Multibeam Surveying

1 Introduction

Multibeam surveying affords the surveyor with many advantages, but it also requires more thought behind the survey itself.

1.1 Survey Design

Multibeam surveying survey planning is very different than single beam survey planning. The main considerations are line spacing and line direction. In single beam surveying, lines are normally spaced based on the scale of the desired chart. The line direction is normally at the discretion of the surveyor. In multibeam surveying, the surveyor has to plan the survey carefully, with thought to overlap between adjacent lines and the direction that those lines are run.

1.1.1 Line Spacing

The entire concept of multibeam surveying is based on the swath coverage that defines the multibeam system. The survey lines should be designed so that there is 100% overlap in coverage between adjacent lines. As swath width is a function of water depth, it follows that the spacing between lines may not be constant. Looking at a chart of the survey area, the surveyor should be able to determine the swath width that will be obtained and can design the line spacing accordingly.

A large overlap in swath coverage is required due to various factors. One prime factor is roll. As the vessel rolls the swath coverage will vary in relation to this roll. If the vessel rolls to port (port-side down), the swath coverage on the port side will be lessened, whereas the swath coverage on the starboard side will increase. If there is not sufficient overlap in swath coverage there could be gaps in coverage, between adjacent lines, due to the roll.

If the helmsman has problems keeping the vessel on the designated line, this could case gaps if the vessel goes off line to opposite directions on adjacent lines.

Unexpected shallows will reduce the swath coverage. If the lines are designed with very little overlap, a shallow area on the lines will see reduced swath coverage and the possibility of gaps between the lines.

1.1.2 Line Direction

In single beam surveying, the usual practice is to survey normal to the contours. The concept is to cut the contours at 90° to obtain the best definition of the slope. Multibeam survey is exactly opposite of this; in multibeam survey the lines are planned to survey parallel to the contours. Multibeam surveying can be likened to side scan surveying; the best definition is obtained when the slope is within the port or starboard swath coverage. There will be poor definition of the slope covered by the nadir beams, as they act similar to a single beam echosounder.

In setting up the survey lines, if the lines were to run up and down slope, the spacing would have to vary between the start and the end of the lines as the swath coverage would vary due to the change in water

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depth. The lines would not be parallel. By surveying along the contours, the depths will remain more or less constant so that the spacing does not have to change from beginning to end. However, the spacing between adjoining lines may vary due to increased or decreased depth.

1.1.3 Line Run-in

As was previously noted, it is good survey practice to allow the motion sensor and gyro time to settle after making a turn. With this in mind, the surveyor should set up the survey lines so that an adequate lead in, before the start of data recording, is allowed.

Extra lead in time allows the helmsman the opportunity to get on to the line and make any adjustments that are necessary to counteract wind or current conditions. It is much better for the vessel to be a little off of the planned survey line, but heading in a straight direction, rather than 'fish-tailing' back on forth across the line, trying to maintain zero offline.

Surveying into a beach may only allow very limited run-in, if the lines are also to be surveyed out from the beach. In this case it may be better to design the lines so that they run parallel to the beach. Of course, if it shallows greatly towards the beach, the lines should be run parallel to this slope anyway as detailed above.

1.2 Record Keeping

It is essential that detailed records be kept of all aspects of the multibeam survey. The logging of all details of the survey will greatly assist those in charge of processing the data. Maintaining a vessel log, that reflects offsets, draft measurements, sound velocity profiles and etc; will give the surveyor a reference that can be easily accessed. The more information that is logged, the easier it will be during processing and it will also provide the surveyor with a means to assess survey technique with a view to improving the efficiency of the survey.

1.2.1 Vessel Record

A hardbound ledger book should be kept for the vessel record. The vessel record should include, but is not limited to:

- Diagram of the vessel with measurements
- All offsets
- Daily draft measurements
- Diary of sound velocity profiles
- Surveyors / Operators
- Equipment list
- Equipment interface information
- Diary reflecting dates of individual surveys

The vessel record is meant to be a quick reference for general information that is required for multibeam surveying. Some of the information does not change from survey to survey and should go either in the front of the book or the back of the book. A section of pages can then be devoted to the information that does change from survey to survey or day to day.

As an example:

- Page 1 – Plan of the vessel with all vessel measurements.
- Page 2/5 – Plan of the vessel with all offsets
- Page 6/9 – Equipment list and interfacing information
- Pages 10/20 – Dates of individual surveys with listing of surveyors responsible for those surveys.
- Pages 21/40 – Diary of draft measurements
- Pages 41/60 –Diary of sound velocity measurements

As can be seen, this is a general reference which can provide dates and general details.

When naming surveys and sound velocities, a certain degree of logic in their naming will greatly assist deciphering an individual event out of many events. In the case of sound velocity profiles, it is common to name the profiles for the date that they were taken. A sound velocity profile taken on 04 July 2009 would be referred to as 20090704. If more than one profile is taken during the day, then a letter suffix can be added: 20090704a, to separate the profiles, or a time of cast can be added to the file name. Keep in mind that personnel, who were not on board during the data collection, may need to reference the information; keeping it logical and chronological will help.

Ensure that many blank pages are kept for the various categories. When a book is filled, plainly mark on the cover the inclusive dates that the vessel log covers. If possible also mark this information along the spine of the vessel log. These logs should be kept in a safe and dry place on the vessel.

1.2.2 Daily Survey Log

The Daily Survey Log is where all the details of the survey are recorded: start/stop time of the lines, line names, and line direction, speed of survey, and comments pertaining to that survey line. A copy of the appropriate survey log should accompany all multibeam data along its path during processing.

Daily Survey Logs are of two types: rough and smooth. The smooth log is a sheet that is arranged in rows and columns, where the appropriate survey information is entered, much like a spread sheet. It can be a single sheet that is printed out on board, or it can be professionally produced pad of sheets. The rough log is similar to the vessel log; it is normally a ledger book; the start/stop times, line name, line direction and comments are entered line by line, usually on the right hand page as they occur. The left hand page then is left for details of draft, sound velocity profile data, tides or any other information that is pertinent to the lines that are detailed on the right hand page.

A copy of the survey log is sent along with the multibeam data to processing and a copy is kept on board the vessel.

An example of the information on a smooth log:

- Sensor offsets
- Calibration offsets
- Date
- Survey name, area and surveyors

- Name of sound velocity file
- Name of tide file
- Vessel name
- Start/Stop time of survey line
- Line name
- Direction
- Comments

Due to the nature of a single sheet type log, the information should be entered on each individual sheet, even though many items do not change from one day to the next.

With the log book style of daily log the items that do not change can be listed on one page, so that everything following that page will be under those parameters (offsets, vessel name etc.). The right hand page will include the start/stop times, line name, direction and comments. The left hand page, as noted above, is for additional information. A further advantage to using a log book is the space available to sketch diagrams of the survey or other visual aids that might make the survey easier to understand.

The surveyor uses a log book to record the data as it occurs. A daily survey log sheet can be created in any word processor or spreadsheet program. At a convenient time the surveyor can call a sheet up, within the appropriate program, enter the data and print it out. This has many advantages, the most obvious is that the daily log sheet is typed in and printed out making it very legible to read; it can be stored down to memory, making a permanent record.

Although maintaining a good detailed log of daily survey events may be difficult to get use to, after a short time the advantages will become obvious.

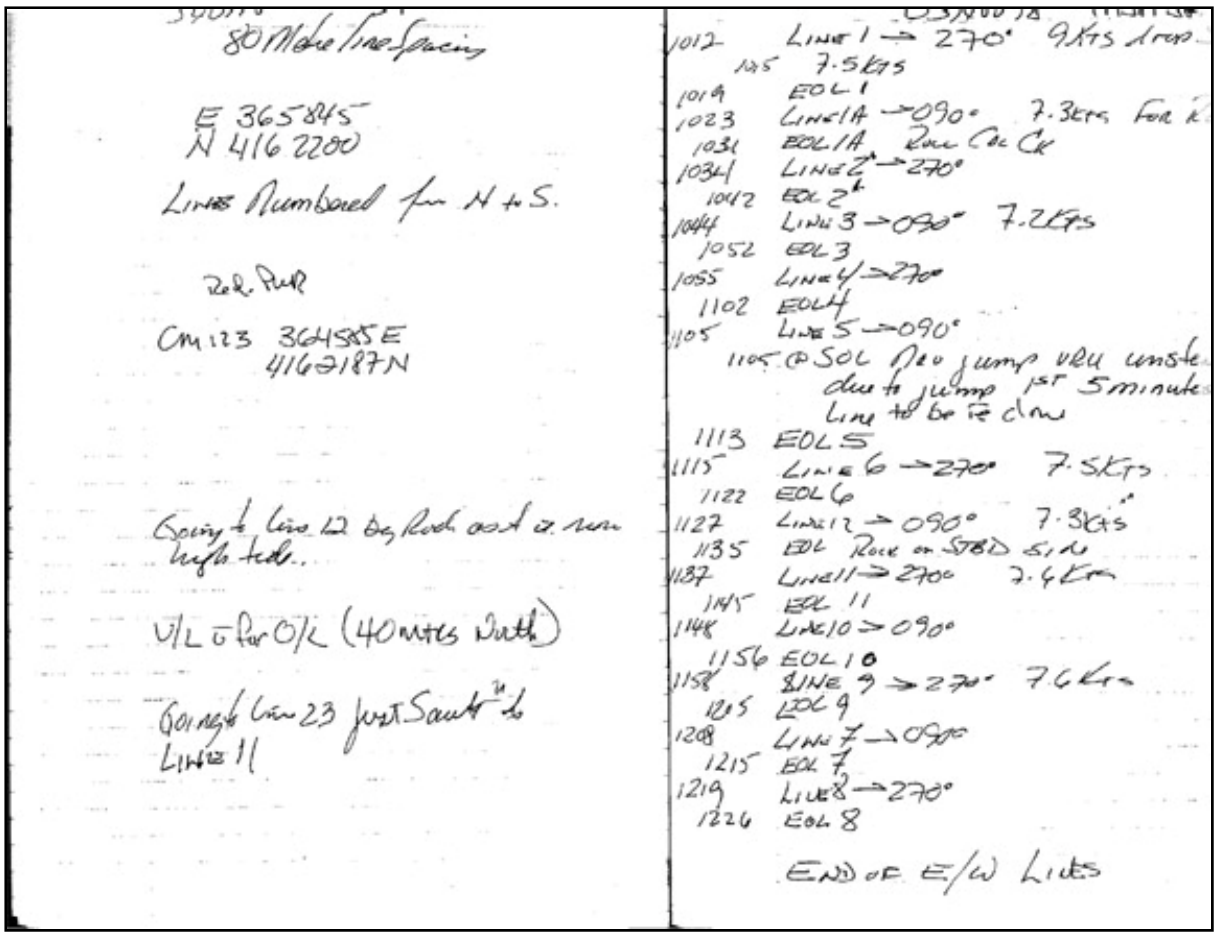
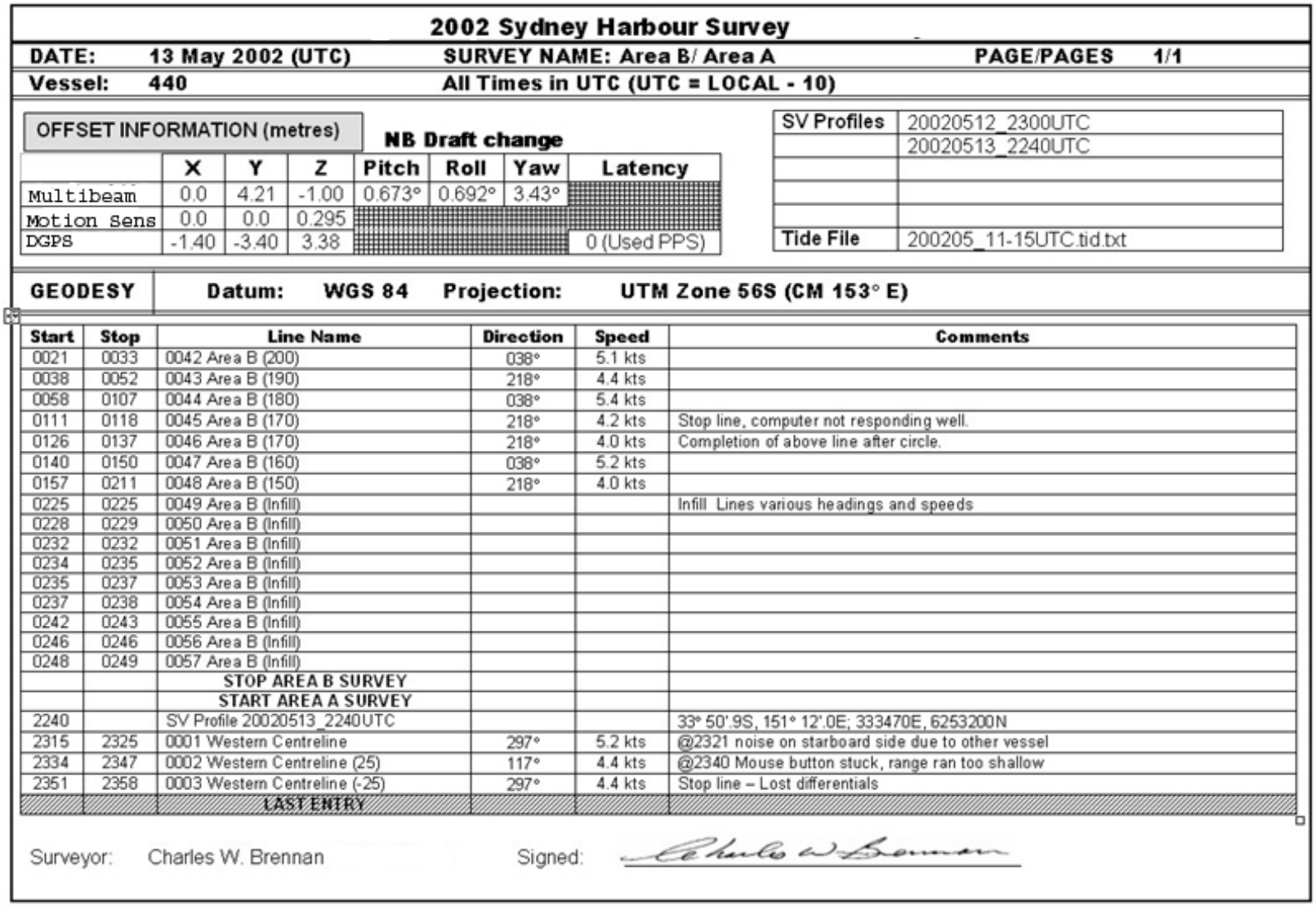


Figure 1: Rough log, kept during survey operations...does not need to be neat, but must contain all pertinent information



2002 Sydney Harbour Survey

DATE: 13 May 2002 (UTC) **SURVEY NAME:** Area B/ Area A **PAGE/PAGES** 1/1

Vessel: 440 **All Times in UTC (UTC = LOCAL - 10)**

OFFSET INFORMATION (metres) **NB Draft change**

	X	Y	Z	Pitch	Roll	Yaw	Latency
Multibeam	0.0	4.21	-1.00	0.673°	0.692°	3.43°	
Motion Sens	0.0	0.0	0.295				
DGPS	-1.40	-3.40	3.38				0 (Used PPS)

SV Profiles	20020512_2300UTC
	20020513_2240UTC
Tide File	200205_11-15UTC.tid.txt

GEODESY **Datum:** WGS 84 **Projection:** UTM Zone 56S (CM 153° E)

Start	Stop	Line Name	Direction	Speed	Comments
0021	0033	0042 Area B (200)	038°	5.1 kts	
0038	0052	0043 Area B (190)	218°	4.4 kts	
0058	0107	0044 Area B (180)	038°	5.4 kts	
0111	0118	0045 Area B (170)	218°	4.2 kts	Stop line, computer not responding well.
0126	0137	0046 Area B (170)	218°	4.0 kts	Completion of above line after circle.
0140	0150	0047 Area B (160)	038°	5.2 kts	
0157	0211	0048 Area B (150)	218°	4.0 kts	
0225	0225	0049 Area B (Infill)			Infill Lines various headings and speeds
0228	0229	0050 Area B (Infill)			
0232	0232	0051 Area B (Infill)			
0234	0235	0052 Area B (Infill)			
0235	0237	0053 Area B (Infill)			
0237	0238	0054 Area B (Infill)			
0242	0243	0055 Area B (Infill)			
0246	0246	0056 Area B (Infill)			
0248	0249	0057 Area B (Infill)			
		STOP AREA B SURVEY			
		START AREA A SURVEY			
2240		SV Profile 20020513_2240UTC			33° 50'.9S, 151° 12'.0E; 333470E, 6253200N
2315	2325	0001 Western Centreline	297°	5.2 kts	@2321 noise on starboard side due to other vessel
2334	2347	0002 Western Centreline (25)	117°	4.4 kts	@2340 Mouse button stuck, range ran too shallow
2351	2358	0003 Western Centreline (-25)	297°	4.4 kts	Stop line – Lost differentials
		LAST ENTRY			

Surveyor: Charles W. Brennan Signed:

Figure 2: Smooth log; information copied from real-time survey log