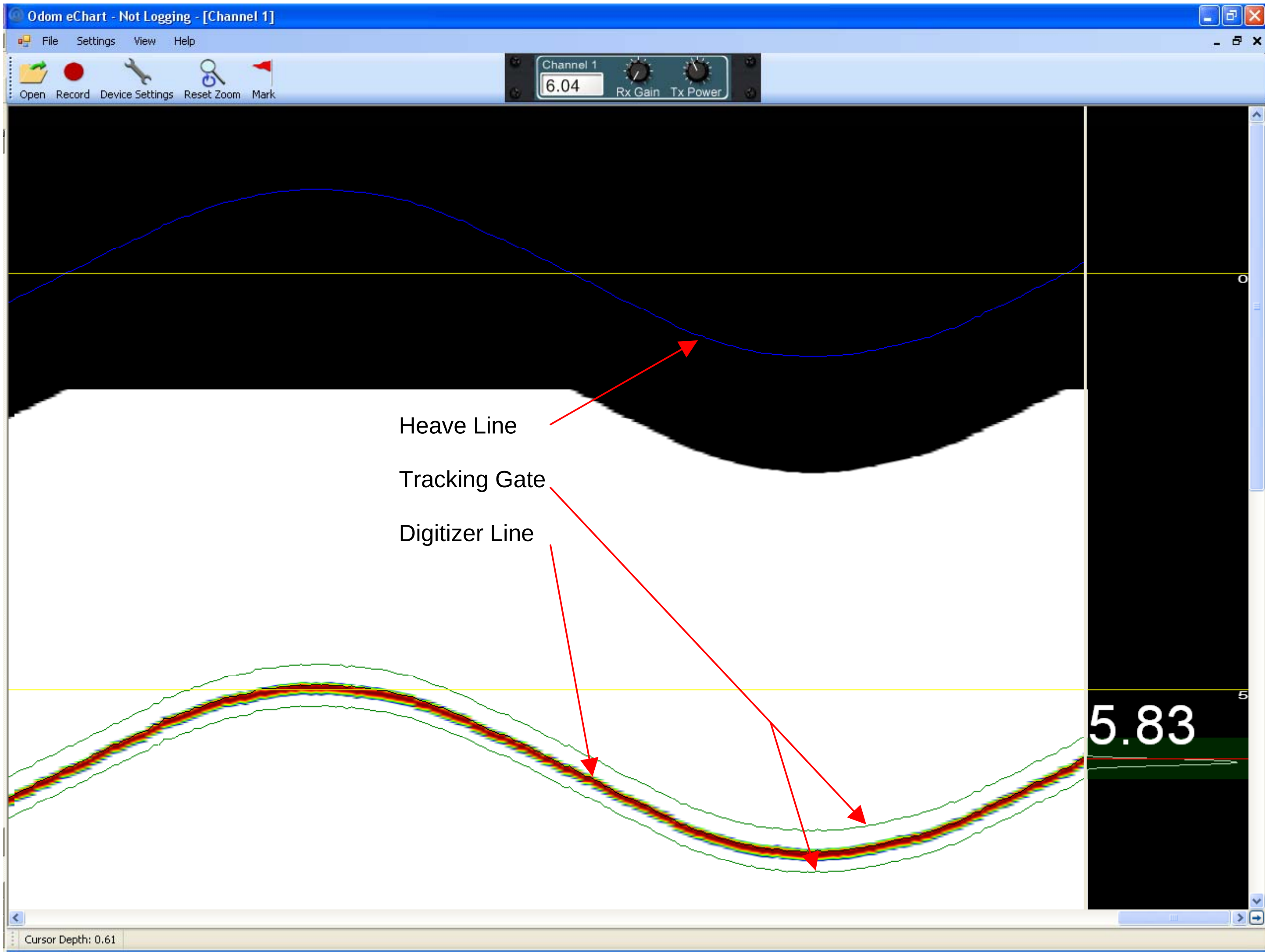
Echotrac sounders maintain a dynamic tracking window around the seabed, so that any objects (acoustic reflectors) appearing outside of the window are ignored once a valid bottom is determined. This window is called the tracking gate. This menu item determines whether the gate is displayed or not and how it is displayed. Please note that the gate is always displayed as a dark shade of green on the signal display.

3.2.5.2.2 Display Digitzer Line

The Digitized Depth is the depth the Echotrac has determined to be the bottom. This feature allows the operator to plot the line that represents that depth on the screen. This feature is designed to help the operator visualize what the echo sounder has picked as the seabed.

3.2.5.2.3 Display Heave Line

The heave line is used when a motion reference unit is connected to the Echotrac. Displaying the heave line is useful in determining how well the heave compensation instrument is correcting for the vertical displacement of the transducer resulting from wave action.



3.2.5.3 Show Digitized Depth in Scope

This check box determines whether the digitised depth from the Echotrac is displayed in the oscilloscope window (to the right of the scrolling data).

3.2.5.4 Track Bottom when Zoomed In

When zooming in on a particular part of a record, enabling this feature will keep the data corresponding to the Echotrac's bottom pick in the viewing area regardless of the zoom power used.

3.2.5.5 Scale Offset

This feature enables the operator to add a small voltage offset to the data before displaying it on the screen. The feature is only useful for Echotrac units that can display the Full AC waveform data (the units must be equipped with the 31RD Low Frequency Transceiver Card). Compensating for small differences in the DC offset serves to keep the AC waveform data (Wiggle display) centered in the color range and leads to a more easily interpreted record.

3.2.5.6 Combined View

The Combined View tab sets the display properties for the Combined View window. This window allows the operator to select two or more channels to overlay or display on top of each other (viewed simultaneously in one Window).

3.2.5.6.1 Opacity

This display function fades the data for the channel selected in and out. The capability to change Opacity is useful when comparing dual frequency records where the high and low frequency returns are plotted at very nearly the same depth.

3.2.5.6.2 Per-Pixel Transparency

Again with two channels plotted simultaneously in one Window, selecting Per-Pixel Transparency results in the pixel with the highest intensity being displayed regardless of which channel is plotted as the top layer.

3.2.5.6.3 Show Digitized Depth

This function turns on the display of the selected channel's depth in the signal window.

3.2.5.6.4 Orientation

This feature determines the plot orientation of the data in the combined view. Horizontal scrolling is usual for bathymetry data while vertical scrolling is normal for side scan data.

3.2.5.7 Preferences

This tab sets the preferences that affect all the windows

3.2.5.7.1 Grid Lines

The grid lines box allows the operator to customize the scale lines on the scrolling chart. The operator can select the color of the major and minor scale lines and how far apart the lines are. The transparency slider allows the operator to set how transparent the scale lines are.

3.2.5.7.2 Horizontal Scaling

Changes the rate at which data is scrolled horizontally across the screen.

3.2.5.7.3 Auto Zoom Mode

Auto Zoom Mode determines how the Reset Zoom icon on the tool bar will work. If "Zoom to display all previous data" is selected and the operator clicks on the Reset Zoom icon, the vertical scale will zoom to encompass all the previous since eChart was connected to the Echotrac. If "Zoom to current chart width" is selected and the Reset Zoom icon is clicked, the vertical scale will change to the scale width set by the Echotrac. "Auto Zoom Disabled" de-activates the Reset Zoom icon.

3.2.5.7.4 Lock views together when zooming and panning

This check box will lock all the displays to zoom and pan together.

3.3 View

Selects which views are turned on.

3.3.1 Channel 1

Normally the high frequency channel in an Echotrac.

3.3.2 Channel 2

Normally the low frequency channel in an Echotrac

3.3.3 Channel 3

The only Echotrac that supports three channels is the Echotrac CV3. In most cases, the third channel is a second high frequency channel or a side scan channel.

3.3.4 Combined View

Turns on the combined view window. Go to Settings->Display to select which channels to display on this window.

3.3.5 Tile Horizontally

Tiles the active windows horizontally.

3.3.6 Tile Vertically

Tiles the active windows vertically.

3.3.7 Device Control Only

If Device Control Only is checked, eChart will only display the menu along with the depth and gain adjustment displays. The chart windows will be eliminated.

3.4 Help

3.4.1 About…

The About menu lists information about Odom Hydrographic Systems, Inc. and eChart version.

4 FEATURES

This section covers some of the features and helpful control of eChart.

4.1 Zooming

To zoom in or out of the data in one of the channel windows, click on the window to make it active, then either roll the mouse button or use the + and – keys to zoom. If the check box in Settings->Display->Preferences->Lock view together is checked all the windows will zoom together. If the operator clicks on a channel window to pan backward in time, eChart will stop displaying real time data. However, it will continue saving incoming data. To start displaying real time data again, either click on the reset zoom icon on the tool bar or click on the lower right had arrow in the channel window.

STANDARD OPERATING PROCEDURES FOR UNDERWATER DIGITAL GEOPHYSICAL MAPPING

Underwater DGM Survey at Area UXO-0003
Naval Weapons Station Yorktown
Yorktown, Virginia

Contract Task Order: WE03

9675 Summit Place
Chaska, MN 55318
Tel: 952-556-1118 • Fax: 952-556-1119
Email: info@3dgeophysics.com

October 30, 2013

TABLE OF CONTENTS

1. PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide specific procedures for data collection, processing and equipment for the underwater geophysical investigations at Area UXO-0003, Naval Weapons Station Yorktown (WPNSTA Yorktown), Yorktown, Virginia (the "site").

2. EQUIPMENT AND THEORY

This SOP is applicable for the Geonics, Ltd. EM61-Flex3 time domain metal detector, operated using the 3Dgeophysics (3Dg) Underwater UXO Towed Array (UUTA), Trimble 5700 Real Time Kinematic (RTK) Global Positioning System (GPS), and a Trimble AgGPS FmX integrated navigation system.

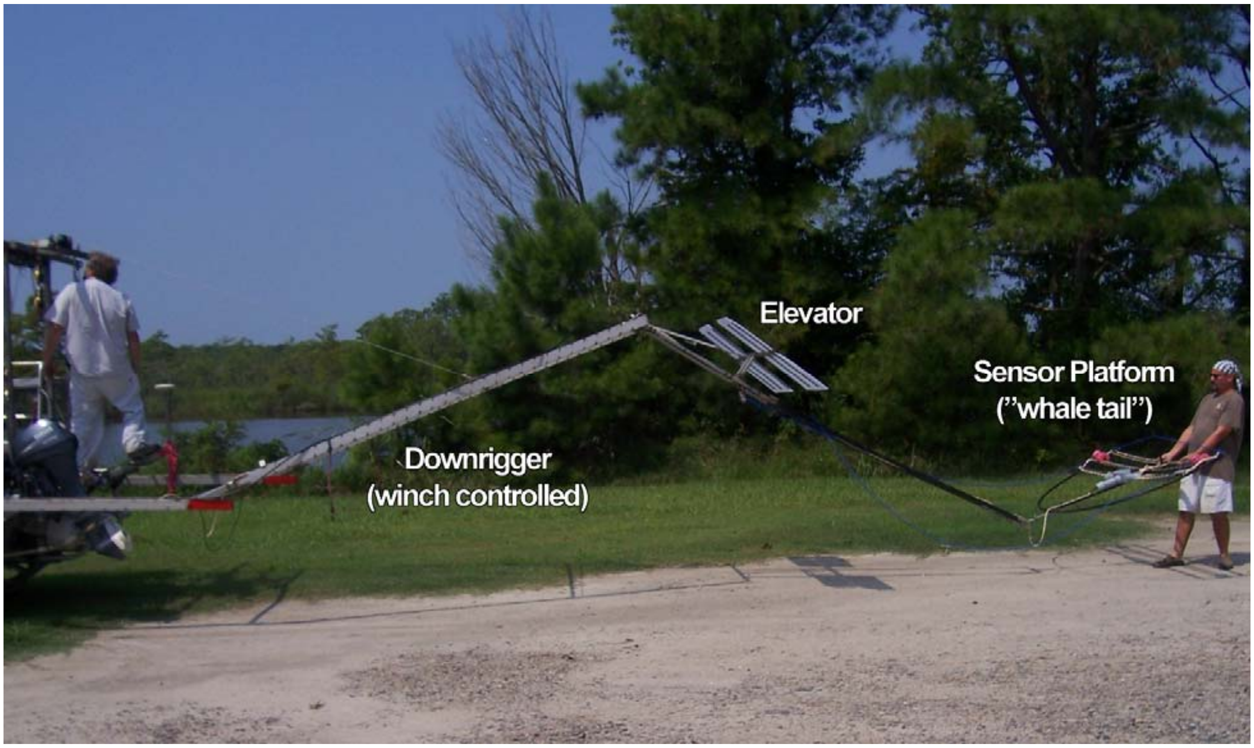
The EM61-Flex3 (see manufacturer operating notes in **Appendix A**) is a high-resolution time-domain electromagnetic instrument designed to detect, with high spatial resolution, shallow ferrous and non-ferrous metallic objects. The EM61-Flex3 system is based on the standard Geonics EM61-MK2 metal detector. The EM61-Flex3 consists of two air-cored receiver coils, a grand air-cored transmitter coil, a digital data recorder, batteries and processing electronics. The 1.0 x 0.5 meter receiver coil pairs are arranged side by side and are encompassed by the transmitter coil. The EM61-Flex3 uses a transmitter repetition rate of 140 Hertz (Hz) and a 24-volt transmitter pulser; both specifications are doubled in comparison to the standard EM61-MK2. The EM61-Flex3 transmitter generates a pulsed primary magnetic field, which then induces eddy currents in nearby metallic objects. Each of the two spatially separated receiver coils measures these eddy currents. The EM61-Flex3 offers the ability measure the eddy currents at two operator selected time gates (firmware). The "early" time gate provides enhanced detection of smaller metallic objects. The "late" time gate is analogous to the 3rd time gate from the standard EM61-MK2. Secondary voltages induced in both coils are measured in millivolts (mV). Data is collected using the MLFXmarine acquisition program (Geomar Software, Inc.) and temporarily stored in a Panasonic ToughBook PC.

The Electromagnetic (EM) system will be deployed using a UUTA ("Utah") developed by 3Dgeophysics (Chaska, MN). The UUTA includes an EM coil support platform (whale tail) and a rigid down-rigging system. The downrigger is equipped with a control surface (hydrofoil or "elevator") and an electric winch system that allows the system operator to control the height of the coil above the river bottom during data acquisition. Several sensors are integrated with the UUTA to provide position control of the Flex3 coil platform. A pressure transducer on the platform measures the accurate depth of the receiver coils. An inclinometer measures the exact angle of the downrigger and is used to determine horizontal offset of the coil platform from the boat. A bow-mounted side scan sonar and bottom finder are used to map the river bottom depth and image potential bottom obstructions during the survey.

The UUTA uses two RTK receivers to accurately measure the exact position and heading of the boat. The rigid downrigger is designed to keep the sensor platform inline with the keel of the boat and the two RTK GPS receivers so that accurate geolocation of the platform can be achieved. The Trimble 5700 GPS is a 24-channel dual frequency RTK receiver that uses both L1 and L2 satellites. This system operates with a base and rover units; the base sends corrections to the rovers via radio link, thus maintaining a 3cm horizontal accuracy and a 5cm vertical accuracy. For configuration with the EM61-Flex3, the rovers are set to output a GGA National Marine Electronics Association (NMEA) string at 1 Hz. The MLFXMarine program captures the GPS, pressure transducer, inclinometer, and sonar bottom depth data and performs the position calculation of the sensor platform. The sonar transducer is mounted on the bow of the boat providing the system operator advance warning of water bottom changes and allowing time to use the elevator and winch systems to adjust and maintain the sensor height above bottom. When boat speed and elevator angle remain constant the depth of the sensor platform does not change.

Shown below are several photographs of the UUTA deployed on a 22-ft ThunderJet jet boat. Several of the important subsystems have been labeled in the photographs. When fully loaded the boat drafts less than 2 feet in the water. The survey boat is equipped with a 6-liter V8 engine with a high-output alternator and electronic power bus, sufficient to drive the survey operation continuously without the need to charge batteries.

UUTA in travel mode deployed on 22-ft ThunderJet boat



UUTA downrigger system and sensor platform

UUTA control systems and data displays

3. INSTRUMENT STANDARDIZATION

All instruments and sensors will be assembled as specified in their specific User Manuals. Additionally, each instrument will be field tested daily to ensure that the instrument is operating properly (explained in Section 6).

4. SIDE SCAN SONAR DATA ACQUSITION

Prior to the EM data collection a Side Scan Sonar (SSS) and Bathymetry (Bathy) surveys will be performed throughout the defined survey area. The survey area is further described in Section 5 below. The purpose of the SSS and Bathy surveys is to identify any bottom obstructions and inaccessible areas in the York River that may impede or pose a hazard to the UUTA systems and sensor platform. SSS and Bathy survey parameters are described in more detail under separate cover ("Standard Operating Procedures for Side-Scan Sonar and Bathymetry Mapping").

After the SSS and Bathy surveys are performed the field crew will demobilize from the site and the data will be analyzed. Identified bottom obstructions will be catalogued in a spreadsheet that provides geographic coordinates for each potential obstruction. A GIS shapefile will be produced from the list of obstructions and uploaded into the UUTA navigation system prior to EM data acquisition. The AgFMX navigation software provides a visual and audio warning of all navigation hazards input in its system during survey operations.

5. EM DATA ACQUISITION

Data will be collected within an approximate 18 acre area of the site that encompasses the former Pier R-1 and the R-2 structure (see attached Figure). Currently, no remnants from Pier R-1 are visible; however, pilings may remain below the water level. The R-2 structure is a former small boat landing associated with the Pier. The focus of the DGM activities will be the area extending approximately 250 feet to all sides of the former Pier R-1 berthing area and the 100 foot offset area surrounding Structure R-2 (as shown in the figure). All accessible areas will be surveyed with nominally 100% coverage (allowing for gaps due to obstacle avoidance and limitations due deployment considerations). The side-scan sonar and bathymetry data will be used to identify and avoid inaccessible areas.

The boat will be operated at an average velocity of 2 to 4 miles per hour (MPH). Data will be recorded automatically along each survey line using up to 18 readings/second for each receiver coil. In addition to the EM data, the output of two RTK GPS receivers, one pressure transducer, one boom angle sensor (inclinometer) and one bottom finder transducer are logged to the hard drive by the acquisition software. Data will not be collected in heavily vegetated areas that prevent boat propulsion, or in areas with significant bottom obstructions that prevent safe operation of the equipment. Data will be collected in a minimum water depth of 3 ft to prevent the boat or sensor platform from touching the bottom. All EM data will be collected within 5 ft of the river bottom except when avoiding bottom obstructions. Grid lines will be spaced 1.25 meters apart. Grid lines will be collected using a generally systematic progression in which lines approximately separated by a distance equal to the turning radius of the boat will be collected sequentially. The actual grid line collection sequence will be affected by wind direction and strength, sea-state and tidal conditions. The proposed grid lines will be straight line segments parallel to the long axis of the defined study area (see attached figure).

5.1 NAVIGATION

Navigation is facilitated by the Trimble AgGPS FmX integrated navigation system and the RTK GPS. A base station is setup on a terrestrial control point and differential GPS corrections are sent via radio link to the rover receivers.

The FmX display allows the creation of virtual survey lines based on an operator-defined lines ("AB lines"). The AB lines are set by placing two points in the field or by importing a Geographic Information System (GIS) .shp file. Once a line has been established, the FmX processor can calculate a virtual grid using an operator supplied line spacing. The FmX display also provides a light bar display to assist the boat operator in guiding the boat along the virtual survey lines. The FmX provides a swath coverage display that shows the boat operator the current survey line and previous lines on which data have already been collected.

5.2 START-UP PROCEDURES

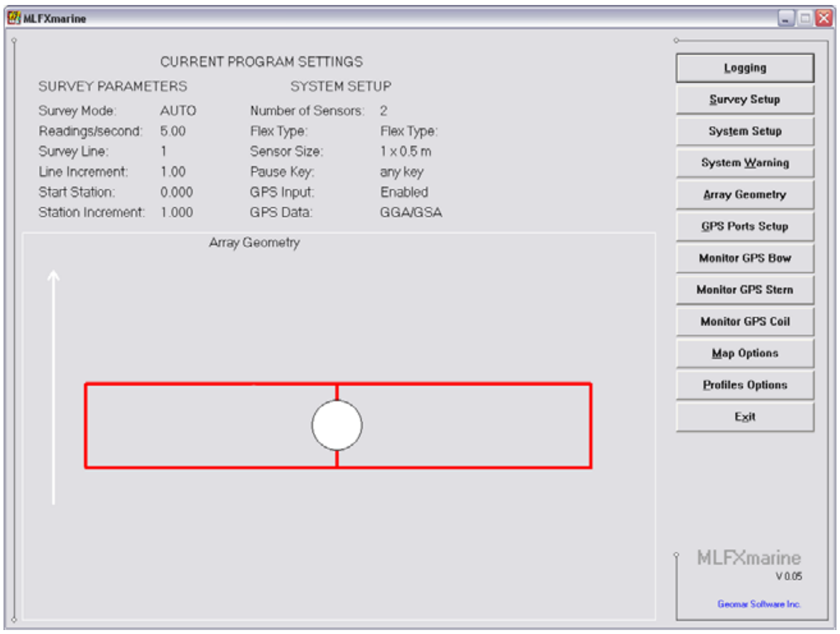
The following steps describe the daily startup procedures prior to data collection:

1. Setup GPS base station
2. Prepare boat (on trailer)
   - Remove rigging safety chains and straps
   - Install drain plugs
   - Engage battery systems
   - Visually inspect all mechanical systems for defects; repair/replace if necessary
   - Inventory boat safety equipment (Personal Flotation Devices [PFDs], fire extinguisher, first aid kit)
   - Turn on all electrical systems
3. Perform land-based system Quality Assurance/Quality Control (QA/QC) tests (Section 7)
4. Launch boat
5. Prepare boat (in water)
   - Engage primary motor
   - Start and test trolling motor
   - Test all boat electrical systems
   - Test UUTA winch and elevator operation
   - Deploy sonar transducer
6. Perform water-based system Quality Assurance/Quality Control (QA/QC) tests (Section 7)

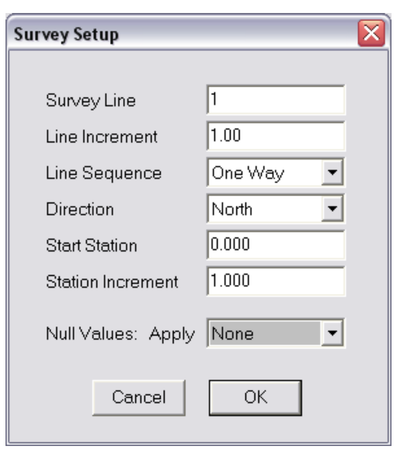
5.3 DATA COLLECTION STEPS

Below are the steps to begin surveying with the EM61-Flex3 and UUTA system:

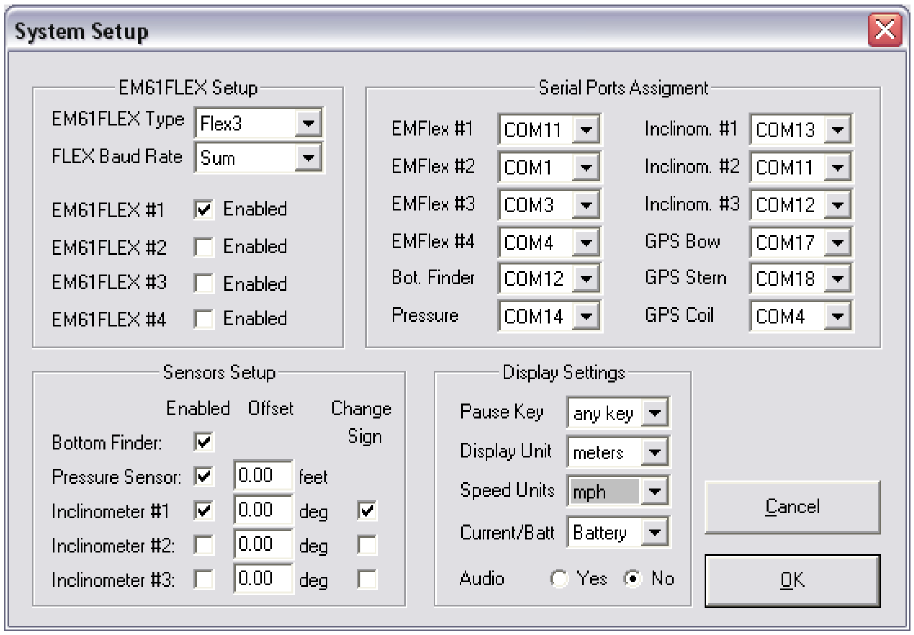
- Turn on instrument and cooling fans by engaging the toggle switches.
- Allow the system to warm up for at least 15 minutes
- Prepare data acquisition field log
- Turn on the Toughbook PC and open MLFXMarine program. The screen below will be displayed.



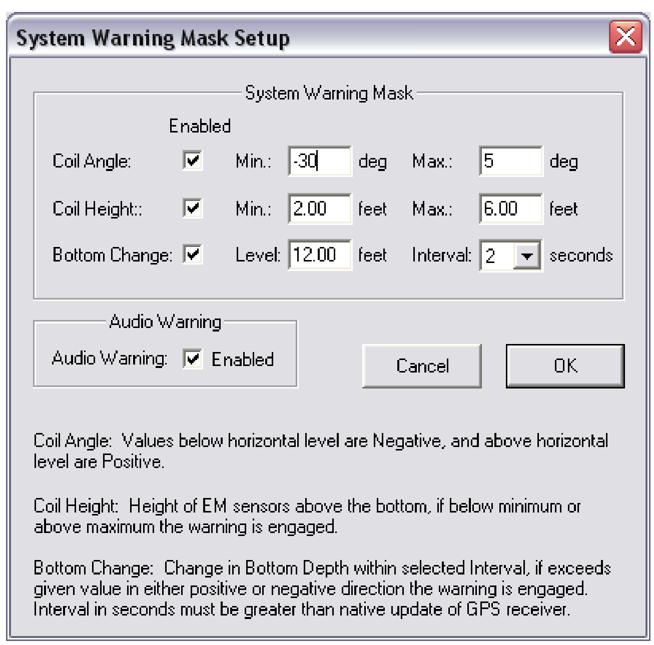
- Click on "Survey Setup" and specify the below options. The important option is 'Survey Line'. Survey Line will initially be set to 1 and then will be changed to the current grid line as data collection progresses. Instrument nulling will be preformed periodically throughout the survey.



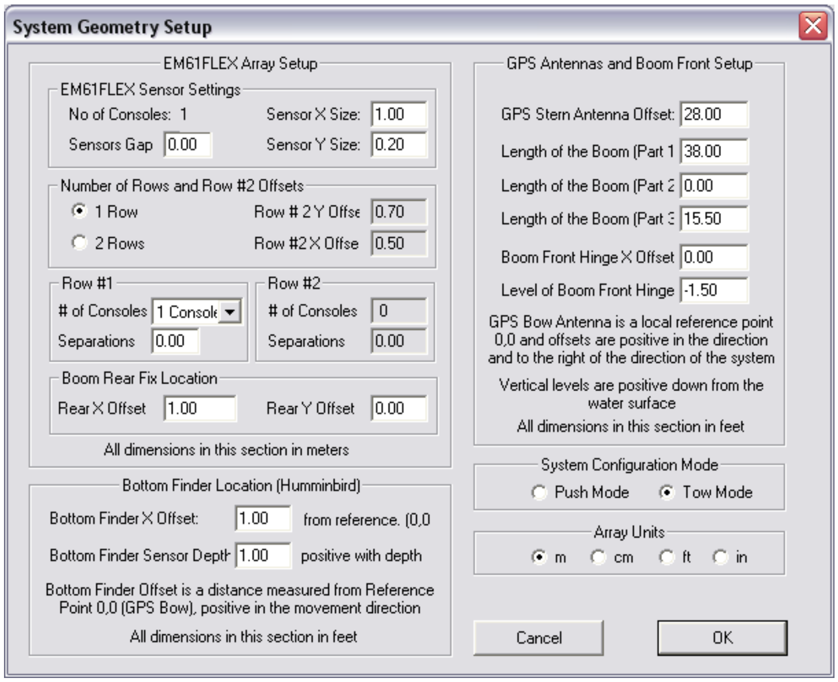
- Click on "System Setup" and specify the below options. These settings will remain the same throughout the project.



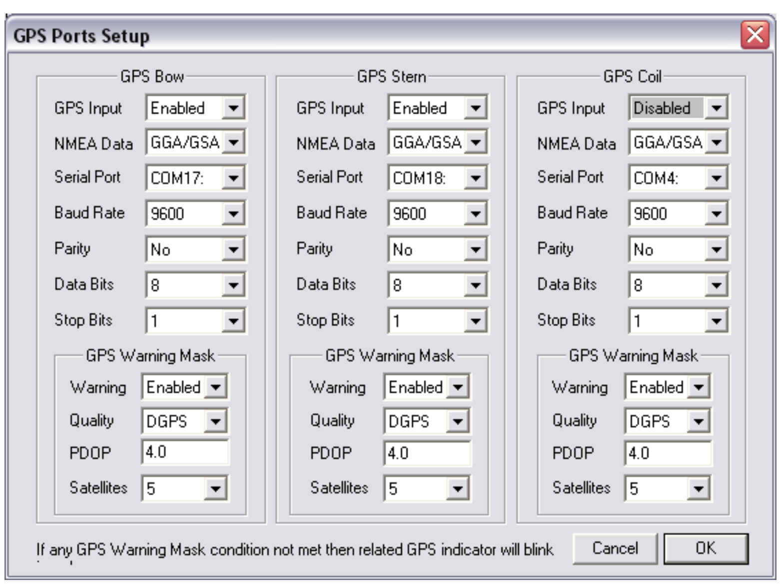
- Click on "System Warning" and specify the below options. These settings will remain the same throughout the project.



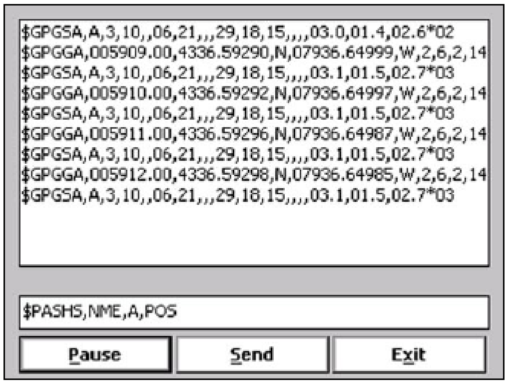
- Click on “Array Geometry” and specify the below options. These settings will remain the same throughout the project. It is critical that all values in this dialogue box are correctly entered. The position calculation of the array platform determined by the values entered here.

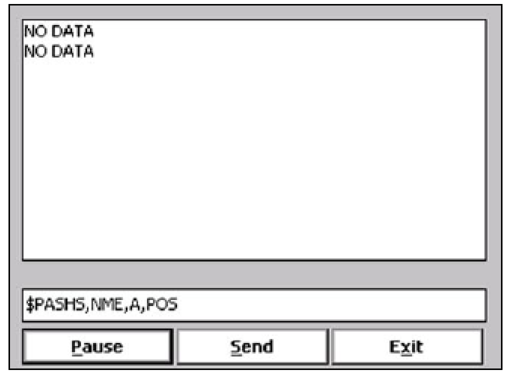


- Click on “GPS Ports Setup” and specify the below options. When using GPS the below settings will be used. GPS Bow and GPS Stern are “enabled”; GPS Coil is disabled.

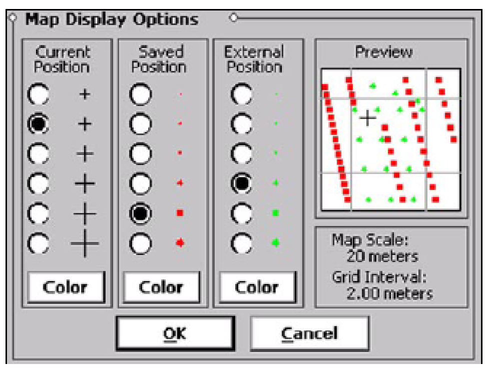


- Click on "Monitor GPS Bow" and "Monitor GPS Stern" in succession; the below window will open. If the NMEA strings are being output correctly, the screen will appear like the one on the left. If there is a problem with the baud rate, "No Data" will appear once a second. If there is nothing coming through "No Data" will flash once every 6 seconds.

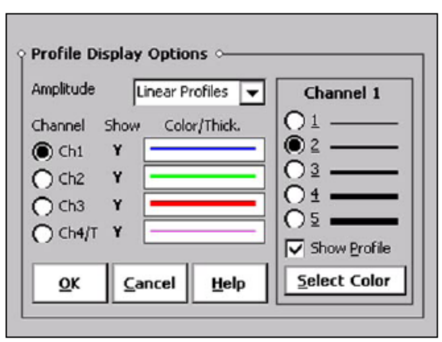


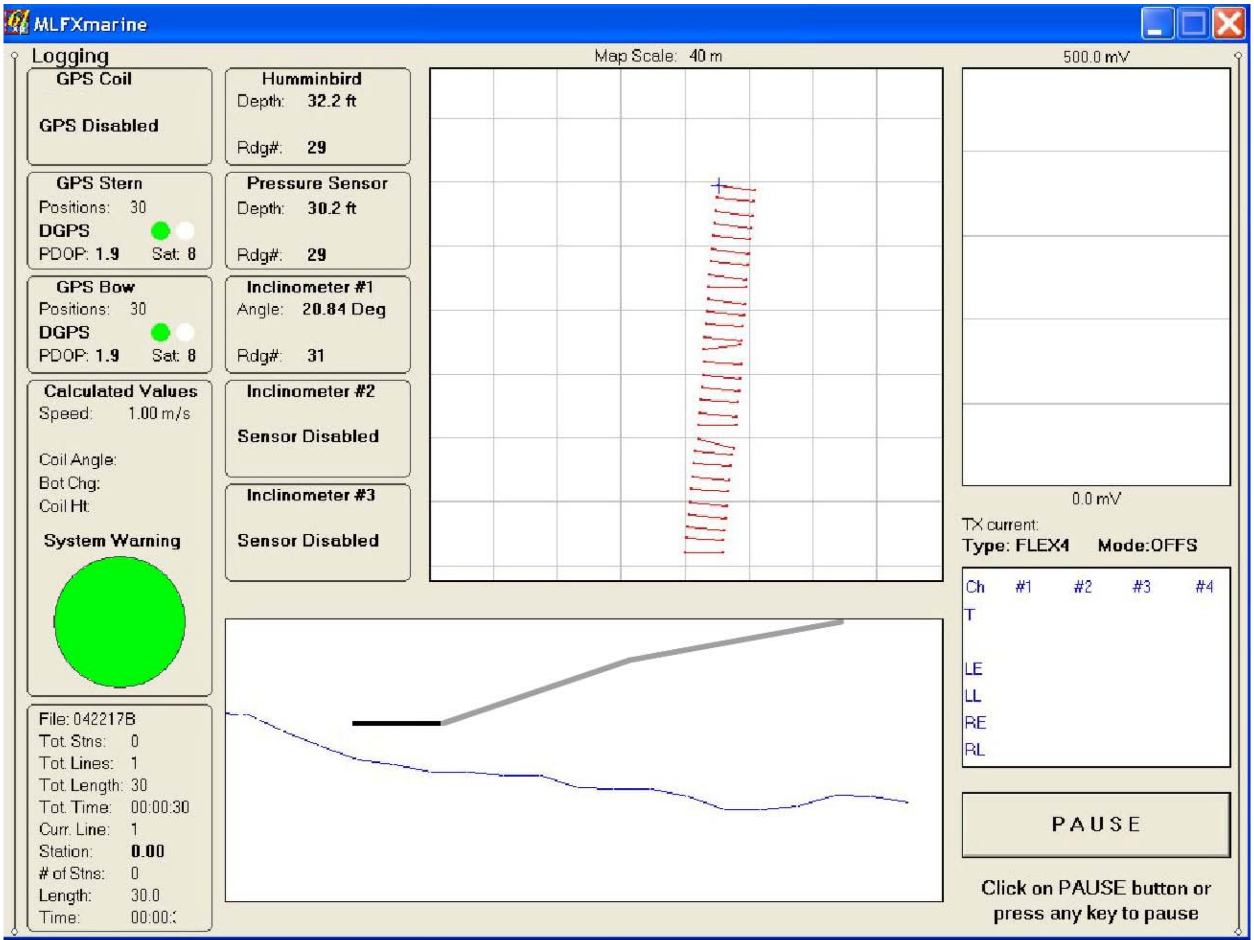


- Click on "Map Options" and specify the below options. These are more operator preferences for aesthetics then for performance of the software.



- Click on "Profile Options" and specify the below options. These are more operator preferences for aesthetics then for performance of the software.





- Once all the parameters are set click on the "Logging". The screen above will be displayed. Click on *File* and name your file and save it. Line up on the current survey line according to the AgGPS FmX display and select *Go*. The software will start logging the EM readings and a large *Pause* button will appear on the screen. At the end of the line, tap the *Pause* button or hit enter on the keypad.

  On the above screen, the EM data, positional sensor data, the data coverage and platform location map, and a scrolling bottom depth profile are monitored. Operator defined system warnings, including sensor platform angle, change in bottom depth, and coil height above bottom depth, are also monitored.

- At the end of the file, the *Exit* button is selected. The file automatically saves at the end of every line.

- During data collection the system operator will maintain a detailed field log. The log will be used to document all data collection activities. A sample field log is provided in **Appendix B**.

6. DATA STORAGE AND PRELIMINARY PROCESSING

The EM61-Flex3 array data are temporarily stored on a Toughbook PC during data collection. At the end of each field day, the data are transferred to a PC workstation for further on-site processing using Geosoft Oasis Montaj software.

Initial data processing (pre-processing) will be performed by the field team and includes reviewing data for integrity and repeatability. The following data pre-processing steps will be performed on the collected underwater DGM and QC/QA data:

1. Convert binary field files
2. Apply appropriate data channel template
3. Perform Georeferencing (UTM meters, NAD83 datum)
4. Output Geosoft XYZ format

7. QUALITY CONTROL - INSTRUMENTATION

The Industry Standard Object (ISO) that will be used for Static Test:

- Shape: Straight Nipple
- Schedule: 40
- Pipe Size: 1in (1.315in OD)
- Length: 4in
- Finish: Black Welded Steel

The following quality control (QC) procedures are performed and documented during the data collection process and reviewed by a qualified geophysicist on a daily basis. Depending on the logistics of the project site these tests may be performed on land prior to boat launch or in water after boat launch.

1. Equipment Warm-up: Minimum 15 minutes
2. Personnel Test: Will not be preformed. The sensor platform is a rigid structure that is remains at a constant distance from the tow vessel. Boat personnel do not operate within the influence of the sensor platform.
3. Cable Shake Test: Will not be preformed. All the cables are securely fastened and cannot be shaken without shaking the entire system.
4. Record Sensor Positions: Accuracy of the GPS will be demonstrated by operating the two GPS antennas over a known control point. The accuracy of the data positioning will be assessed by calculating the difference between a known location over which the GPS antennas are held and the displayed positions. The sensor position test will be conducted at the beginning of the survey operation for each workday. Maximum position error for successful completion of the test is 10 cm.

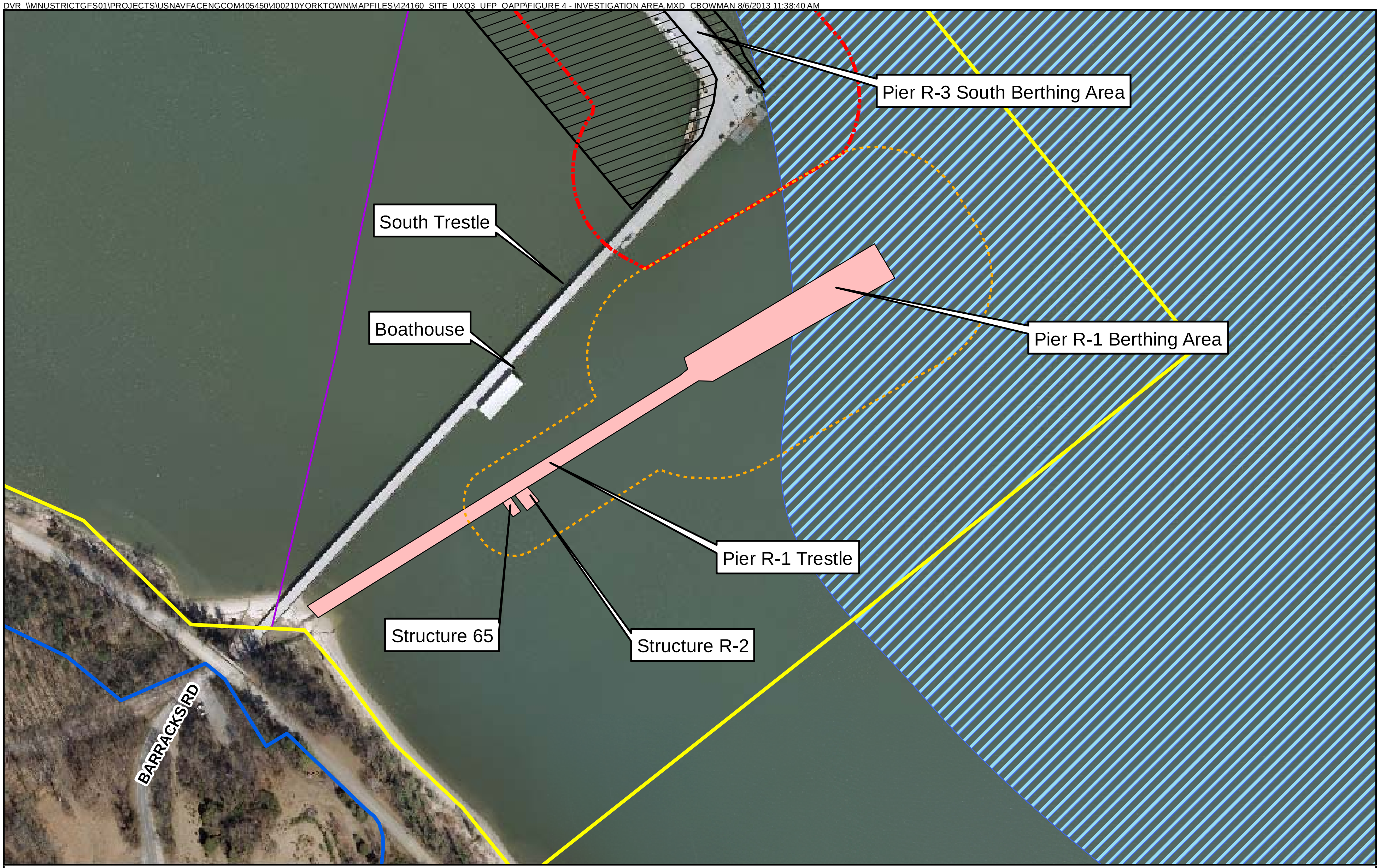
5. Static Background / Standard Response ("spike") Test: A test jig will be manufactured using an ISO. The test jig will attach to the array platform and provide a standard for daily tests. The standard response test will be performed on land prior to and after data collection each day. The test will be performed by partially extending the downrigger structure to move the coil set beyond the magnetic influence of the boat. The coil structure will be positioned parallel to the ground surface using a non-conductive support structure in an area free of metallic contacts. The test will consist of collecting data for a 3-minute period. During this time, the instrument will be held in a fixed position for 1 minute without the test jig (background test), for 1 minute with the test jig in place, and finally for another minute without the test jig. The purpose of the static test is to determine whether unusual levels of instrument or ambient noise exist. To proceed with data collection the measured magnetic response for the test jig is required to be within 20% of the first project day's measured response.
6. Pressure Sensor Test: Prior to data collection the accuracy of the pressure sensor (i.e. EM sensor platform depth) will be tested. Two data points will be recorded during the test to verify the functionality of the pressure sensor. The test will be performed on land with the boat held in a fixed position. The pressure sensor's depth results are required to be within 6 inches of the known depth.

7. Repeat data: Because of the difficulty and expense of setting an IVS with terrestrial specifications in a marine environment, coupled with the difficulty of conducting an IVS test in air with a trailered boat, the repeat data test will provide daily evidence of system response and positioning repeatability. Daily a single line of data will be collected over an object. The object will be a known object (10 lb dumbbell weight) that will be seeded near the survey area. There are two objectives for this test. First, to demonstrate positioning repeatability that meets the DQO of 2-meter accuracy. Second, to demonstrate repeatability of the response that meets the DQO of general repeatability.

Positive completion of the daily tests provides assurance that the MLFXMarine system software will accurately calculate the position of the sensor platform during data collection.

FIGURES

DVR \\MNUSTRICTGFS01\PROJECTS\USNAVFACENGCOM405450\400210YORKTOWN\MAPFILES\424160_SITE_UXO3_UFP_QAPP\FIGURE 4 - INVESTIGATION AREA.MXD CBOWMAN 8/6/2013 11:38:40 AM



Legend

- Approximate SI Investigation Area
- Area Recommended for SI once munitions loading operations have ceased
- Former Dredged Area
- Yorktown Base Boundary
- UXO 3 Boundary
- Location of former pier known as Pier R-1 (submerged pilings remain)
- York River Main Channel
- Sewer Utility (Submerged)

Note:
The investigation area boundary may be adjusted in the field based upon site conditions encountered during the investigation.

N W E S

0 175 350 Feet

Imagery: 2010

Figure 3
Investigation Area
UXO 3 SI MEC-QAPP
WPNSTA Yorktown
Yorktown, Virginia

CH2MHILL.

Legend

- Proposed DGM Line Path (1.25m)
- Area Recommend for SI
- Former Structures
- Former Pier R-1 Footprint
- UXO-3 Boundary

N
W
E
S

60 30 0 60 120 180 240
Feet

3Dgeophysics.com

NAeVA GEOPHYSICS INC.
THE LEADER IN SUBSURFACE DETECTION
Subsurface Geophysical Surveys

Proposed DGM Line Paths
Former Pier R-1 - UXO-03
WPNSTA Yorktown
Yorktown, Virginia

APPENDIX A

EM61-Flex3 Operating Notes

GEONICS LIMITED
1745 Meyerside Dr. Unit 8 Mississauga, Ontario Canada L5T 1C6

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Fax: (905) 670-9204
E-mail: geonics@geonics.com
URL: http://www.geonics.com

EM61-FLEX 3
HIGH SENSITIVITY WIDE SWATH METAL DETECTOR

OPERATING NOTES

GEONICS LIMITED

LEADERS IN ELECTROMAGNETICS

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August 2009

EM61-FLEX 3
HIGH SENSITIVITY WIDE SWATH METAL DETECTOR

TABLE OF CONTENTS

INTRODUCTION

Geonics EM61-FLEX 3 is a high sensitivity, wide swath, large sensing depth electromagnetic detector for detection of ferrous and non ferrous metallic objects such as unexploded ordinance (UXO) and improvised explosive devices (IED). The unique sensor configuration allows for detection of small and deep targets in the presence of large ambient electromagnetic noise.

A. EM61-FLEX 3 SYSTEM

1. SYSTEM DESCRIPTION

The EM61-FLEX 3 consists of four main parts: (1) sensor assembly (sensor head), (2) main console, (3) data acquisition field computer with associated software, and (4) power supply. Figure 1 depicts the system main components.

The sensor assembly consists of transmitter coil, two pairs of receiver coils and interconnecting box. The transmitter coil is a multi-turn loop connected to the pulse generator inside the main console. Two pairs of receiver coils (left and right pair) are situated inside the transmitter loop for left and right detection footprint.

Under control of field computer two coils in each of the pair (L1, L2 and R1, R2) can be connected either to measure difference in signal between two coils, or sum, which will depend on the application.

The main console contains electronics for transmitter pulse generation, signal processing, timing control and communication with data acquisition computer.

The difference mode of operation (two coils in the left and right pair connected in opposition) is used to detect targets located on or near surface in presence of high ambient electromagnetic noise. The sum mode of operation (two coils in left and right pair connected to add signal) is used for detection of larger targets at depth in relatively electromagnetically quiet environment.

For each mode of operation, difference or sum, each pair of sensor in conjunction with main console will produce two time gates: early and late.

Ratio between signal from early and late gate can be used as a rough indicator of target size. In general, the ratio between early and late gate response is larger for smaller targets than for bigger targets.

In addition, the late gate response will be less affected by the noise and effects of ambient temperature change – important fact when looking for a deep target in the sum mode of operation.

Nominal instrument operation power supply is 24 V. The instrument will operate with lower power supply voltage, down to 12 V.

2. EM61-FLEX 3 CALIBRATION DEVICE (QC COIL)

2.1 Introduction

Calibration device, QC Coil, can be used to check the gain calibration of the EM61-FLEX 3. The device can be used as an "absolute" calibration, so that the different EM61 units, if calibrated with the QC coil, would under the same conditions give the same results over a particular target.

2.2 Description

The EM61-FLEX 3 calibration device is used to check the operation of the complete EM61-FLEX 3 system, including transmitter and all four receiver coils, as well as the signal processing console.

The device should be positioned when checking calibration as per Figure 5.

2.3 Calibration Procedure

The calibration check procedure is as follows:

The instrument under test should be placed outdoors as for normal operation far from any larger metallic object. After the instrument nulling, QC coil should be set as per Figure 1, all four gates responses recorded and compared with value in Table I. We suggest that ± 10% deviation from the standard value is considered acceptable.

2.4 Measure response for both modes: difference and sum.

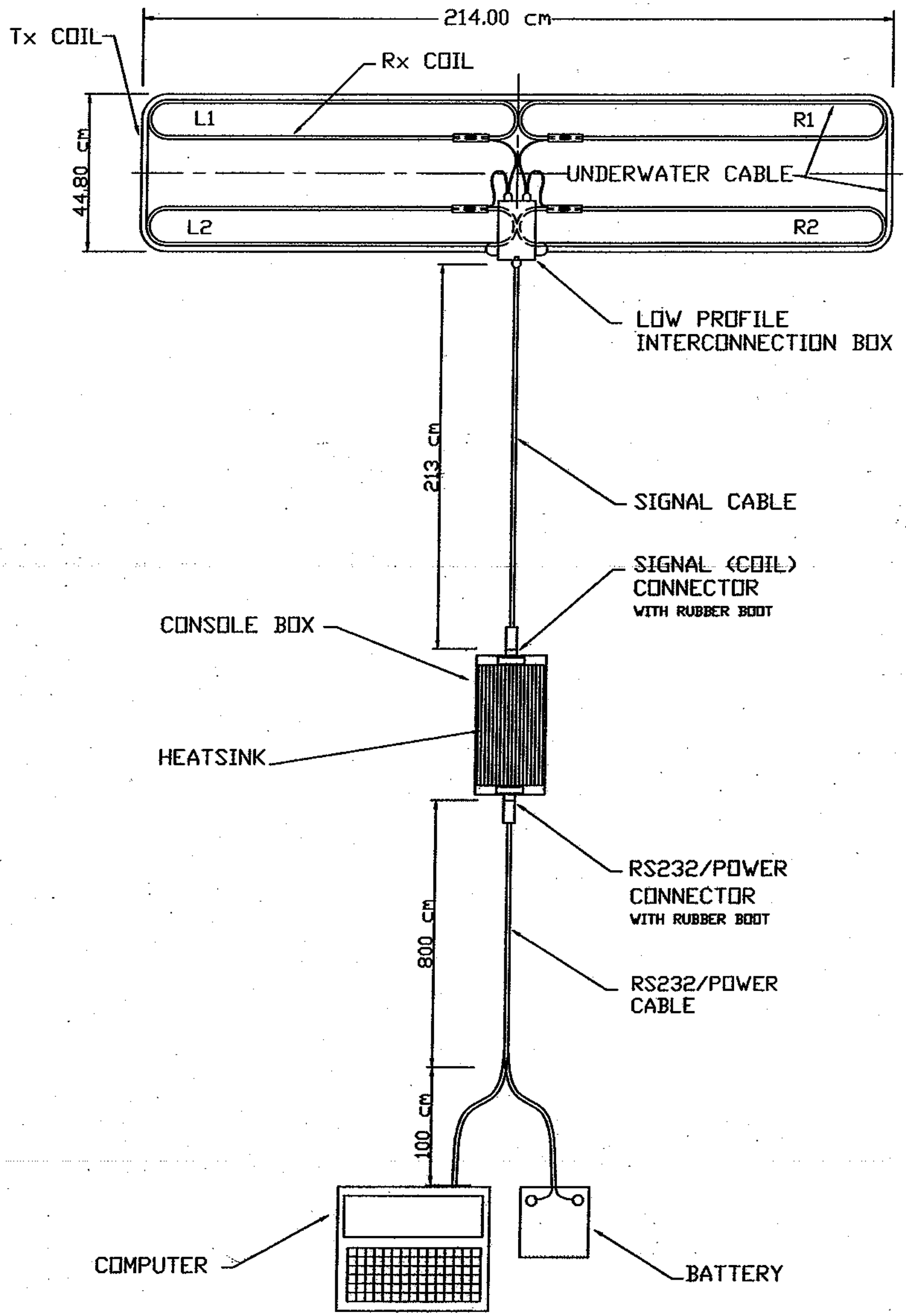
Table I of the Standard Value

Difference Mode	**Sum Mode**
$L_E < \pm 100$ mV	$L_E = 3750$ mV
$L_L < \pm 70$ mV	$L_L = 2450$ mV
$R_E < \pm 100$ mV	$R_E = 3750$ mV
$R_L < \pm 70$ mV	$R_L = 2450$ mV

3. EM61-FLEX 3 Technical Specifications

Measured Quantity	:	Four channels of secondary response in mV
EM Source	:	Air-cored coil, 2.14 x 0.45 m size
Current Waveform	:	Unipolar rectangular current with 50% duty cycle
EM Sensors	:	Left coil pair: Two air-cored coil, 1.05 x 0.1m each Right coil pair: Two air-cored coil, 1.05 x 0.1 m each
Maximum Output	:	25 000 mV
Dynamic Range	:	18 bits
Time Gates	:	Two gates for left and right coil pair each, centered at 196 and 446 μs after T/O time.
System Controller	:	Field computer
Acquisition Speed	:	Up to 16 records per second (4 time gates per record)
Calibration Check	:	QC Coil
Power Supply	:	24 V / 4.5 A (13 A peak)
Operating Temperature	:	-30°C to +51°C
Storage Temperature	:	-40°C to +71°C
Operating Weight	:	kg (W) x (L) x (H) cm
Shipping Weight & Dimensions	:	kg (W) x (L) x (H) cm (Box 1 of 1)

EM61 - FLEX 3
SYSTEM BLOCK DIAGRAM



JULY 29, 2009

FIG 1

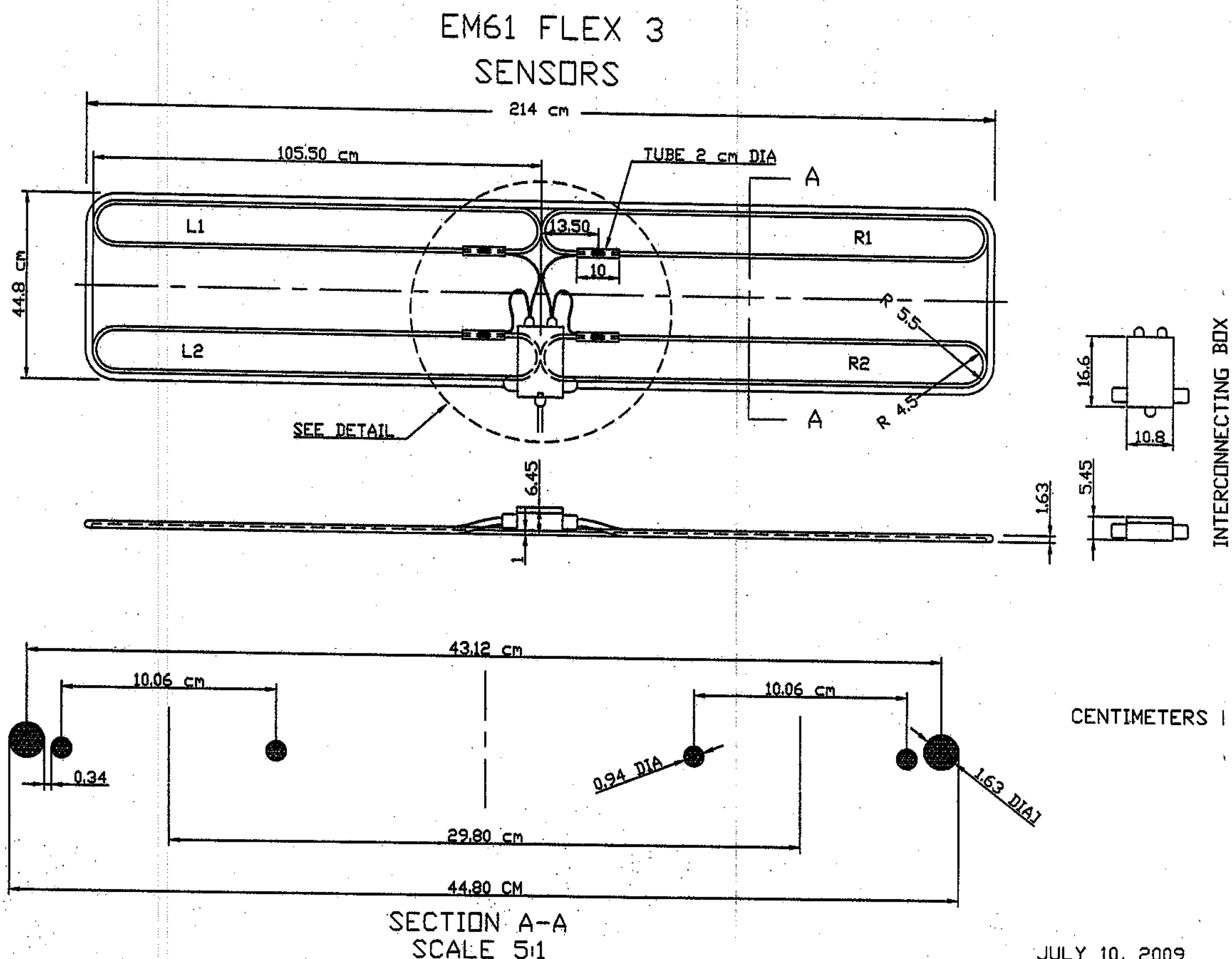
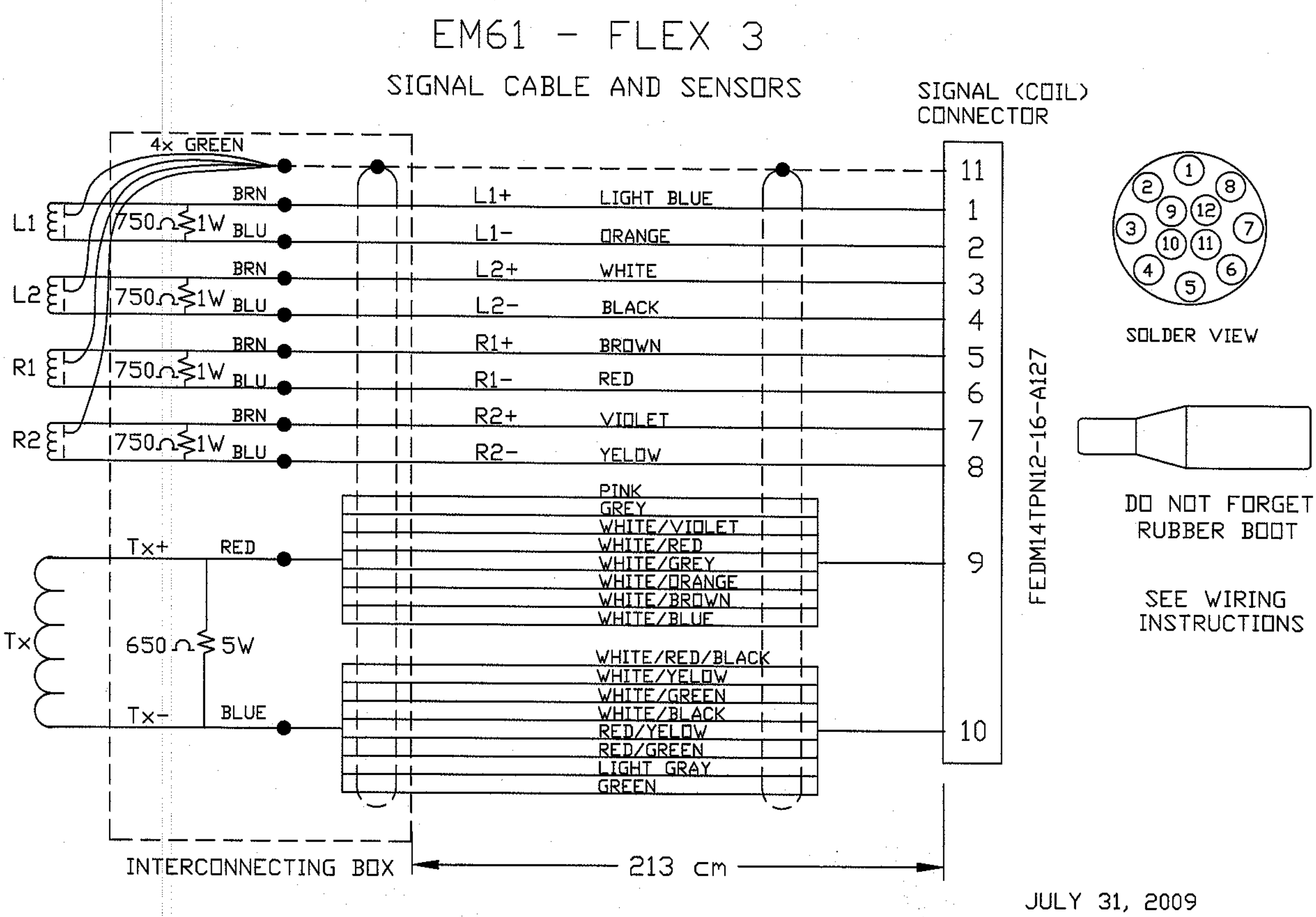

EM61 FLEX 3
SENSORS
214 cm
105.50 cm
TUBE 2 cm DIA
A
L1
13.50
R1
10
44.8 cm
R 5.5
L2
R2
R 4.5
SEE DETAIL
16.6
10.8
INTERCONNECTING BOX
6.45
1.63
5.45
1
43.12 cm
10.06 cm
10.06 cm
CENTIMETERS
0.94 DIA
0.34
1.63 DIA
29.80 cm
44.80 CM
SECTION A-A
SCALE 5:1
JULY 10, 2009

FIG 2



EM61 - FLEX 3
SIGNAL CABLE AND SENSORS
SIGNAL (COIL) CONNECTOR
4x GREEN
L1
L2
R1
R2
Tx
BRN
BLU
750Ω 1W
Tx+
RED
Tx-
BLUE
650Ω 5W
L1+
L1-
L2+
L2-
R1+
R1-
R2+
R2-
LIGHT BLUE
ORANGE
WHITE
BLACK
BROWN
RED
VIOLET
YELLOW
PINK
GREY
WHITE/VIOLET
WHITE/RED
WHITE/GREY
WHITE/ORANGE
WHITE/BROWN
WHITE/BLUE
WHITE/RED/BLACK
WHITE/YELLOW
WHITE/GREEN
WHITE/BLACK
RED/YELLOW
RED/GREEN
LIGHT GRAY
GREEN
11
1
2
3
4
5
6
7
8
9
10
FEDM14TPN12-16-A127
SOLDER VIEW
DO NOT FORGET RUBBER BOOT
SEE WIRING INSTRUCTIONS
INTERCONNECTING BOX
213 cm
JULY 31, 2009

FIG 3

EM61 FLEX 3
RS232/POWER CABLE

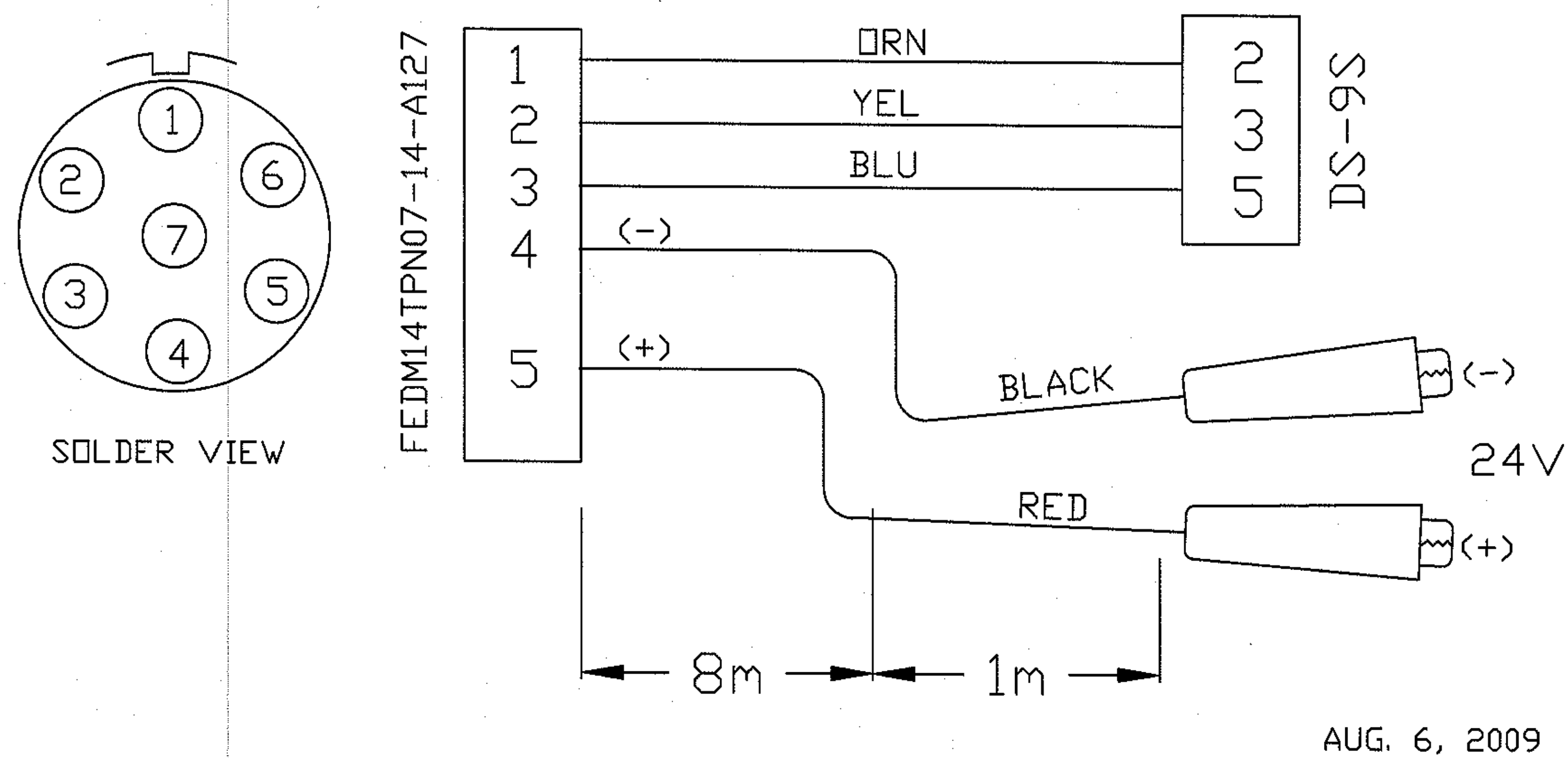


FIG 4

EM61 FLEX 3 QC COIL CALIBRATION SETUP

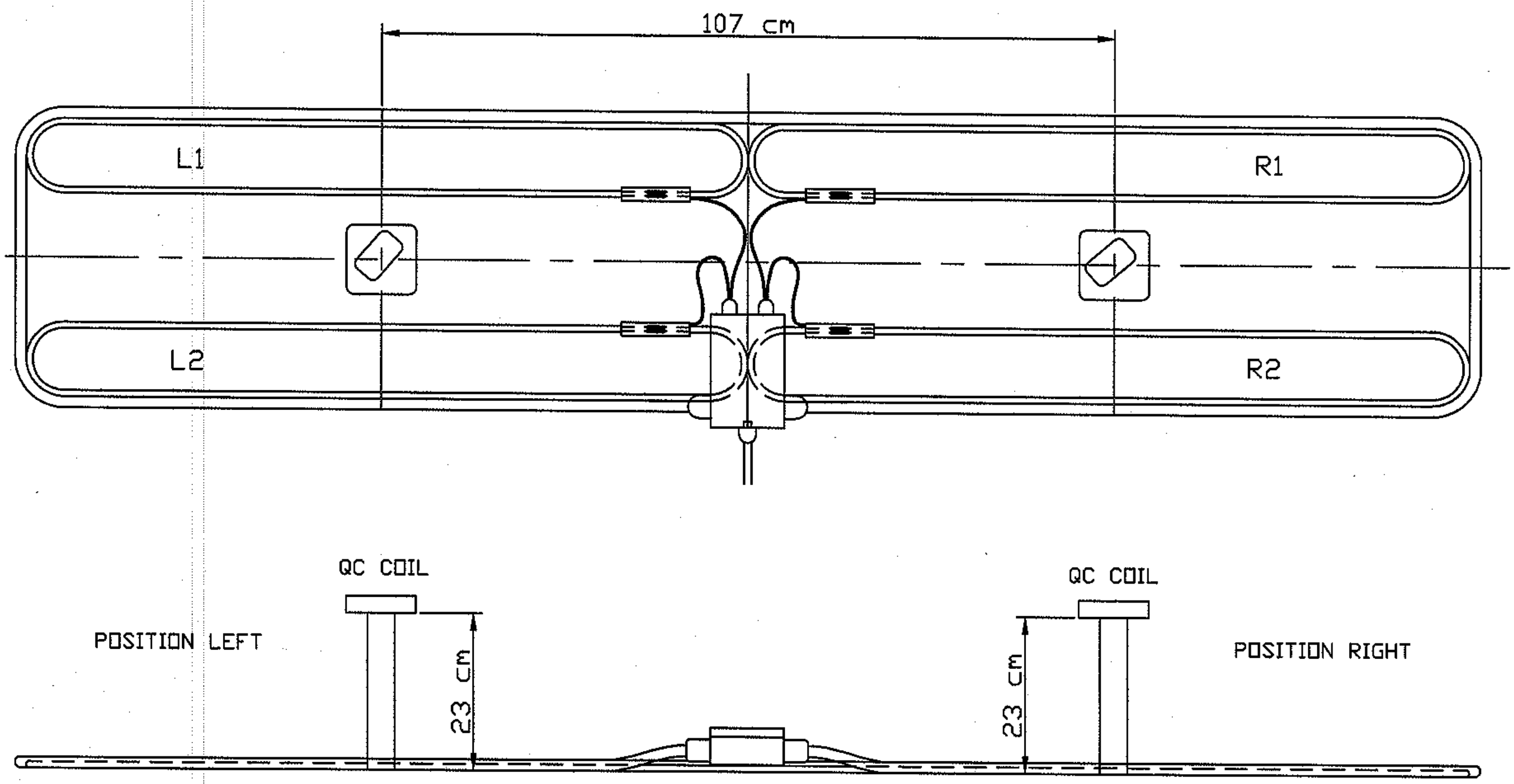


FIG 5

5. COMPUTER INTERFACE FORMAT

EM61FLEX3 INFORMATION

COMPUTER INTERFACE PORT INFORMATION
31 July 2009

PORT AND CABLE PIN ASSIGNMENT

EM61FLEX3 computer COM PORT INTERFACE CABLE functions are summarised as follows:

DS-9 connector	function
5	GROUND
2	RS-232 RXD
3	RS-232 TXD

RS-232 CONFIGURATION

The port is configured as a DCE (Date Communication Equipment). No handshaking is used.

The port is initialised as follows:

Baud rate:	9600
parity:	none
data bits:	8
stop bit:	1

CONTROLLING COMPUTER COMMANDS
(all ASCII code, 30 ms between characters)

COMMAND	COMMAND INTERPRETATION
S	SUM MODE
D	DIFFERENTIAL MODE

EM61FLEX3 RESPONSE MESSAGES

OK	computer command received correctly
ER	receiving error

EM61FLEX3 DATA FORMAT

Each data record consists of 16 bytes detailed below:

Byte 1 (ASCII) start byte
D: Differential modes
S: Summing Mode

Byte 2 (HEX number for ranges. Ranges are the gains of the DC amplifiers.)

HEX	R1	R1A	R2	R2A	R3	R3A	R4	R4A	CH1	CH2	CH3	CH4
0	0	0	0	0	0	0	0	0	1	1	1	1
1	0	0	0	0	0	0	0	1	1	1	1	10
3	0	0	0	0	0	0	1	1	1	1	1	100
4	0	0	0	0	0	1	0	0	1	1	10	1
5	0	0	0	0	0	1	0	1	1	1	10	10
7	0	0	0	0	0	1	1	1	1	1	10	100
C	0	0	0	0	1	1	0	0	1	1	100	1
D	0	0	0	0	1	1	0	1	1	1	100	10
F	0	0	0	0	1	1	1	1	1	1	100	100
10	0	0	0	1	0	0	0	0	1	10	1	1
11	0	0	0	1	0	0	0	1	1	10	1	10
13	0	0	0	1	0	0	1	1	1	10	1	100
14	0	0	0	1	0	1	0	0	1	10	10	1
15	0	0	0	1	0	1	0	1	1	10	10	10
17	0	0	0	1	0	1	1	1	1	10	10	100
1C	0	0	0	1	1	1	0	0	1	10	100	1
1D	0	0	0	1	1	1	0	1	1	10	100	10
1F	0	0	0	1	1	1	1	1	1	10	100	100
30	0	0	1	1	0	0	0	0	1	100	1	1
31	0	0	1	1	0	0	0	1	1	100	1	10
33	0	0	1	1	0	0	1	1	1	100	1	100
34	0	0	1	1	0	1	0	0	1	100	10	1
HEX	R1	R1A	R2	R2A	R3	R3A	R4	R4A	CH1	CH2	CH3	CH4
35	0	0	1	1	0	1	0	1	1	100	10	10
37	0	0	1	1	0	1	1	1	1	100	10	100
3C	0	0	1	1	1	1	0	0	1	100	100	1
3D	0	0	1	1	1	1	0	1	1	100	100	10
3F	0	0	1	1	1	1	1	1	1	100	100	100
40	0	1	0	0	0	0	0	0	10	1	1	1
41	0	1	0	0	0	0	0	1	10	1	1	10
43	0	1	0	0	0	0	1	1	10	1	1	100
44	0	1	0	0	0	1	0	0	10	1	10	1
45	0	1	0	0	0	1	0	1	10	1	10	10
47	0	1	0	0	0	1	1	1	10	1	10	100
4C	0	1	0	0	1	1	0	0	10	1	100	1
4D	0	1	0	0	1	1	0	1	10	1	100	10
4F	0	1	0	0	1	1	1	1	10	1	100	100
50	0	1	0	1	0	0	0	0	10	10	1	1
51	0	1	0	1	0	0	0	1	10	10	1	10
53	0	1	0	1	0	0	1	1	10	10	1	100
54	0	1	0	1	0	1	0	0	10	10	10	1
55	0	1	0	1	0	1	0	1	10	10	10	10
57	0	1	0	1	0	1	1	1	10	10	10	100
5C	0	1	0	1	1	1	0	0	10	10	100	1
5D	0	1	0	1	1	1	0	1	10	10	100	10
5F	0	1	0	1	1	1	1	1	10	10	100	100

70	0	1	1	1	0	0	0	0	10	100	1	1
71	0	1	1	1	0	0	0	1	10	100	1	10
73	0	1	1	1	0	0	1	1	10	100	1	100
74	0	1	1	1	0	1	0	0	10	100	10	1
75	0	1	1	1	0	1	0	1	10	100	10	10
77	0	1	1	1	0	1	1	1	10	100	10	100
7C	0	1	1	1	1	1	0	0	10	100	100	1
7D	0	1	1	1	1	1	0	1	10	100	100	10
7F	0	1	1	1	1	1	1	1	10	100	100	100
C0	1	1	0	0	0	0	0	0	100	1	1	1
C1	1	1	0	0	0	0	0	1	100	1	1	10
C3	1	1	0	0	0	0	1	1	100	1	1	100
C4	1	1	0	0	0	1	0	0	100	1	10	1
C5	1	1	0	0	0	1	0	1	100	1	10	10
C7	1	1	0	0	0	1	1	1	100	1	10	100
CC	1	1	0	0	1	1	0	0	100	1	100	1
CD	1	1	0	0	1	1	0	1	100	1	100	10
CF	1	1	0	0	1	1	1	1	100	1	100	100
D0	1	1	0	1	0	0	0	0	100	10	1	1
D1	1	1	0	1	0	0	0	1	100	10	1	10
D3	1	1	0	1	0	0	1	1	100	10	1	100
D4	1	1	0	1	0	1	0	0	100	10	10	1
D5	1	1	0	1	0	1	0	1	100	10	10	10
D7	1	1	0	1	0	1	1	1	100	10	10	100
DC	1	1	0	1	1	1	0	0	100	10	100	1
DD	1	1	0	1	1	1	0	1	100	10	100	10
HEX	R1	R1A	R2	R2A	R3	R3A	R4	R4A	CH1	CH2	CH3	CH4
DF	1	1	0	1	1	1	1	1	100	10	100	100
F0	1	1	1	1	0	0	0	0	100	100	1	1
F1	1	1	1	1	0	0	0	1	100	100	1	10
F3	1	1	1	1	0	0	1	1	100	100	1	100
F4	1	1	1	1	0	1	0	0	100	100	10	1
F5	1	1	1	1	0	1	0	1	100	100	10	10
F7	1	1	1	1	0	1	1	1	100	100	10	100
FC	1	1	1	1	1	1	0	0	100	100	100	1
FD	1	1	1	1	1	1	0	1	100	100	100	10
FF	1	1	1	1	1	1	1	1	100	100	100	100

Byte 3 Higher byte of the 2's complement Hex number of channel 1.

Byte 4 Lower byte of channel 1.

Byte 5 Higher byte of the 2's complement Hex number of channel 2.

Byte 6 Lower byte of channel 2.

Byte 7 Higher byte of the 2's complement Hex number of channel 3.

Byte 8 Lower byte of channel 3.

Byte 9 Higher byte of the 2's complement Hex number of channel 4.

Byte 10 Lower byte of channel 4.

Byte 11 Higher byte of the 2's complement number of TX current.

Byte 12 Lower byte of the 2's complement number of TX current.

Byte 13 Hex number of battery voltage

Byte 14 7F Stop byte

Byte 15 7F Stop byte

EM61FLEX3 CONVERTING FACTORS

Each EM61FLEX3 unit has four channels. RANGE1, RANGE2, RANGE3 and RANGE4 affect channel 1, channel 2, channel 3 and channel 4 respectively.

RANGEs are determined by the microprocessor in the EM61FLEX3 unit, based on the instantaneous amplitudes of the signals in each channel. RANGEs have also three settings: 1,10 and 100.

GEONICS's convention is that the response is converted to output voltage in mV at the output of each sampling channel by the following:

$$\text{RESPONSE} = \frac{\text{DATA} \times 4.8333}{\text{RANGE}} \quad (\text{mV})$$

RESPONSE is the data on computer

DATA is the data from instrument

RANGE is controlled by the EM61FLEX3 which could be 100,10,1

CH1 (channel 1) = LE (left early channel)

CH2 (channel 2) = LL (left late channel)

CH3 (channel 3) = RE (right early channel)

CH4 (channel 4) = RL (right late channel)

APPENDIX B

Example Field Log

Marine Geophysical Survey – Data Acquisition Log

Date: ____________ **Vessel:** ____________ **Instrument:** ____________ **Page:** ________ of ________

Project: ____________ **Captain:** ____________ **# Sensors:** ____________

Client: ____________ **Observer:** ____________ **Sensor Size:** ____________ **Grid Pattern:** ____________

Location: ____________ **Crew:** ____________ **Separation:** ____________ **Line Spacing:** ____________

Grid	Nav Line	EM Line	File	Dir	Wind Dir	Note
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	
					S-------B	

Wave Ht: ____________ **Wind Speed:** ____________ **Weather:** ____________

Onsite: ____________ **Begin Data:** ____________ **Misc Notes:**

Offsite: ____________ **End Data:** ____________ ____________