Land Information New Zealand
Toitū te whenua

Contract Specifications for Hydrographic Surveys

Version 1.3

New Zealand Hydrographic Authority

New Zealand Government

Record of Changes

Table 1

Version	Date	Amendment
V 1.0 Customer Services	25 September 2007	Change to Section 8.2 Multibeam Survey Uncertainty Requirements, Table 8. LINZ Order MB-2, Target Detection for water depths less than 40m is 4m. Changes to Section 10.4 Data to be Rendered on Completion of Survey. Update to Section 10.4.3 The Tidal Data Pack. Addition of descriptive text for report contents. Update to Section 11 Digital Data. Changes to data format and media. Requirement added for Rendered Data Set (Thinned) Section 11.1.3. Update to Section 3 Surveying Operations Ashore. Update to Section 1.3 Related Standards and Publications Update to Section 10.4.5 The Standard Sheet Update to Section 10.4.6.2 Photographs. Minor amendments in many other sections.
V1.1	7 August 2008	Delete reference to NZ201, publication withdrawn. Reference made to IHO INT1. Update to Section 2.17.1 Approval of SIC. Update Section 2.2, obtaining Resource Consents Update to Section 8.8.1. MBES Reference Surface check Update to Section 9.4, two tide gauges required at Primary Tidal Station. Update to Section 9.5, Pole to Gauge observation period reduced to 13 hours. Update to Section 11.4 Data to be Rendered on Completion of Surveys. Two copies of all FINAL sheets to be rendered, 1 paper and 1 film. Update to Section 11.4.5.12 Depths. Rounding rules for depths and drying heights Update to Section 12.1.3 Rendered Data Set (Thinned). CARIS NTX files to be rendered, if available. Add Section 12.1.4 Rendered Data Set (Contours). Contours to be rendered in DXF format. Update to Section 12.1.6 Digital Copies of the Signed Standard Sheets. Low resolution JPG format. Add Section 12.1.7 Digital Photographs to be rendered. Minor amendments in many other sections.
V1.2	18 June 2010	Reference to *Specifications for Geodetic Hydrographic Control Points* removed and reference made to new geodetic specifications throughout. Update to Section 2.17.1 Approval of SIC. Reference to recent field experience with MBES systems. Update to Section 2.17.2 Responsibilities of Surveyor-in-Charge. Re-definition of SIC role. Update to Section 3 Surveying Operations Ashore. Secondary Geodetic Control Points removed; Tidal Station BM NZGD2000 Order amended; and levelling uncertainty included. Update to Section 3.6 Conspicuous Objects and Landmarks. To be rendered on Ancillary Sheet rather than Standard Sheet. Update to Section 8.8.1 Mobilisation Calibration. Procedure for creating high confidence Reference Surface. Update to Section 9.1 Sounding Datum and Chart Datum. Transfer of

		Sounding Datum methodology amended. Update to Section 9.2 Establishing Datum. MSL value above CD checked by 13 hours observation period. Update to Section 9.4 Establishing Tidal Stations. Secondary Tidal Stations removed. Update to Section 9.7 Tidal Observations. Reset recording interval after data download. Update to Section 10.3 Fixing of Floating Navigational Marks. To be shown on Ancillary Sheet. Update to Section 10.8 Amendments to Sailing Directions. Method of proposing amendments. Update to Section 11.4 Data to be Rendered on Completion of Surveys. One copy of Standard and Ancillary Sheets and Accompanying Tracings to be rendered on matt plastic/polyester for FINAL deliverables. Update to Section 11.4.1.2.8 Annex H Significant Bathymetric Features (Shoal Summary). Format for table and information required. Update to Section 11.4.5.1 The Standard Sheet, General. Standard sheets do not need to be stowed flat. Update to Section 11.4.5.19 Conspicuous Objects. To be shown on Ancillary Sheets Update to Section 11.4.5.23 Ancillary Sheets. Fixed and floating navigational marks and conspicuous objects to be shown. Update to Section 12.1.2 Rendered data Set (All Pings). ASCII format amended. Update to Section 12.1.3 Rendered Data Set (Thinned). GSF format removed, ASCII format amended.
V1.3		Update to Section 2.2 Liaison with Iwi/Maori added Update to Section 2.8 Survey Planning. Survey to be progressed in a systematic manner. Update to Section 2.16 Surveyor-in-Charge. Addition of IHO IAB recognised National or Regional Scheme. Requirement for Signature removed. New Section 2.17 Survey Team. Update to Section 3.2 Requirement for Cadastral Surveyor to establish Order 5 mark relaxed with addition of *Specifications for Order 5 Surveys for Hydrographic Control - V 1.0*. Levelling requirements aligned with Geodetic Specs. Update to Section 3.8 Heights of Objects and Landmarks. Datum for clearance heights is HAT. Update to Section 4.1 Uncertainties, Table 2 Horizontal Uncertainties. Order 3 ##m +5%d and 100% Bottom Search removed. Update to Section 4.3 Secondary Positioning required to be logged. Update to Section 4.3 References to EPF systems removed. New Section 5 LINZ Orders created to align MB & SB standards Update to Section 6.6 Disproving Searches. Update to Section 6.7 Channels, Leading Lines and Recommended Tracks. Update to Section 7.1 Single Beam Echosounder Uncertainty Requirements, Table 5 – Depth Uncertainty for Reduced Depths. To reflect IHO S44 5th Ed. Requirement for Paper Trace removed. Update to Section 8.6 Acquired Data. Data flagged as rejected to be included in processed data deliverables. Update to Section 8.8.1 Mobilisation Calibration updated and reference deliverables Section 8.9 Additional MBES Survey Deliverables, removed.

		Update to Section 9.5 Added possibility of Tide Gauge Calibration via GNSS Tide Buoy upon approval by LINZ Section 10.4 renamed from Characteristics of Lights and Buoys to Characteristics of Aids to Navigation. Update to Section 10.6.1 Name Proposals for Newly Identified Features. Update to Section 10.8 Amendments to Sailing Directions. Update to Section 11.4 Data to be Rendered on Completion of Surveys. Requirement for hard copies of reports and sheets removed; minor amendments. Update to Section 11.4 Annex E – Sound Velocity and Bar-Check Observation Results. Requirement to render SV results in spreadsheet. Update to Section 11.4 Annex O – Ancillary/Miscellaneous Observations. Requirement to photograph seabed samples removed. Update to Section 11.4 The Tidal Data Pack. Requirement to include the Interim Tidal Data Pack in the mobilisation report and more definition on content. Update to Section 11.4.4 Requirement for Significant Charting Differences table added. Update to Section 11.4.8 The Standard Sheet, General. Simplified requirements for grid and geographical intersections; and borders depiction inserted. Previous Section 11.4.5.5 Geographical Intersections. Simplified and include in Section 11.4.8 – see above. Previous Section 11.4.5.6 Grid Intersections. Simplified and include in Section 10.4.8 – see above. Previous Section 11.4.5.7 Geographical Border. Simplified and include in Section 10.4.8 – see above. Previous Section 11.4.5.8 Grid Border. Simplified and include in Section 10.4.8 – see above. Update to Section 11.4.8 Ancillary Sheets. Requirement to depict Sound Velocity Dip locations; nav-aid calibration data removed. Update to Section 11.4.8 Contours. Contour intervals aligned with S-4 requirements Update to Section 12.1. Processed Data Set (All pings). GSF files to include soundings flagged as 'rejected'. Update to Section 12.1.1 Rendered Data Set (Thinned). Requirement for time (t) removed. Section 12.1.3 renamed Mobilisation Visit Deliverables from Multibeam Deliverables. Update to multiple sections: All deliverables to be rendered in digital format Minor amendments in many other sections.

1 Introduction

As a contracting government to the International Convention of Safety of Life at Sea (SOLAS), New Zealand has an obligation to "*arrange to collect and compile hydrographic data, and to publish, disseminate and update all nautical information necessary for safe navigation*" (SOLAS V, Regulation 9). Land Information New Zealand (LINZ) is the New Zealand Hydrographic Authority (NZHA) and is the competent authority responsible for meeting these obligations. The information in this specification details the requirements for hydrographic surveys undertaken on behalf of LINZ and is to be used in conjunction with the relevant project-specific Contract Documents i.e. project specification and desk top study, to give comprehensive guidance for delivering the required services in its entirety.

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1.1 Related Standards and Publications

The following publications must be read in conjunction with this standard. The most recent versions of the following documents at the time of contract signing apply:

1. *Standards for Hydrographic Surveys* (S-44), 5th Edition. International Hydrographic Bureau, Monaco. February 2008.

2. *Specifications for Order 5 Surveys for Hydrographic Control,* V 1.0. New Zealand Geodetic Office, LINZ. May 2016.

3. *Manual on Hydrography* (C-13) 1st Edition. International Hydrographic Bureau, Monaco. May 2005 (Corrections to February 2011).

4. *The Mariner's Handbook* NP100, Edition 10. Admiralty Publication. 2015.

5. *Admiralty Manual of Hydrographic Surveying,* Volume One, NP 134 a. Admiralty. 1969

6. *Admiralty Manual of Hydrographic Surveying,* Volume Two, Chapter 2 Tides and Tidal Streams NP 134 b (2). Admiralty. 1969.

7. *General Instructions for Hydrographic Surveyors (GIHS),* NP 135, Seventeenth Edition, 1996. Admiralty.

8. *INT1 Symbols, Abbreviations and Terms used on Charts,* 7th Edition. International Hydrographic Bureau, Monaco. 2011.

9. *Symbols and Abbreviations used on Admiralty Paper Charts* NP5011 (INT 1Format), Edition 5. Admiralty Publication. April 2011

10. *LINZ Source Data Specification,* Version 4.0. New Zealand Hydrographic Authority, LINZ. 2013.

11. *Backscatter measurements by seafloor-mapping sonars: Guidelines and Recommendations.* Publication by GeoHab Backscatter Working Group. May 2015

12. *Standard for the Geospatial Accuracy Framework.* LINZS25005, LINZ. 2009.

13. *Standard for Tiers, Classes, and Orders of LINZ Data,* LINZS25006, LINZ. 2009.

14. *NP122(2) Admiralty Tidal Handbook No.2*. Admiralty Publication. 1975.

Note: All LINZ publications detailed above are published at the LINZ web-site: http://www.linz.govt.nz/ or are available from the New Zealand Hydrographic Authority (NZHA).

1.2 Terms, Definitions and Abbreviations

Table 2

Accompanying Tracing	the presentation of data that cannot be depicted on a Standard or Ancillary Sheet due to constraints of scale.
AMHS	Admiralty Manual of Hydrographic Surveying (NP 134A)
Ancillary Sheet	the presentation of other survey related information
AtoN	Aids to Navigation
BM	Benchmark
CD	Chart Datum
C-O	Correct minus Observed
CM	Central Meridian
CTD	Conductivity / Temperature / Depth
CRP	Common Reference Point
DGNSS	Differential Global Navigation Satellite System
DOP	Dilution of Precision
GDP	Geodetic Data Pack
GIHS	General Instructions for Hydrographic Surveyors (NP 135)
GNSS	Global Navigation Satellite System
GSF	Generic Sensor Format
HAT	Highest Astronomical Tide
HSS	Hydrographic Survey System
IHO	International Hydrographic Organisation
LAT	Lowest Astronomical Tide
LINZ	Land Information New Zealand
LOP	Line of Position
MBES	Multibeam Echo Sounder
MHHW	Mean High High Water
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
M	International Nautical Mile
MRU	Motion Reference Unit
MSL	Mean Sea Level
NZGB	New Zealand Geographic Board Ngä Pou Taunaha o Aotearoa
NZGD	New Zealand Geodetic Datum
NZHA	New Zealand Hydrographic Authority
NZNA	New Zealand Nautical Almanac (NZ204)
PA	Position Approximate
QC	Quality Control
QADP	Quality Assurance Data Pack
RMSR	Root Mean Square Residual
ROS	Report of Survey
SBES	Single Beam Echo Sounder

SD	Sounding Datum
SIC	Surveyor in Charge
SO	Special Order
SSS	Side Scan Sonar
Standard Sheet	the presentation of sounding data and seabed contours
SV	Sound Velocity/Satellite Vehicle
SVP	Sound Velocity Probe
TDP	Tidal Data Pack
THU	Total Horizontal Uncertainty
TM	Transverse Mercator
TPU	Total Propagated Uncertainty
TVU	Total Vertical Uncertainty
UTM	Universal Transverse Mercator
WGS-84	World Geodetic System 1984
XBT	Expendable Bathythermograph

2 General Principles

2.1 Project Nomenclature

1. Survey contracts or projects issued by LINZ will state the following three identifiers:

   Project Name : Whangaroa Harbour Survey
   Contract Number : HYD 1314-HS41
   Project Number : HYD 2013/14-02

2. Every page of data, every item of hard-copy record, every item of electronic media and every page of every report rendered for a hydrographic survey is to be labelled with the above three fields to aid in identification.

3. Similarly, the title page of every rendered document together with every item of electronic media and every rendered graphic (e.g. standard sheets) is also to be labelled with "Crown Copyright Reserved"

2.2 Liaison with Local Authorities

1. The Contractor is to contact and inform relevant national and local authorities well in advance of any intended survey work ashore and afloat. The local harbour authority should be consulted at all stages of the planning and execution of any harbour surveys.

2. Where survey operations require the use of facilities or access or entry to Wildlife or Marine Reserves, the Contractor is to contact the relevant authorities and obtain approvals for any landing and activities prior to commencing the work.

3. Where survey operations require Resource Consents to access sensitive areas, the Contractor is to make every effort to ensure the relevant consents from the appropriate authorities are obtained in good time prior to survey operations commencing.

4. Any approvals, permits, proposals etc. given or obtained for the undertaking of the survey are to be copied to LINZ.

2.2.1 Liaison with Iwi/Māori

1. Prior to the release of the Request for Proposal LINZ will identify and initiate engagement with the relevant Iwi agencies as appropriate. Copies of any communications sent to relevant Iwi agencies, including any contact details for representatives of these agencies, will be provided to the contractor upon award of contract.
2. Following the award of contract LINZ will send a letter to the appropriate Iwi agency that:
   a. introduces the contractor,
   b. provides an updated schedule of works, as outlined in the contractor's project plan, and;
   c. provides the contractor's contact details and details of the appropriate contact person.

   A copy of this letter will be provided to the contractor for their records.

3. Should this be required, it is the expectation of LINZ that the contractor will possess, or will obtain, the necessary skills to engage responsively with Māori at the community level, e.g. whanau, hapu, individual level.

   Given the wider context of LINZ's engagement with Iwi – which may impact other areas of LINZ's business – the contractor is required to:

   - Notify LINZ of intended communication campaign with Iwi, Māori before it is undertaken
   - Advise LINZ of any requests received from Iwi, Māori in relation to the work undertaken
   - Notify LINZ and seek advice for any issues or potential issues regarding land access that may involve Māori land

2.3 Access to Land

1. All Contractors are to obtain permission from the owners and/or relevant authorities before permanent or temporary surveying marks are installed, or any equipment is placed on private, populated, restricted or sensitive property. Arrangements are to be made to remove all equipment and temporary marks on completion of the work.

2. In planning hydrographic surveys, obtaining approval to occupy land is the responsibility of the Contractor. If the rightful owner of any property cannot be established within a reasonable time, and establishing the site without delay is essential for the conduct of the survey, then the local police should be given full particulars and requested to inform the owners of the land.

3. Prior approval is always to be obtained before installing surveying marks of any sort on structures maintained by the various lighthouse and harbour authorities, who are also to be informed when the marks have been removed. Care is always to be exercised whenever it is necessary to visit lighthouses, navigational beacons, etc., that the functioning of such aids to navigation is in no way affected.

4. Any approvals, permits, proposals etc. given or obtained for the undertaking of the survey are to be copied to LINZ.

2.4 Original Documents

1. The term 'Original Documents' is used to describe the various Fair Sheets, maps, geodetic schemes, digital records, reports etc. that exist from previous surveys. In normal circumstances only copies are supplied to Contractors. The greatest care is to be taken of all 'Original Data' received on loan, and special attention is to be paid to their careful preservation. When a survey is completed, all 'Original Data ' pertaining to that survey is to be returned to the originating authority without delay.

2. No additions or amendments are to be made to any 'Original Data'. Under no circumstances are original digital records ever to be altered; if an amendment is necessary, a copy of the original is to be taken and the alteration made to this copy. The amended copy is to be clearly marked as such.

2.5 Transmission of Survey Data

1. Whenever Original Data, survey records, Standard Sheets, digital survey records, or material of a similar unique, sensitive or delicate nature are transferred between two parties, proper measures are to be taken to ensure safe, secure and economic transfer.

2. All hard-copy and digital data must be transported appropriately to ensure timely and secure transmission of deliverables.

2.6 Hydrographic Books and Forms

1. It is the responsibility of the Contractor to maintain appropriate hydrographic records for use throughout the survey to ensure an audit trail exists for all data collected. Copies of all records, including daily logs, are to be rendered in the QADP.

2.7 Digital Surveying Systems (Hydrographic Software Packages)

1. The operation of Digital Surveying Systems is to be in accordance with the Contractor's standard operating procedures. As a minimum however, backups of raw data are to be made at the end of each working day. Regular backups of processed survey data are also to be made.

2.8 Survey Planning

1. During the tender process the Contractor will provide a comprehensive Project Plan that is specific to the project. This should include, but not limited to the following; dates, milestones, methodology, processing, and equipment, quality procedures and any assumptions. If there are any changes to the Project Plan after award of contract, a revised Project Plan is to be submitted to LINZ.

2. The hydrographic survey shall be progressed in a systematic manner to ensure coverage of all areas specified is complete in all respects.

2.9 Scale

1. LINZ will specify in the contract document a scale at which the graphical data and Standard Sheets of the survey are to be rendered.

2. The scale to be used for shoal examinations and disproving searches will be at the discretion of the SIC (see Sections 6.5; 6.6 and 7.8). The scale must be large enough to allow such close examination that the feature cannot escape detection and will be dictated by the type of bottom, the depth of water and the echo sounder footprint. The scale must not be less than that of the largest scale standard sheet or chart of the area. The need to locate and show all significant bottom features must be the guiding principle. Such searches, whether or not the reported shoal has been located, must result in the forwarding of a plot at a suitable scale, showing the area covered by the search, the sounding density and the soundings obtained.

3. When utilising MBES for shoal investigation or disproving searches, the SIC must ensure that ping density is such that the chance of a danger escaping detection is remote. This may necessitate performing sounding at slower speeds and greater swath overlaps than for standard survey lines.

2.10 Positional Control

1. The method, or methods, to be used for positional control during a survey will be specified in the project contract document.

2.11 Surveying Uncertainties

1. Horizontal and vertical uncertainties will be specified in the contract document. The standards in Section 5 detail the minimum uncertainty requirements which are to be used.

2.12 Geodetic Control

1. The contract will specify the horizontal datum and projection to be used for a survey.

2. Geodetic control is to be in accordance with the LINZ specification, *Specifications for Order 5 Surveys for Hydrographic Control,* V 1.0. (refer to 1.1 Related Standards and Publications)

3. The survey contract may require that a number of Geodetic Control Points be established for the conduct of the survey. Details of requirements are outlined in Section 3.2.

4. All geographic positions are to be quoted in the format DDD MM.MMM, unless otherwise specified.

2.13 Tidal Datums and Tidal Data

1. The datum to which depths are to be reduced is fundamental to any bathymetric survey and the contract document will contain details of how this is to be established. Where the relationship between tidal levels and the land survey datum is known, details will be supplied, together with descriptions of suitable benchmarks. Elsewhere, it may be necessary to establish sounding datum by observation, and due allowance for this must be made when planning the survey. Any newly established sounding datum must be related to the local land survey datum whenever practicable.

2. Tidal observations, tidal stream and current measurement requirements will be specified in the contract.

2.14 Verification of Charts and Publications

1. During the execution of the contract every opportunity should be taken to verify the adequacy or otherwise of existing published charts and documents of those areas in which the survey is being carried out.

2. When examining the detail on a published chart, attention should be paid to whether land features are visible from seaward (or even whether they still exist), to the prominence or otherwise of objects described as 'conspicuous' and to whether major changes have taken place in built-up areas.

2.15 Time and Date

1. All times rendered to LINZ in digital data in terms of UTC and descriptive text used in reporting in terms of NZST.

2. All dates are to be quoted in terms of the Julian Calendar.

2.16 Surveyor-In-Charge (SIC)

2.16.1 Approval of SIC

1. The SIC of the project is to be approved by LINZ prior to commencement of the project. Such approval will involve a review of the individual's hydrographic surveying experience, qualifications and references.

2. As a minimum, the nominated SIC is to have successfully completed an FIG-IHO-ICA IBSC Category A recognised course and/or an FIG-IHO-ICA IBSC recognised National or Regional Scheme with a specialism in Nautical Charting.

3. A proven track record of at least five years recent field experience as SIC, supported by evidence and references, is required which demonstrates that they are capable of meeting the requirements of a hydrographic survey for nautical charting purposes.

4. Additionally, if a MBES system is to be utilised for the survey, the SIC is to have completed professional training in the principles and operation of MBES/interferometric systems. An example of such training is the course run by the UNB-OMG / UNH-CCOM. The SIC must also provide evidence of at least two years recent field experience with MBES systems.

2.16.2 Responsibilities of Surveyor-In-Charge

1. The SIC is responsible for, and must be involved in, all aspects of the work required for the survey including planning, preparation, conduct, rendering and approval.

2. The SIC must take the lead role in the mobilisation, calibration and performance check of the integrated survey system and be present during all critical sounding operations and readily available for acquisition, processing and delivery of data.

3. The SIC may not be replaced or substituted without the prior written approval of LINZ.

4. The SIC is to validate all data and document the quality control that has been undertaken.

5. The SIC is to sign final data, reports and graphics before they are rendered or accepted by LINZ. This signature is an acceptance of liability and approves the use of the data for chart compilation.

2.17 Project Team

1. The project team shall include personnel with relevant and adequate experience of surveying and data processing for nautical charting purposes.

3 Surveying Operations Ashore

3.1 Geodetic Datums

1. Shore-based geodetic control surveys in New Zealand are to be carried out in terms of New Zealand Geodetic Datum (NZGD2000).

2. Vertical geodetic datum will normally be referred to MSL. However, depending on the type of geodetic observations undertaken and the particular use of the station, WGS-84 spheroidal heights are often more appropriate. Care should be taken to ensure that geodetic heights used throughout the survey are related to the correct datum.

3.2 Geodetic Control Points

1. Where existing geodetic control points of Order 5 NZGD2000, or better, are available and suitable, these should be used for shore-based base stations and reference marks.

2. Lower order marks, or newly established stations, may be used provided they meet the requirements set out in *Specifications for Order 5 Surveys for Hydrographic Control,* V 1.0 (see Section 1.1 Related Standards and Publications) and are either surveyed, or upgraded, to at least Order 5 NZGD2000 standards.

3.3 Tidal Station Benchmarks

1. A minimum of three BMs are required close to each tidal station. Existing suitable survey marks may be designated for this purpose, otherwise new marks will need to be established.

2. At least one of these marks is to be surveyed to Order 5 NZGD2000 standards in accordance with *Specifications for Order 5 Surveys for Hydrographic Control,* V 1.0.

3. Newly installed marks should be positioned in a manner conducive to future survey activity requirements, e.g. GNSS measurement.

4. Position descriptions and diagrams are to be rendered for all BMs. Position descriptions and finder diagrams are to contain bearings and distances to identifiable permanent features in the vicinity. A second or third BM must therefore not be described solely in relation to the first. Panoramic photographs with each BM identified are to be taken and rendered in the GDP

5. Levelling between the BMs and tide pole shall meet the LINZ Class I Standard as outlined in LINZ documents LINZS25005 and LINZS25006.

3.4 Conspicuous Objects and Landmarks

1. The positions of all objects which may be of use to the mariner are to be fixed, shown on the Ancillary Sheet and documented in written reports.

2. Conspicuous objects are natural or artificial features that stand out, are easily identifiable and plainly visible in varying light conditions over a large area of sea (except in narrow approach channels).

3. When classifying objects within a survey area, the surveyor must ensure that their judgement is not affected by familiarity with the region. The objects must be obvious to those navigating in the area.

4. Photographs are to be taken to support reports and comments on conspicuous objects and landmarks. All photographs are to be clearly labelled.

3.5 Coastlining

1. The coastline is the line reached by MHWS tides, and care is necessary in order to locate the line accurately in places where the tidal range is large. The surveyor must always observe the coastline and record the details specified in AMHS Vol. 2, Binder 5, Coastlining and Topography. Imagery is often available and will be provided by LINZ where possible to assist in plotting the coastline. LINZ contracts may call for spot checks along the coastline to verify the uncertainty of the depicted coastline.

2. Where no suitable maps or aerial imagery is available, the contract document may direct that the coastline is to be surveyed by regular methods appropriate to the scale of the survey. Geodetic GNSS used in kinematic mode should be used where possible.

3. Whenever a surveyor is examining the coastline, the nature of the foreshore and position of the drying line, where this can be determined, is to be recorded. The best way to fix the drying line is by reduced soundings, but it is important that the whole foreshore should be sighted at least once at low water in order to detect features and dangers which it may not be possible to distinguish whilst sounding close inshore. It is often better to delineate and height rocks along with other isolated dangers at low water than to rely on lines of soundings which may be a considerable distance apart.

3.6 Delineation of the Drying Line

1. The survey contractor must delineate the drying line. Surveyors are to take special care that the drying line of the mainland, of islands and of all drying features, is adequately surveyed.

3.7 Topography

1. Where recent topographic maps, aerial photographs, plots from photographs or satellite imagery are used as a source of additional information, they should be thoroughly checked in the field and updated to reflect new or changed features. The topography shown on the largest scale chart should also be checked in the field, to update detail which is not normally shown on maps and which may not be visible on air photographs, paying particular attention to coastal detail such as beacons, flagstaffs, groynes, harbour development etc.

2. A description of Charted Objects which no longer exist must be tabulated in the ROS in Annex H in the Charted Difference section and reflected in the Ancillary Sheets.

3.8 Heights of Objects and Landmarks

1. All newly co-ordinated objects and all established objects for which heights are not known are to have their heights determined and recorded. The heights of all prominent features within a survey area, whether natural or man-made, are to be observed and calculated. The heights are to be given as metres above MHWS, or if MHWS is not known, as heights above MSL.

2. The drying height of all offshore rocks and islets is to be determined, recorded and documented. The height of drying rocks is to be given as height above Sounding Datum. Where there are many offshore rocks then the seaward-most rocks are to be heighted as these will be the ones a mariner will use to determine distance from.

3. Any clearance under bridges, wires or power cables is to be determined as height above HAT.

3.9 Coastal and Harbour Facilities

1. Brief details, including dimensions, of ramps, slipways and those beaches free of obstructions and suitable for beaching boats, should be included in the rendered documents.

2. The following information (as a minimum) is to be obtained for all jetties, wharves, marinas and ramps:

    a. dimensions;

    b. orientation;

    c. depth alongside,

    d. particular berthing or mooring arrangements (e.g. dolphins);

3. Where there is intensive recreational interest in an area, further details should be obtained from the Harbour Master, Marina Manager or other authority. Any local navigational or statutory regulations or recommendations should also be obtained.

4 Positioning

4.1 Uncertainties

1. The contract document will state the maximum permitted horizontal and vertical uncertainties.

2. Tender responses are to include a detailed description of how the horizontal and vertical positioning uncertainty requirements are to be met.

3. Uncertainty calculations are to include an assessment of the sum of the contributions of the uncertainties (TPU) from positioning and sounding systems and the likely use of the data. A statistical method to combine the uncertainty estimates of all sources must be adopted and the position uncertainty at the 95% confidence level recorded along with the survey data.

4. Positions are to be referenced to the geodetic framework specified in the contract.

5. Horizontal control is to be in accordance with Section 3 Surveying Operations Ashore.

6. See Section 5 LINZ Orders for horizontal uncertainty requirements which are based on the IHO Standards for Hydrographic Surveys (S-44).

4.2 Positioning Uncertainty of Soundings

1. All sources of horizontal uncertainty are to be monitored and the contractor is to undertake sounding operations so as to minimise their impact. An *a priori* THU should be calculated prior to the commencement of sounding to ensure that planned operations will meet the specified standards for horizontal control.

2. The survey contractor must provide evidence that positioning system quality factors are monitored on an ongoing basis (e.g. logs of DOP values, satellite configurations, RMSR values etc).

3. The uncertainty of a position is the uncertainty at the position of a feature (e.g. sounding, nav aids etc.) to be located within a geodetic reference frame and not simply the uncertainty at the positioning system sensor.

4. If a SBES is being used to obtain bathymetry then the horizontal uncertainty of the sounding is related to the position of the sounding system transducer.

5. If a MBES is being used to obtain the bathymetry then the horizontal uncertainty of the sounding is related to the position of the sounding on the seabed.

6. The position of soundings, dangers, navigation aids and all other important hydrographic features should be determined such that the horizontal uncertainty is less than that specified in Table 3.

4.3 Quality of Positioning

1. Two independent positioning systems are required on all survey platforms to maintain redundancy. Both systems will be logged throughout survey operations.

This requirement may be waived for small survey launches (<7m) with agreement from LINZ.

2. Both the primary and the secondary positioning systems are to be referenced to a common datum point (the primary echo sounder transducer).

3. As part of the QADP, the survey contractor is to provide evidence of regular comparisons between primary and secondary positioning systems. Any instances when the difference between primary and secondary positioning systems exceeds the required survey uncertainty are to be noted and rendered to LINZ.

4.3.1 GNSS Quality Control

1. The following are the minimum criteria to be monitored for GNSS positioning systems to ensure that the quality of horizontal positioning is within specifications. Any periods where real-time QC indicates that the required tolerances have been exceeded are to be rendered to LINZ as part of the QADP. This includes data obtained from any integrity monitoring station.

    a. The sigma values or semi-major axis of the positional error ellipse are not to exceed 3.5m at the 95% confidence level.

    b. The DGNSS correction age is not to exceed 10 seconds

    c. PDOP is not to exceed 6 for recording and continued sounding. If PDOP is greater than 7 then surveying is to be halted until it improves.

    d. The minimum number of healthy satellites being tracked for continued sounding is to be 5.

    e. The minimum elevation for SVs is to be 10^{o} above the horizontal.

    The integrity of DGNSS signals must be monitored for the duration of survey operations. Any deviation outside the positioning specifications must be noted and rendered in the ROS. Copies of Alarm log files to be referenced in QADP.

4.4 Calibration of Position Fixing Systems

1. Whenever DGNSS or other positioning systems are used (e.g. RTK) for control of positioning for a survey, they must be verified against a reference position which is more accurately known, or by comparison with a more accurate system before sounding commences.

2. Positioning confidence checks are required during the course of the survey at least once per week. A confidence check must also be performed after any major positioning component swap-out, any change to geodetic parameters entered into firmware, etc. or any change of vessel offsets. Records of all calibrations, parameters and checks must be provided to LINZ as part of the QADP.

3. All positioning equipment (including antennae) is to remain mounted onboard the vessel during positioning confidence checks. The contractor is to demonstrate that the measured sensor offsets in relation to the Common Reference Point (CRP) have been carried out and applied correctly within the HSS to meet the positioning uncertainty requirements of the specified LINZ Standard.

4. Heading sensors must be calibrated during mobilisation. The method and results of all calibration and checks must be provided to LINZ as part of the Mobilisation Report (see section 11.4.1).

5 LINZ Orders

The table below details LINZ's standards for depths, sounding positions, target detection, seafloor coverage and ancillary feature positions for SBES and MBES surveys and is partly based on the IHO Standards for Hydrographic Surveys (S-44).

Table 3 – Standards for LINZ Hydrographic Surveys

LINZ Order		**LINZ - Special**	**LINZ-1**	**LINZ-2**	**LINZ-3**
IHO SO Multiplier for Depth Uncertainty (M)		1	1.5	2	2.5
Maximum Allowable Uncertainty of the Horizontal Position of Soundings		2m	5m + 5% of depth	5m + 5% of depth	20 m + 10% of depth
Target Detection		**Minimum Horizontal Size of Target to be Detected**			
Water depth < 40m	MBES	1m	2m	4m	8m
	SBES	1m	2m	Not Applicable	Not Applicable
Water depth >40m	MBES	2.5% of depth	5 % of depth	10% of depth	20% of depth
	SBES	1m	10% of depth	Not Applicable	Not Applicable
Seafloor Coverage to be Achieved					
MBES Swath to Swath Area Coverage		200%	100%	100%	100%
SBES Full sea floor search		Compulsory	Selected Areas	As Specified	Not Applicable
Ancillary Features		**Maximum Allowable Uncertainty of the Horizontal Position of Ancillary Features**			
Fixed Aids and Features Significant to Navigation		2m	2m	2m	5m
Drying Rocks		2m	5m	5m	10m
Natural Coastline		10m	10m	15m	20m
Mean Position of Floating Aids to Navigation		10m	10m	10m	20m
Topographical Features		10m	10m	10m	20m

Notes:

1. All uncertainties are at the 95% Confidence Level
2. The horizontal positional uncertainty for MBES surveys is the uncertainty of the position of the sounding on the seabed.
3 The horizontal positional uncertainty for SBES surveys is the uncertainty of the position of the echo sounder transducer.

The formula below is used to calculate LINZ's maximum allowable depth uncertainty (TVU) in metres:

$$TVU = \pm M\sqrt{[0.25^2 + (0.0075d)^2]}$$

Where:

M is the IHO SO multiplier for depth uncertainty for the LINZ Order (from Table 3 above)

0.25 and 0.0075 are the maximum allowable TVU values at 95% confidence level for IHO Special Order surveys (from the Minimum Standards for Hydrographic Surveys table in S-44), and

d = depth.

Table 4 indicates the results of calculations of LINZ's maximum allowable TVU values at 95% Confidence Level for LINZ Orders at various depths.

Table 4 – Examples of maximum allowable TVU values for LINZ Orders

Depth (m)	LINZ - Special (m)	LINZ-1 (m)	LINZ-2 (m)	LINZ-3 (m)
5	0.25	0.38	0.51	0.63
10	0.26	0.39	0.52	0.65
15	0.27	0.41	0.55	0.69
20	0.29	0.44	0.58	0.73
25	0.31	0.47	0.63	0.78
30	0.34	0.50	0.67	0.84
50	0.45	0.68	0.90	1.13
100	0.79	1.19	1.58	1.98
200	1.52	2.28	3.04	3.80
300	2.26	3.40	4.53	5.66
500	3.76	5.64	7.52	9.40
1000	7.50	11.26	15.01	18.76
2000	15.00	22.50	30.00	37.51

6 Bathymetry

6.1 Total Propagated Uncertainty

1. Depth uncertainty is the uncertainty of the reduced depths. In determining the depth uncertainty all sources of uncertainties need to be quantified and incorporated into a statistical model to derive the TPU.

2. To provide a measure of the uncertainty of sounding achieved during a survey, and verify that the uncertainty criteria at Section 7.1 Single Beam Echo Sounder Uncertainty Requirements and Section 8.2 Multibeam Survey Uncertainty Requirements have been met, the ROS is to contain a table listing the standard uncertainty assessments for each of the components listed below.

3. An example of the layout of a table of assessed standard uncertainties in a sounding, for a survey in which the depth of water varied throughout the area from 50m to 200m is given in Table 5. The values given in the table are fictitious.

4. A list of those occasions where the criteria for sounding uncertainty is not achieved is also to be included in the survey report, with an explanation for each occasion.

5. Sources of Uncertainty to be Considered;

    a. Draught Setting: Draught setting is achieved by shallow bar check or comparable methods and should be determined and verified before survey operations start. For large vessels, the draught of the transducer is set by computations based on the ship's trim. The variation should be determined with an appropriate method at the beginning and end of a period of sounding.

    b. Sound Velocity: The SV is usually determined by sound velocity profile using a SVP, CTD or XBT. The uncertainty of the determination of SV will depend on the equipment calibration and the uncertainty of the echo sounder.

    c. Spatial Variation in SV: Depending on the survey location and extent, it is likely that SV will vary across a survey area, particularly in the vicinity of fresh water rivers or discharges.

    d. Temporal Variation in SV: In temperate climates SV will change with the seasons and although the sign of change can be predicted with some certainty, the rate of change of the value may be uncertain. In shallow water, marked local variations may occur throughout the day and during severe weather.

    e. Depth Measurement (Instrumental Uncertainty): The determination of depth by echo sounder depends on the internal precision of the machine.

    f. Motion: Heave, pitch and roll may be determined by motion sensor and correctly applied to the depth measurements. Heave should be observed in no less than 0.05m increments and for verification a reference surface may be used in combination with manoeuvring lines. Pitch and roll corrections should be recorded at no less than 0.1 degree increments.

g. Settlement and Squat: Settlement and squat can be quantified through the conduct of squat and settlement trials.

i. Tidal Readings: The uncertainty of tide readings will depend on the system used and the sea state at the time of reading. The standard error of the gauge reading can be determined during the calibration.

6. Tide Corrections: The uncertainty of the tidal correction, from single station or co-tidal model is to be estimated.

7. When the individual standard uncertainty of the various elements determining the uncertainty of a sounding have been assessed, they are to be combined into the total standard uncertainty (z) of a sounding by the basic combination of uncertainties formula. The co-variance between the elements is considered to be nil.

$z^2 = x^2 + y^2 + ...$

where: z is the total standard uncertainty,
x and y etc. are the standard uncertainties of individual elements.

Table 5 - Example of a Table of Total Propagated Uncertainty

SOURCE OF ERROR	At 200m	At 100m	At 50m
Draught Setting	0.1	0.1	0.1
Variation of Draught	0.05	0.05	0.05
Velocity of Sound	0.27	0.13	0.07
Spatial Variation in SV	0.13	0.07	0.03
Temporal Variation in SV	0.13	0.07	0.03
Application of Measured SV	0.13	0.07	0.03
Depth Measurement (Inst. Acc)	0.1	0.1	0.1
Heave	0.05	0.05	0.05
Settlement and Squat	0.1	0.1	0.1
Roll and Pitch	0.7	0.35	0.17
Tidal Readings	0.06	0.06	0.06
Co-tidal Corrections	0.79	0.79	0.79
Tide Corrections	0.01	0.01	0.01
Total Propagated Uncertainty	1.16	0.94	0.84

6.2 Use of Side-Scan Sonar

1. The requirement to conduct a SSS search will be advised in the contract document. SSS searches are to be conducted along all leading lines, anchorages and recommended tracks.

2. SSS searches are to ensure a full bottom search of the survey area is achieved. Survey lines are to be spaced to ensure that the seabed directly under the transducer, and at least 50m beyond it, is insonified by the adjacent sweeps. Where practical, adjacent lines are to be run in opposite directions. Along leading

lines and recommended tracks the search should extend to the width of the channel or to at least 185m on either side of the centre line.

3. Prior to commencing a SSS search, and regularly during its execution, confidence checks are to be made using known features. These confidence checks must be documented in the QADP.

4. Sonar searches must be conducted at speeds at which all targets of 2m and greater in cross-section should produce a meaningful 'return'.

5. The optimum height at which to keep the fish above the seabed is equivalent to 10% of the range scale in use, i.e. using the 150m range scale the fish should be flown 15m above the seabed.

6.3 Examination of Seabed Features

1. Agreement between international hydrographic authorities has defined a significant bathymetric feature as a feature that has dimensions as follows:

Table 6 – "Significant Feature" Criteria

Depth	Is a Significant Feature if the variation in depth is Greater than
< 10m	0.1 x depth
10m to 40m	1.0m
> 40m	10% variation in depth.

For example:

in 5m of water a change of 0.5m is significant
in 20m a change of 1m is significant
in 45m a change of 4.5m is significant

2. Whilst it is desirable to investigate every feature which meets the above criteria, for SBES surveys in complex areas this will not be possible. Surveyors may need to use their own judgement as to which shoals warrant investigation, and in this matter they also need to consider the likely use of the area (draught of vessels etc.), and the likely significance of the shoal noting the general depths in the area.

3. At the end of each examination the SIC, being the only person with all the facts at their disposal, must give a firm opinion as to the status of each feature located. Findings are to be included in the rendered data. Newly discovered features which may be dangerous to navigation, and charted features which are found to be significantly changed, are to be reported without delay by Hydrographic Note.

4. See Section 7.8 for the requirements for obtaining the least depth over seabed features with SBES.

6.3.1 Wreck Investigations

1. For navigationally significant wrecks, and especially where the depth may be critical to navigation in the vicinity, the feature is to be wire-swept, or examined in sufficient detail by either MBES, SSS or diver so as to allow the SIC to make a firm

statement as to whether the least depth has been found, and to document the reason for any differences.

2. Where MBES has been specified for the survey, a large-scale plot of the navigationally significant wreck showing position, extent and least depth is to be produced. If wire-sweeping and MBES is not employed, side-scan sonar is also required for heighting of all navigationally significant wrecks. Side-scan sonargrams of such wrecks must be rendered as "Accompanying Tracings" (see section 11.4.9).

6.4 Variations

1. It is very likely that significant bathymetric features (see Section 6.3 for definition) which require an unknown level of additional work to fully delineate their least depth and extent will be detected during the course of a hydrographic survey.

6.4.1 Limits of Variations Included

1. Where significant bathymetric features are found to lie within the specified project area, or up to a distance of 185m outside the area, then examination, delineation and delivery of such work is considered to be part of the work of this survey, and is not considered to be a variation (unless otherwise stated in the contract document).

2. Where an examination or investigation of either doubtful data or a shoal is specified and listed as part of the survey, the work required to determine the extent and least depth is not considered to be a variation.

6.4.2 Limits of Variations Excluded

1. Where significant bathymetric features are detected more than 370m outside the survey project area and the least depth and extent of such dangers requires them to be determined such work is deemed to be a variation and the work should be referred to LINZ before being undertaken.

6.5 Shoal Soundings

1. The examination of all indications of shoal areas or of other dangers, whether new or already charted, is one of the most important aspects of any survey. No survey can be considered complete until all shoals and dangers have been examined, and any charted shoals or dangers which have not been located have been conclusively disproved. The failure to find charted shoals should be reported in detail with recommendations concerning future charting.

2. Where the scale of the survey allows (see Section 2.9), sufficient soundings are to be inserted on the Standard Sheet to indicate that a full examination has been made in the vicinity of each new or previously charted danger. The least depth obtained is invariably to be shown.

3. On drying shoals the least depth is to be established by observation whenever practical and reduced to tidal datum.

4. It is the responsibility of the SIC to ensure that all dangers are fully examined, and that charted shoals are verified or disproved. In the absence of a careful search and a definitive report proving the non-existence of a previously reported danger or shoal sounding, charted detail is to be retained.

5. All shoals located during the course of any survey are to be examined with respect to position, extent and least depth. Shoals are to be proved or disproved with a definitive statement in the ROS, whether or not they have been examined and the SIC recommendation for subsequent charting action.

6. Advantage should always be taken of the local knowledge of fishermen (and others) to ascertain the existence and position of rocks and other dangers which are frequently known to them due to their attraction to fish.

7. Details of the required scales with which to perform shoal examinations are described in Section 2.9.

6.6 Disproving Searches

1. Best endeavours must be exercised in disproving charted wrecks, reported obstructions or other dangerous features which have not been located and examined during previous surveys. They will not be removed from the chart without a positive statement from the SIC that this is justified.

2. In determining the effort required to disprove a reported danger whose position is not accurately known the guidance at GIHS article 0752, Searches for Reported Dangers or Shoals is to be used.

3. Objects whose positions have been previously established, but which cannot be found during the survey, need a very detailed investigation to disprove them. Such searches are to include either full MBES insonification where the resolution of the sonar system can be proved to be better than the size of the target, SSS sweep in two directions at right angles to each other or, for SBES operations, a close echo sounding search over a radius of at least 0.5 M from the charted position. Consideration should be given to including a wire-sweep

4. When searching for an object whose position is known only approximately (usually a "PA") the sonar search (high-definition MBES or SSS) should also be undertaken in two directions at right angles and consideration should be given to extending the search over a radius of at least 2.5M.

5. Searches for charted wrecks outside of the main survey area must be extended to a radius of at least 2.5 M.

6.7 Channels, Leading Lines and Recommended Tracks

1. Whenever a survey includes a channel, recommended track or leading line in restricted waters, it must be very carefully sounded and examined. Where possible this is to be by full MBES insonification or SSS search.

2. A distance of 200m either side of the leading line is to be to be examined unless otherwise specified in the contract. This is especially important when the terrain is rocky or the channel lies between reefs or rock ledges, or if the seabed is believed to be mobile and subject to sand-wave activity.

3. If a leading line or recommended track is found to be unsuitable, consideration should be given to recommending alternatives (consulting local authorities where possible), which must also be fully examined and shown on the Ancillary Sheet.

4. The true bearing of the leading lines is to be determined and annotated on the Ancillary Sheet and detailed in the ROS.

6.8 Shallow Water Sounding

1. The contractor must demonstrate during the contract that every effort has been made to survey in shallow waters. Examples are as follows:

    a. posting bow and stern lookouts at all times when sounding in shallow waters;

    b. carrying out a reconnaissance at low water;

    c. sounding suspect areas in shallow-draught boats or inflatables fitted with portable echo sounders prior to the survey vessel entering the area or ahead of the vessel; and

    d. carrying out a MBES or SSS sweep parallel to the shore, or a series of such sweeps successively closer inshore, prior to commencing sounding.

2. Contractors should also consider the value of local knowledge. An effort is to be made to obtain advice and information by contacting potential sources prior to commencement of the survey. Such sources may include local harbour authorities, fishermen, yacht clubs or articles of local knowledge in the local press.

3. When surveying within harbours and boat havens, it should be remembered that drying heights and the location of foul ground, in areas where small craft anchor or take the ground, are very important to owners, and should be precisely surveyed whenever possible.

4. In undertaking surveying operations close inshore, particularly in close to poorly charted and/or coral features, all care must be taken to ensure the continued safety of the vessel.

5. Any area deemed too hazardous for sounding operations by the SIC must be reported to LINZ during the fieldwork stage.

6.9 Reporting New Dangers

1. It is of paramount importance that any new danger located is reported without delay and the SIC must take steps to ensure that all such dangers are brought to the attention of LINZ immediately.

2. The SIC is to advise the method of establishing least depth over new dangers (e.g. predicted tides, observed tides, etc.) and an estimation of TPU of the position and depth.

3. Changes to charted information not posing an immediate threat to the mariner may be promulgated via a Hydrographic Note using the form included at Annex A, available on the LINZ website or use of the mobile app available for Android or Apple smartphones.

6.10 Automated Systems – Logging Parameters & Sounding Selection

1. In all cases, the ping rate should be determined so that the sounding positioning criteria for the project are met when sounding speed and survey scale are taken into consideration.

2. Automatic sounding selection is an aid to processing logged data and to the production of final digital depth models and subsequent plotting of standard sheets. Processing parameters should be set to achieve a sounding density appropriate for the scale of the survey.

3. The SIC should ensure that any gaps in soundings are not the result of missing data, and that no significant soundings have been omitted. Care should be taken in selecting processing parameters so as to minimise the need for further editing.

4. Where automated sounding selection algorithms are used to thin digitally logged soundings the system is to use a Shoal Biased True Position model.

6.11 Reducing the Soundings

1. In reducing soundings, the principle to be observed is that depths are never to be shown greater than they actually are, relative to sounding datum.

2. All soundings are to be corrected for vessel draught.

3. Squat, settlement, pitch, roll, yaw and heave are to be recorded as appropriate to the platform type and soundings reduced accordingly.

4. All soundings are to be reduced for tidal heights unless otherwise stated.

5. Soundings must also be corrected for variation in sound velocity (SV) as described in 6.12 Observation of Sound Velocity.

6. See Section 9.8 Reduction of Soundings for Tide.

6.12 Observation of Sound Velocity

1. Sound velocity must be measured at 6-hourly intervals for MBES operations and 12-hourly intervals for SBES operations. For MBES operations the SV must be monitored in real time at the transducer head. SV should be re-observed when the difference between the existing SVP value and the observed value at the Transducer head exceeds 1m/sec. The interval between SV measurements may be relaxed at the discretion of LINZ.

2. Determination of SV must be by an independent method other than by echo sounder. Velocity must be measured to better than 1 m/sec.

3. For soundings in depths less than 200m, the SV can be determined by SVP or CTD probe.

4. For SBES soundings deeper than 200m, the SV correction can be determined by probe (e.g. XBT, CTDS, SVP etc.) or by deriving corrections from NP139 or other approved digital record. Whichever method is chosen, evidence must be produced

to confirm that errors obtained in measuring SV will not cause the sounding error budget to be exceeded. SV is to be applied to SBES soundings as a harmonic mean of the obtained profile.

5. For MBES soundings deeper than 200m, the SV correction must be determined by probe (e.g. XBT, CTD, SVP etc.). For MBES soundings, SV observations are to be made to a minimum of 95% of the anticipated water depth and used to generate velocity profiles for reduction of bathymetry.

7 Single Beam Echo Sounder Operations

7.1 Single Beam Echo Sounder Uncertainty Requirements

1. Four orders of survey (LINZ-Special to LINZ-3) are used by LINZ to identify the uncertainty criteria whenever use of a SBES is specified.

   The maximum allowable depth uncertainty for LINZ SBES surveys is stated as a function of multiples of 1.0, 1.5, 2.0, and 2.5 times the IHO Special Order depth uncertainty for reduced depths. The maximum allowable uncertainties associated with each order are detailed in Section 5.

7.2 Single Beam Echo Sounding Equipment

1. If two systems are used, the preferred system is to be nominated "Primary".

2. The system must produce a digital record that is capable of being processed in an automated system.

3. The system is to operate at frequencies capable of determining the first bottom return in depths less than 40m.

4. The system is to continuously track the bottom in steeply shelving areas.

5. Where the system has multiple frequencies then the highest frequency is to be operated and logged in depths less than 40m.

7.3 Calibration of Single Beam Echo Sounding Equipment

1. Echo sounders must be calibrated precisely and adjusted for draught setting, index error and sound velocity. Allowance must be made for vessel squat.

2. Index error and draught setting (TX) are to be determined from a shallow bar check and corrected for by adjusting the draught control on the echo sounder recorder. This method ensures that the echogram record can be directly related to the digital record when checking and validating data.

   a. The spacing of the marks on the bar lowering lines should allow for the appropriate mark to be placed on the sea surface when bar-checking, and not at the deck-edge.

   b. The shallow bar check should be carried out on a weekly basis for all inshore work.

   c. Between bar checks the echo sounder draught setting should be adjusted for known changes in the draught of the vessel.

d. When a bar-check is not possible due to sea state, etc., the transmission line should be set at the depth of the transducers below the waterline or determined by another method.

3. In depths below 30m, the SV as determined by probe (see Section 6.12) is to be verified on a weekly basis by deep bar check. This check should also be carried out at the start and finish of sounding (in any depth) or if changing area. If accurate bar checking is impossible, SV should be determined by probe alone (CTD or SVP).

4. Where an echo sounder has multiple frequencies, each frequency is to be calibrated independently in order to allow for the different response times of the transducers. When such echo sounders are used, the depths logged in digital form are to be those arising from the highest frequency used, to ensure that the highest resolution is maintained.

5. Vessel squat effects from minimum speed to survey speed, and over a range of water depths, are to be determined from carefully controlled trials. Squat is to be applied to all measured depths where the effect exceeds 0.05m.

6. The lengths of bar-check lines may change significantly due to wear, stretch, temperature and the effects of corrosion due to the ingress of salt water. Except where the bar is the same length as the beam of the craft at the position of the echo sounder transducers, the bar check lines will not hang vertically in the water, and allowance for this must be made when they are constructed to ensure that the markings on the lines are such that the bar will be lowered to the correct depth below the sea surface.

7. The lengths and markings of bar-check lines must be verified at mobilisation and demobilisation.

7.4 Speed Whilst Sounding

1. When determining the speed at which to conduct sounding the surveyor must consider the depth of water being sounded and the pulse repetition rate of the echo sounder. High speed combined with a slow pulse repetition rate may lead to small but significant features being missed, particularly in shallow water. The surveyor is to adjust the ping rate to achieve the target detection requirements at the chosen survey speed: this should ensure the detection of all significant features.

2. A general formula for calculating the depth at which five pulses should insonify a target of given size at different speeds is (source: GIHS):

$$D = \frac{(S \times 1852/3600 \times 5/prr) - t}{2 \tan(\phi/2)}$$

Where:

D = least depth of detection (metres below transducers)

S = speed in knots

t = along track dimension of target to be detected (metres)

ϕ = echo sounder's beam width (fore and aft) in degrees.

prr = pulse repetition rate (pulses per second (Hz))

3. As a normal rule, the echo sounder should be operated in the shallowest range scale possible and at the highest frequency possible (and therefore the highest pulse repetition rate). In very shallow water, or on a steeply sloping seabed or coral atoll, it may still be necessary to reduce speed.

7.5 Density of Soundings

1. In detailed surveys on the continental shelf, the spacing of sounding lines will generally be determined by the scale of the survey. For SBES it will be usual for these to result in line spacing of 5 mm at the rendering scale. This spacing is to be adopted for all detailed surveys unless discretion is given to increase the spacing between lines of soundings in particular circumstances.

2. Additional soundings are to be obtained along recommended tracks, in any indentations in the coast that may be used as anchorages, or off headlands where a mariner may pass closer to shore than normal.

3. Where irregularities are found to exist, or where the nature of the seabed or adjacent coastline features may indicate previously undetected dangers, the areas must be more carefully sounded using interlines and/or cross-lines.

4. In detecting shoals the Contractor must make the most of an efficiently spaced network of sounding lines which both maximise the possibility of detection and minimise the effort required to sound the area (see Section 6.5).

5. For surveys using SBES, unless otherwise specified in the contract, the spacing for sounding lines are;

Table 7 – Sounding Line Spacing

Depth	Line Spacing
0 - 200m	5 mm on paper at rendering scale
200-1000m	10 mm on paper at rendering scale but not more than 800m on the ground
>1000m	1 kilometre intervals on the ground

This equates to:

Scale of Survey	Sounding Line Spacing
1:5 000	25m
1:10 000	50m
1:25 000	125m
1:50 000	250m
1:100 000	500m

7.6 Direction of Single Beam Echo Sounder Sounding Lines

1. When sounding is not being undertaken concurrently with a SSS sweep, the lines should generally be run approximately at right angles to the trend of depth

contours if these have been established, or at right angles to the coast when working near the shore.

2. In the vicinity of jetties or wharves, lines are to be run parallel to the line of the berths to indicate where shoal depths may extend from them.

3. Additional lines of soundings are to be run along the line of recommended routes and leading lines identified on the survey ground.

4. In many cases, where an anchorage exists in a coastal survey, it may be desirable to differentiate it from the surrounding work by running additional lines of soundings. Any indentation of the coast which may afford an anchorage in times of stress, or any headland which vessels will pass close to on normal passage, must receive special attention.

5. When working in areas where the existence of sand waves is known or suspected, sounding lines should be run at right angles to the line of the crests to avoid the possibility of missing the crest-lines should soundings be run parallel to, or along, the troughs.

7.7 Single Beam Echo Sounder Cross-Lines

1. Cross-lines are to be run at angles of 60° to 90° to the main track-lines.

2. Cross-lines are to be run at intervals no greater than 20 times the line interval of the main track-lines (e.g. at intervals of 10 cm on paper if the main track-line interval is 0.5 cm on paper).

3. Cross-lines should also be run whenever the SIC is not satisfied that the normal sounding has revealed all significant features, as well as in sand wave fields, near headlands, in bays and along channels and recommended routes.

4. A statistical comparison of raw data between the main survey track and the cross-line is to be undertaken to ensure that the uncertainty requirements of the order of the survey are met. A summary of the statistics and definitive statement about the results are to be included in the ROS.

5. Whenever cross-lines reveal a discrepancy in depth exceeding twice the sounding uncertainty specified in the contract, the discrepancy is to be investigated, resolved if practicable, explained and detailed in the weekly progress report.

7.8 Examinations with Single Beam Echo Sounder

1. Some shoals found during sounding or inter-lining will require detailed examination to determine the least depth. Unless specified in the contract for the elimination of doubtful data, the decision to conduct an examination lies with the SIC. Consideration must be given to the position and probable least depth of the shoal, the seabed topography and the draught of vessels operating in the area.

2. During examinations, the vessels speed must be sufficiently slow to ensure that all pinnacles are located.

3. Line spacing during examinations must be determined by considering the footprint of the sounder's beam and the probable extent of the shoal. At times it may be necessary to run lines as little as 5m apart.

4. The surveyor should have available a predicted tidal curve so that the least depth can be recognised when found. The surveyor should keep a tally of the least depth and its position on each line so that the approximate shape of the shoal can be established.

5. When the least depth has been found a hand lead-line is to be dropped on it to confirm the depth and obtain a bottom sample where possible. If a diver is available the lead can be held on the shoalest point, and a bottom sample and description of the shoal can be obtained. In many cases the only positive means of establishing the least depth over a rock pinnacle or wreck is by use of a wire drift sweep or by divers.

6. Where diving or wire-sweep is not possible, the least depth is to be obtained by saturation sounding. The required line spacing is to be calculated from the echo sounder beam width and general depths in the area, allowing an overlap of at least 25% between lines of sounding.

7. Details of the required scales with which to perform shoal examinations are described in Section 2.9.

8 Multibeam Echo Sounder Operations

8.1 Corrections to be Determined and Applied to Multibeam Soundings

1. Platforms utilising MBES systems must be fitted with peripheral equipment which can provide corrections for the following;
    - Vessel Heading
    - Vessel Roll
    - Vessel Heave
    - Vessel Pitch
    - Vessel Speed
    - Vessel Squat and Settlement
    - Vessel Draught
    - Vessel Positioning
    - Vessel Offsets
    - Synchronised Timing
    - Velocity of Sound in Water
    - Tidal Time and Height

8.2 Multibeam Survey Uncertainty Requirements

1. Four orders of survey (LINZ-Special to LINZ-3) are used by LINZ to identify the uncertainty criteria whenever use of an MBES is specified.

2. The maximum allowable depth uncertainty for LINZ MBES surveys is stated as a function of multiples of 1.0, 1.5, 2.0, and 2.5 times the IHO Special Order depth uncertainty for reduced depths. The maximum allowable uncertainties associated with each order are detailed in Section 5.

3. As stated in Section 5, the system uncertainty criteria have to be met at the 95% confidence level over the full width of the selected swath. Outer beams may well have to be "rejected" in order to achieve the criteria. Rejected outer beams are only to be used for reconnaissance and are to be logged but not to be incorporated into the final processed data sets.

8.3 Seabed Coverage and Target Resolution Standards

1. The total coverage of the seabed and target resolution by a MBES is to be achieved by a combination of the following criteria:

8.3.1 Swath to Swath Overlap

1. For these Standards the swath width used to define any coverage is to be that part of the swath which meets the uncertainty standards (see Section 5):

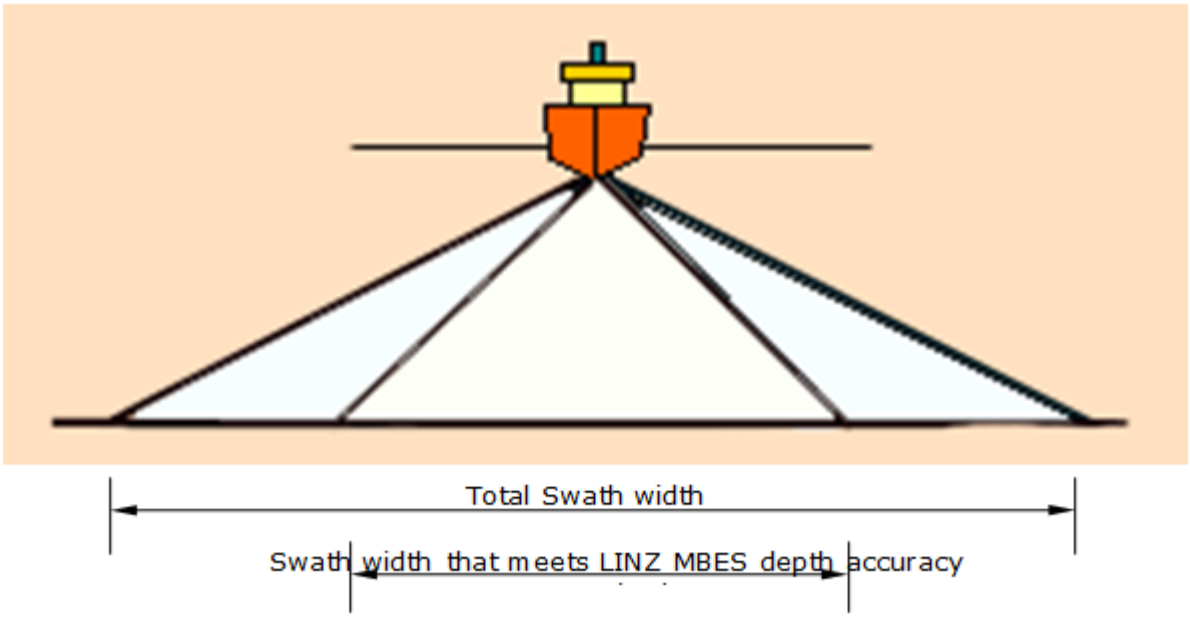

Figure 1: Usable swath width

Overlap for LINZ Special Order Surveys

1. For LINZ Special Order surveys 200% swath to swath coverage is required (see Figure 2). This coverage is to be of that part of the swath which meets the uncertainty standard of 1 x LINZ-Special.

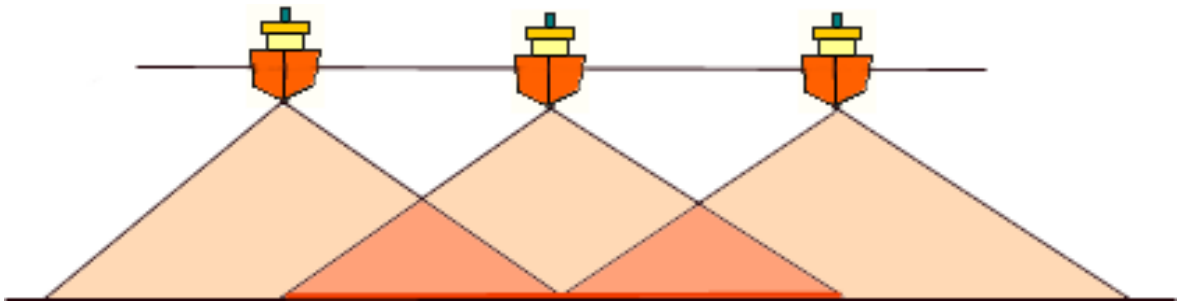

Figure 2: Swath coverage for LINZ Special Order (200%)

Overlap for LINZ Orders 1 to 3

1. The swath coverage for LINZ Orders 1-3 is to be 100% (see Figure 3).

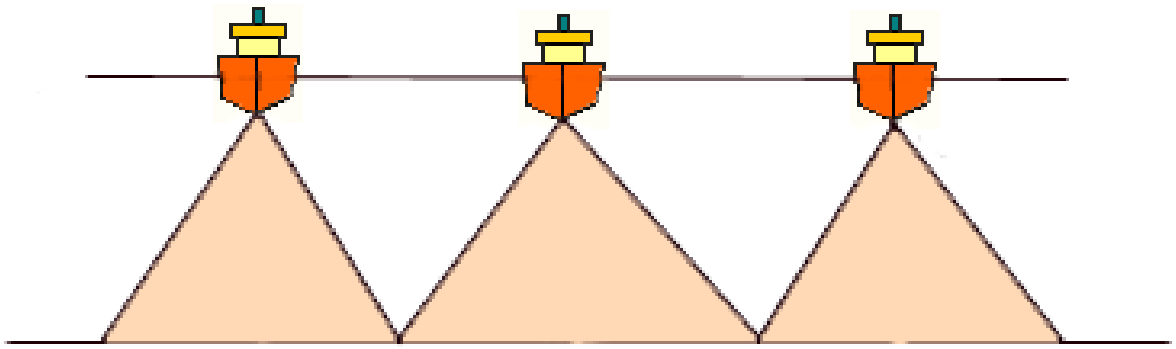

Figure 3: Swath coverage for LINZ Orders 1-3 (100%)

8.3.2 Target Resolution Based on Inter-Ping Gap

1. To ensure insonification sufficient to delineate small wavelength features on the seabed, a minimum of three along track and three across track strikes on a target of specified size are required.

2. To achieve the above, the centre-to-centre distance of each ping (i.e. the bore-site spacings) should be no more than half the required target dimension apart.

8.4 Multibeam Line Orientation and Spacing

1. Sounding track-lines are to be parallel to adjacent track-lines and also the bathymetric contours wherever possible.

2. Track-lines are to be spaced such that the depth uncertainty standard in the outer beams for the order of survey is achieved.

8.5 Multibeam Survey Cross Lines

1. Cross lines are to be run at angles of 60° to 90° to the main track-lines at intervals not exceeding 10cm on paper at the scale of the rendered sounding sheets.

2. A statistical comparison of the main survey swath and cross line swath is to be undertaken to ensure that the uncertainty requirements of the order of the survey are met. A summary of the statistics and definitive statements about the results are to be included in the ROS.

3. Cross line comparisons will be used by LINZ to assess quality of the data. Raw and Processed Data sets of track-line crossings may be required to be delivered at intervals throughout the survey for ongoing LINZ validation.

8.6 Acquired Data

1. Data acquired during turns and when following sinuous track-lines is to be logged but not to be incorporated into the final processed data-sets. However, on providing evidence that uncertainty requirements are acceptable during these manoeuvres, they may be incorporated into the final processed data-sets on the approval of LINZ.

2. The exception to this is data acquired during periods of calibration and testing. During these times all data is to be logged and processed.

3. Data acquired by the outer beams of the MBES which fall outside the required uncertainty standard are to be used for reconnaissance and are to be logged but not incorporated into the final processed data sets.

4. Data filtered and/or edited as erroneous is to be flagged as Rejected and included in the final processed data set, as per Section 12.1.

8.7 Multibeam Backscatter

1. For all MBES surveys for LINZ, high resolution, geo-referenced backscatter intensity is to be logged and rendered as a survey deliverable. As the method by which the backscatter intensity is derived is system specific, documentation of the method used is to be outlined in Section 5 of the ROS.

2. Changes to the settings of the MBES should be kept to a minimum during data acquisition to prevent artefacts in the resulting backscatter product.

3. Further guidance for best-practice methodology for the acquisition of seafloor backscatter data can be found in Chapter 5 of the reference document *Backscatter measurements by seafloor-mapping sonars: Guidelines and Recommendations* in Section 1.1.9.

8.7.1 Multibeam Backscatter Parameters to be Logged

1. The contractor should render all raw data backscatter data in the proprietary format of the HSS, with all system parameters recorded as indicated below. This is to allow post-processing of the backscatter.

    - Backscatter Intensity
    - Source level
    - Pulse Length
    - Transmit Beam Patterns
    - Receive Beam Patterns
    - Receiver Time Varying Gain Functions
    - Path Length Attenuation Characteristics, (Spherical spreading and absorption co-efficient)
    - Seabed Grazing Angle

8.8 Multibeam Echosounder Calibrations

8.8.1 Mobilisation Calibration

1. Calibrations of the MBES and all peripherals are to be undertaken prior to each survey project or after any significant component swap-out of the MBES system or associated sensors. Methodology and results are to be outlined in the Mobilisation Report in the format specified in 11.4.1. As a minimum, such calibrations are to quantify the following error sources or to verify their correct measurement:

- Sensor offsets
- MBES time latency
- Heading alignment
- Roll and pitch alignment
- Heave sensor measurements
- Sound Velocity Profile
- Vessel draught, settlement and squat changes whilst underway

2. The following procedures are to be undertaken prior to each survey project or after any significant component swap-out of the MBES system or associated sensors:

    - Target Detection Capability Verification to validate the system ability to detect targets of the minimum size required by the order of the survey. Such tests may include use of side scan to verify target detection capability, particularly in water depths under 40m.

    - Acoustic noise interference test. This test must demonstrate that the level of vessel noise at all combinations of propeller revolutions and pitches expected during the survey does not interfere significantly with the MBES system. The test must also demonstrate that acoustic noise from other vessel sensors expected to be in use during the survey does not interfere with the MBES system.

    - A comprehensive cross-line analysis or "patch-test" to verify the system capabilities after all corrections have been applied.

    - A Reference Surface (described below) is to be established and the entire integrated hydrographic survey suite tested by manoeuvring the vessel over the surface. This test will enable the SIC to place realistic operational constraints on the MBES system, i.e. as experienced during normal sounding operations.

3. The Reference Surface should be created in water depths of not more than 30m. A minimum of four parallel lines are to be run with at least 150% overlap, ensuring the inner beams overlap to provide redundancy. For MBES systems with a swath width of two times the water depth, the line spacing should be less than the water depth to provide sufficient overlap. At least four parallel lines are to be run perpendicular to the previous lines with the same swath width and overlap. The same speed is to be maintained for all lines and a run-in of at least 800m is required to provide sufficient settling time for the MRU.

    A series of check lines are to be run as follows inside the reference surface: two parallel lines (overlap not required) and one where the vessel manoeuvres as experienced during normal sounding operations close to the shoreline.

    All data is to be corrected for sound velocity, tides, vessel draught and motion, cleansed of outliers and the outer beams of the swath removed to ensure a high confidence reference surface is produced. A digital terrain model is to be created from the cleansed data using an average gridding algorithm, with a cell size no larger than the average footprint of the inner beams. Each beam depth from the processed check lines are then compared against the reference surface and statistics computed. Statistics are to include: beam number, mean, maximum and minimum differences and standard deviation.

4. LINZ will make every effort to conduct a mobilisation visit to the survey location as close to the start of fieldwork as possible. This will be arranged during the contract initiation. For MBES Surveys LINZ will witness a patch test and manoeuvring lines over the pre-defined Reference Surface as outlined in 8.8.1.3. Data in accordance with Section 12.1.3 is to be provided during the mobilisation visit to enable LINZ to verify the calibration and performance of the integrated survey system.

8.8.2 Periodic Calibration

1. The following errors have to be quantified by calibration on a six-monthly basis or after any significant component swap-out, or suspected damage to the MBES system or associated sensors. In addition, the following errors have to be quantified immediately prior to demobilising the survey vessel at the end of a project.

    - MBES time latency
    - Heading alignment
    - Roll and pitch alignment

8.8.3 Daily Verifications

1. The following daily checks are to be undertaken during MBES operations:
    - Transducer draught measurement.
    - Comparison of the MBES centre-beam data with a single beam survey echo sounder.

9 Tidal Observations

Primary Reference: *Admiralty Tidal Handbook No.2*

9.1 Sounding Datum and Chart Datum

1. Sounding Datum and Chart Datum are defined as follows:

   a. Sounding Datum is a low-water plane to which soundings are reduced and above which drying heights are given on the Standard Sheet and in other survey records.

   b. Chart Datum is the level to which soundings are reduced on the published chart and to which tidal heights are referred in the NZ Nautical Almanac NZ 204 (NZNA). It should be a plane so low that the tide will seldom fall below it but some datums, fixed many years ago, do not conform. Chart Datum may, or may not, be the same as Sounding Datum.

2. The datum to be used during the survey will normally be described in the survey contract, and may not always be that of the published chart. If it is not, care must be exercised when comparing surveyed depths with the chart. All references to the datum used during the survey should bear the wording "Sounding Datum".

3. Whenever a tidal station is established for longer than one spring/neap cycle, any datum transfer should be checked at or near at least one subsequent spring tide.

4. The suitability of the Sounding Datum is also to be checked by inspecting the coastline and drying heights on a day when the tide falls close to datum. Comments on this check are to be made in the rendered reports.

9.2 Establishing Datum

1. In many cases, surveys will be conducted in areas where a datum value already exists. If the BMs associated with the original datum can be recovered, datum is to be re-established by levelling. If all of the BMs have been destroyed, datum must be established afresh.

2. If an incorrect datum is chosen, or the datum is revised as a result of data collected during the survey, the rendered data is to be adjusted to conform to the amended datum prior to rendering the deliverables. When the data is referred to a single tide station, a simple block shift can be applied to the data. In the case of reduction using multi-station models the contractor is to describe and justify the method used to apply tidal adjustments to the data. In all cases LINZ is to be consulted prior to adjustment.

3. All interim soundings are to be reduced using either predicted or observed tides, corrected for temporary datum and then reprocessed for the correct datums once it has been confirmed. Temporary datums are to be established by semi-diurnal sounding datum transfer.

4. New datums must be connected by levelling to a minimum of three benchmarks in the vicinity of the tide station. When recovering datum, levelling is to be conducted between the tide pole and all of the available marks. Full details of all transfers, observations, levelling comparisons are to be detailed in the Tidal Data Pack.

5. If, during the course of a survey, the datum is found to be unsuitable for any reason, LINZ should be informed without delay. Any adjustments made to the datum during a survey are to be fully documented in the survey report.

6. On an open coast, sounding datum may be determined by conducting a transfer from an appropriate reference tidal station using the range ratio method as described in the above Primary Reference.

7. In an estuary, or narrow bay, where the range of the tide alters progressively, datum everywhere should be the low water level of a tide which falls to CD at the main port, or tidal station, as advised by LINZ. However, care is necessary in the transfer of datum from one part of the estuary to another, and it must be borne in mind that the actual tidal characteristics will vary from place to place. In addition, meteorological effects (e.g. persistent winds causing the water to pile up) may often affect one shore more than another.

8. In river estuaries, narrow bays and rivers the transfer method of establishing datum is not appropriate. Refer to Sections 12 to 14 of the above Primary Reference. Datum in a river cannot normally be established by transfer from a gauge outside the river. It must be remembered that as the tide progresses up the river the heights of MHWS and MLWS gradually approach each other until they become coincident. Still further up, Neap tides sometimes fall lower than Spring tides. The positions at which these changes take place can only be established by observations at Spring and Neap tides by suitably placed gauges.

9.3 Connections to Benchmarks

1. Sounding datum must always be connected to at least three permanent existing or newly established BMs close to each tidal station. These BMs will be used as witness marks for future recovery of the sounding datum or for checks on movement of the gauge or pole.

2. Levelling is to be conducted between the three BMs and the tide pole. Levelling is to comprise a looped traverse recorded to the nearest mm and shall meet the requirements of the LINZ Class I Standard as outlined in LINZ documents LINZS25005 and LINZS25006. If old BMs have been destroyed, were established in unsuitable locations, or local intelligence suggests that they may be disturbed, new marks should be established and levelled to. Where the GNSS Tide Buoy methodology has been approved by LINZ, the vertical relationship between the GNSS Base Station and the BMs must be established.

3. Levelling is to include all locatable BMs used during the course of any previous tidal observations at the location, regardless of whether or not they are considered permanent for the purposes of paragraph 1 above.

9.4 Establishing Tidal Stations

1. Each tidal station will comprise; two tide gauges capable of recording tidal time and averaged sea level height; a tide pole/GNSS buoy; and a minimum of three BMs close to the gauge. Both tide gauges are to record data, one is to be used as the primary gauge, the second as a backup in case the primary gauge fails. A GNSS buoy may replace a tide pole with LINZ approval.

9.5 Calibration of Tide Gauges

1. Modern digital tide gauges should not be adjusted in the field and should be returned to the manufacturer for repair if found to be recording erroneous data. Standard procedures for pre-deployment checks are contained in the manufacturers' handbooks.

2. The calibration or connection of the gauge to the pole and thereby to the BMs may be conducted by recording pole and gauge readings at 30 minute intervals for a period of at least 13 hours and as close as possible to spring tides. For the period 30 minutes either side of high and low water, readings should be taken every 10 minutes. Alternatively, with LINZ approval, the installation of a GNSS buoy in close vicinity of the gauge, and from which 1 second epoch post-processed heights can be computed can be substituted for the pole. The gauge readings are to be plotted with the pole/GNSS buoy values along the Y axis and the gauge values along the X axis to display the pole/GNSS buoy to gauge relationship.

3. A straight line fit between the pole/GNSS buoy and gauge readings will mean that a linear relationship exists between pole/GNSS buoy and gauge. This is the Tide Gauge Calibration Curve and is to be rendered with the TDP. The Gradient, Intercept and RMS error must also all be rendered.

4. A table with the following three columns detailing all the raw pole/gauge readings is to be rendered in the TDP:
    - Time
    - Raw Pole Reading or 10 minute smoothed Post Processed GNSS buoy Reading
    - Raw Gauge Reading
5. All rendered sheets detailing the calibration must state the tide gauge make, model, serial number and location as well as the date and times that the calibration took place.

6. Gauge readings are to be verified for reliability and uncertainty by using the Calibration Curve before being converted to pole/GNSS buoy heights, then reduced to sounding datum heights before being used for reduction of soundings.

7. Once established, a daily check of the tide pole and gauge is to be conducted to ensure that the relationship remains valid. The frequency of this check may be relaxed on written approval from LINZ. If a gauge becomes defective and has to be re-established, then a new calibration must be conducted.

8. When an established tide gauge (usually belonging to a local authority or port company) is to be used, the gauge zero versus datum value must always be checked by the calibration procedure described above to ensure that it corresponds to the stated figure. Most Port gauges have the zero set to CD. This check is to be documented in the TDP.

9. Where the GNSS Tide Buoy has been approved by LINZ the vertical movement of the GNSS Tide Buoy must be determined in relation to a local GNSS Base Station.

9.6 Use of Co-Tidal Models

1. If co-tidal reduction methods are specified, the contractor should construct a co-tidal model for the survey area.

2. If co-tidal reduction methods are employed, the contractor must outline in the TDP the extents of each zone of the model, and the parameters that are applied within each zone.

9.7 Tidal Observations

1. The contractor must always obtain observations for each of the tidal regimes which may occur within the survey area to ensure that an accurate tidal model can be constructed.

2. Tidal observations are required for the reduction of soundings and for predicting tidal characteristics and updating NZ 204.

3. Tidal observations are to be recorded for 35 days or the duration of the survey, whichever is longer.

4. The following recording parameters are to be used for all tidal observations:

   a. Time of sea level measurements is to be recorded to within +/- 5 seconds of UTC.

   b. Sea level height is to be recorded to within +/- 0.01m. The recorded value is to be an average of height samples taken over a minimum of 30 seconds centred on the time of reading.

   c. Averaged sea level height is to be recorded "on the hour" and at intervals not greater than 10 minutes.

5. Digital tide gauge data is to be rendered together with relevant deployment records and logging parameters. It is important that gauge data is correctly annotated to differentiate it from the pole readings. Digital tidal data is to be stored in ASCII files in terms of time and height to the nearest 0.001m.

9.8 Reduction of Soundings for Tide

1. In reducing soundings, the principle to be observed is that depths are never to be shown as greater than they actually are, relative to chart datum (sounding datum).

2. When using manual tidal reduction techniques, a true tidal curve obtained from tide pole or gauge readings (corrected to sounding datum), and adjusted if necessary by co-tidal factors, is to be reproduced on the echo sounder trace. This line is to be used throughout as the zero for transferring soundings directly from the analogue trace.

3. In digital logging and processing systems, the tidal data for each station, whether predicted or observed, will be in a discrete file. The processing software will utilise the data to interpolate the tidal heights as required, and reduce the raw depths to Sounding Datum

4. In some circumstances, it may be sufficient to use predicted tides for the reduction of soundings. Such predictions are to be generated from approved computer prediction programs and must be approved by LINZ before acceptance of the rendered survey.

5. Tidal reductions applied to soundings are to be periodically checked for validity.

6. In some circumstances, especially when using conventional survey methods in bathymetrically complex areas, consideration should be given to splitting the survey area into multiple sub-areas centred on localised secondary tidal stations.

7. LINZ may specify in the survey contract the preferred method of reduction of soundings and tidal model, and surveyors are to report any problems with implementation of these instructions.

8. In areas where the character of the tide is unknown, tide poles or gauges should be set up at regular intervals. A comparison of the curves from adjacent gauges should show whether any intervening area requires a separate tide station and, subsequently, whether a co-tidal model should be used.

9. It is often possible to refine a co-tidal model, or guard against gross errors, by mooring the survey vessel in a convenient part of the area where the seabed is flat. Depths are then taken at regular intervals for one or more tidal cycles. From these observations, which must be taken in calm weather, and preferably near Spring tide, approximate range ratios can be obtained, as well as the time differences for High and Low Water. The flat bottom sounding method described above should only be used as a last resort.

10. As a precaution when undertaking coastal surveys, the times at which detached drying rocks are awash should be noted and compared with the tide reduction values. If the reductions are always the same at the times that the rock is awash on successive rising and falling tides, and particularly if the rock is awash at half-tide (greatest rate of change), then there can be no doubt that the correct reductions are being used. If significant differences occur, the reductions are incorrect. Results of this check should be included in the "TDP".

9.9 Tidal Streams and Currents

1. The direction and rate of tidal streams are to be observed wherever they are of navigational significance and where there is no evidence that observations have been made previously. Locations for tidal stream observations will normally be indicated in the survey contract, but Surveyors-in-Charge are to include additional stations if they observe significant stream activity elsewhere. Entrances to harbours, channels, navigable straits, anchorages and in the vicinity of wharves are the most important locations. Short term observations should not be made under abnormal weather conditions.

2. When observations are made using either a moored digital recording current meter or a vessel-mounted acoustic Doppler current profiler (ADCP), the tidal stream data (rate and direction) must be recorded for the upper-most 6m of the water column.

3. Moored current meters should be deployed for a 30 day period, but where this is not practical then the minimum requirement is to make measurements during the spring phase of the tidal cycle. Measurements averaged over a period of 3 minutes are to be recorded at 15 minute intervals.

4. Vessel-mounted ADCP observations would normally be made over 13 hour periods at both spring and neap tide. The frequency of observations should be adequate to ensure that analysis of the stream can meet the spatial resolution specified in the contract.

5. Tidal stream rate and direction measurements should be made with an uncertainty of less than ± 0.1 knot and ± 5° (with respect to true north) respectively, both at 95% confidence. The positional uncertainty of moored current metres and ADCP measurements should be less than ± 20m and ± 2m respectively.

6. The operation of all equipment used for stream/current observations is to be confirmed prior to undertaking survey measurements and checked following the completion of the survey. A copy of the raw downloaded data is to be rendered in addition to the processed data.

7. When using a pole logship, it is practicable to observe tidal streams only over a limited period. The observations should be undertaken at Spring tide and are to last at least 26 hours in semi-diurnal waters, and no less than 49 hours in diurnal waters. Speed and direction for logships should be determined with an uncertainty of less than ± 0.1 knot and ± 5° respectively. When using a pole logship, all reasonable care is to be taken to prevent uncertainties which could result in faulty analysis and erroneous deductions regarding the character of water movement at the location. Logship observations are to be recorded and rendered in an appropriate format.

8. When observing tidal streams, simultaneous observations of tidal height must always be obtained at the nearest convenient location.

9. In addition to measuring the tidal stream using current meters or drifting logships, information of a less formal nature which may be of navigational significance is to be recorded and rendered, especially if it may effect low powered vessels or yachts. Data should include the estimated maximum rates at Spring tides and the directions of tidal streams assessed by the best available means. Local knowledge should be sought where possible.

10. Stream/current information is of particular importance in narrow channels, and may vary between the centre and the sides of the passage, and with the direction of flow. Data should be shown on the Ancillary Sheet or an accompanying tracing, and is to be described in Amendments to Sailing Directions and in the ROS.

11. In processing tidal stream information, results are always to be related to the closest standard port and are to clearly state the recommended text and numerical values to insert in the "tidal diamond" table to be included on the chart.

9.10 Eddies and Overfalls

1. In areas of strong tidal stream, especially in the vicinity of banks, rock shelves, headlands and in narrow passages, eddies and overfalls may occur which can be of considerable significance especially to low-powered vessels or yachts.

2. The limits of these phenomena are to be fixed on both directions of the tidal stream, inserted on the Ancillary Sheet, and remarked on in the ROS.

10 Miscellaneous Observations

10.1 Nature of the Seabed

1. Determination of the composition of the seabed, the collection of samples and interpretation of the side-scan sonar trace or MBES backscatter trace are required during surveys on the continental shelf (unless otherwise stated in the contract document). If seabed texture tracings are required, specific reference will also be made in the contract document.

2. In depths less than 200m, the nature of the seabed is to be obtained in the following situations:

    a. in all charted and likely anchorages;

    b. on all banks, shoals and seamounts, particularly where these are likely to be unstable, and in the channels between them;

    c. at regular intervals in a systematic pattern throughout the survey area. Unless otherwise stated in the contract document, the interval between samples is as follows: In depths under 100m at interval of 15cm on paper at the rendering scale. In depths between 100m and 200m this interval is increased to 25cm;

    d. as required to assist in the interpretation of side-scan sonar records or MBES backscatter records, and

    e. at the discretion of the Contractor.

3. All samples taken are to be recorded, photographed and reported in the ROS. The position and nature of the seabed samples are to be recorded. Sample types are to be classified in accordance with the types shown in INT1 Section J, Nature of the Seabed. If sample retention is specified in the contract, the samples required by subparagraphs a and b, and 10% of c and d above are to be rendered.

4. Samples are to be obtained by diver, grab or dredge. It is especially important to obtain a substantial sample when attempting to relate it to the seabed texture as depicted on the SSS or MBES backscatter trace. The Shipek grab should not be used for sampling soft or liquid mud, as the sample will wash out before the grab reaches the surface.

5. Some indication of bottom type can be deduced from good side-scan sonar or MBES records, and these are especially useful in deciding where one type of seabed merges into another; from this the surveyor may also be able to determine where additional sounding lines will be necessary, for instance in areas of rock or sand-waves. Areas of soft mud overlaying a hard bottom, as indicated by a dual-frequency echo sounder, are to be noted in the ROS.

10.2 Fresh Water Springs

1. The positions of any fresh water springs are to be fixed during normal surveying operations. Indications of such a spring may be obtained from the echo sounder trace and must be verified by water samples.

10.3 Fixing of Floating Navigational Marks

1. Lightships, light floats and buoys should be fixed in both their flood and ebb positions to determine the range of movement and, if the variation is plottable, the limits of drift should be shown on the Ancillary Sheet. The mean position should be shown on the Ancillary Sheet and used in correspondence.

2. When a mark is found to be sufficiently displaced as to be a navigational hazard, it is to be reported immediately by Hydrographic Note.

10.4 Characteristics of Aids to Navigation

1. The characteristics of navigational lights, whether ashore, on beacons or floating marks, are to be carefully checked in the field and compared with the entries in up-to-date light lists in NZ 204 and the Admiralty's Volume K, and on the relevant charts. Light sectors are also to be checked in the field. Such checking is to be done by ship-borne observation and logging the arcs and cut-off.

2. Where differences in the details are found, local authorities should be asked whether the changes are permanent. Discrepancies are to be forwarded in the reports or by Hydrographic Note if considered more urgent. Any lights found to be unlit or to have significantly modified characteristics are to be reported immediately to LINZ by Hydrographic Note. To avoid ambiguity, the Light List publication and the International Number of the light are always to be quoted when reference is made to a listed light.

3. The characteristics of all lights, beacons and lit buoys checked in the field are to be shown on the Ancillary Sheet, or an accompanying tracing.

10.5 Secchi Disk Observations

1. Secchi Disk observations are to be performed when called for in the contract. Unless otherwise specified in the contract, observations are to be taken at 10km intervals in depths of 20-30m.

2. The extinction depth on the down-cast, the up-cast and the mean are to be rendered in the ROS together with the position of the cast. The apparent colour of the disc (e.g. Blue/green) is also to be stated.

10.6 Nomenclature

1. In general, names should be accepted from the latest maps (or charts) of an area, where these are published by an authoritative source. Names and spelling from maps (including topo and cadastral) are accepted for features above the level of MHWS.

2. In areas where there are no modern maps or charts, every endeavour must be made to ascertain the correct names and spelling from local authorities. The source from which names have been obtained should be given in the "ROS".

10.6.1 Name Proposals for Newly Identified Features

1. Names for newly identified undersea features may be proposed by the surveyor and used in the survey. The Report of Survey (ROS) is to indicate which new names are proposed and brief reasons for choosing them.

2. Where a feature has a name in use locally, its origins should be ascertained and summarised in the ROS. Proposed names (whether new or locally known) may appear on 'Standard Sheets' and other documents accompanying the Report, but should be shown in brackets to indicate their provisional nature.

3. It is undesirable to have too many names. The need to name a feature depends primarily on its significance to the mariner, navigation and to science and exploration. Names should not be proposed for minor or insignificant features.

4. The contractor is responsible for ensuring that any locally used name that comes to light, or new name that is proposed during the undertaking of a hydrographic contract is forwarded together with all the required documentation to the New Zealand Geographic Board Ngā Pou Taunaha o Aotearoa (NZGB) for consideration.

5. For information on proposing an undersea feature name see: http://www.linz.govt.nz/regulatory/place-names/propose-place-name.

   or an information pack can be requested from:

   New Zealand Geographic Board Ngā Pou Taunaha o Aotearoa
   PO Box 5501
   Wellington, 6145
   New Zealand

6. All proposals and documentation for undersea feature names should be in accordance with the IHO document *Standardization of Undersea Feature Names:* at http://www.gebco.net/data_and_products/undersea_feature_names,

   and the NZGB's *Interim Standard for Undersea Feature Names NZGBS60000:* http://www.linz.govt.nz/about-linz/news-publications-and-consultations/search-for-regulatory-documents/DocumentSummary.aspx%3Fdocument%3D234.

7. The following is a summary of the NZGB and IHO principles which should be followed when assigning names to features:

   a. A new name is not to be proposed where there is an existing name for a feature, even though this may not conform to the accepted guidelines. Check the *New Zealand Gazetteer*, Sailing Directions, topographic maps, etc.

   b. Names should be short and simple.

   c. The principal concern in naming is to provide effective, convenient and appropriate reference; commemoration of persons or ships is a secondary consideration

   d. The first choice of a specific term, where feasible, should be a name which is geographical in nature, e.g. Canterbury Bight.

   e. Where a ship name is used, it should be that of the vessel discovering the feature.

f. Names of living persons will not be accepted.

g. Groups of like features may be named collectively based on themes, e.g. Star Reefs, where the individual features bear the names of stars.

h. Names should not be duplicated within New Zealand's area of charting responsibility and naming jurisdiction.

i. Descriptive names are acceptable when they refer to distinguishing characteristics, e.g. Halfmoon Reef.

j. Obscure, personal or flippant names are not to be used. The following categories of names must not be used:

- Names in poor taste
- Names that are in any way of a derogatory nature
- Names that are inappropriate
- Names that are insulting
- Names that are offensive

k. Names generally not acceptable are those that are:

- applied to similar feature elsewhere
- full names or unwieldy titles of individuals, institutions or organisations
- commercial products or their manufacturers
- friends or relations of the proposer
- of persons in high office who have not contributed directly and significantly to knowledge of the ocean or undersea geomorphology
- directional, qualifying or indistinct terms, eg. west, north, high, low, new, old
- misspelled
- in the possessive form
- inclusive of an apostrophe or hyphen

l. Acronyms or abbreviations are discouraged, but may be considered if the suggested name is otherwise deemed appropriate.

m. When using generic terms, the following definitions should be considered; however, generic terms should not be combined, as in "Shoal Bank". The following terms have been sourced from IHO S-32 - Hydrographic Dictionary:

- BANK - an elevation over which the depth of water is relatively shallow, but normally sufficient for safe surface navigation.
- REEF - A mass of rock or coral which either reaches close to the sea surface or is exposed at low tide, posing a hazard to navigation.
- SHOAL - an offshore hazard to surface navigation composed of unconsolidated material, except coral or rock.

(Other terms may be found in NP100, *The Mariner's Handbook*.)

10.7 Sailing Directions

(Ref. NZ Pilot NP51)

1. During the course of any survey, the relevant Sailing Directions are to be carefully examined and suggested amendments are to be included in the ROS. Notes for these amendments must be kept throughout the survey, as the need for them is realised, and the revised text should be compiled immediately after the completion of work in the field, when every essential point is still fresh in the mind. It is not possible to write Sailing Directions solely from study of the Standard and Ancillary Sheets. Familiarity with the content of Sailing Directions will ensure that the need for additional details, such as accurate positions, is addressed before the ship leaves the area.

2. Sailing Directions are written by the surveyor as information supplementary to the Standard Sheet, but should also be applicable, if possible, to the existing published chart. It should be borne in mind that the revisers of Sailing Directions do not normally see the Standard and Ancillary Sheets and will use the published chart when examining the surveyor's proposed text. It follows that reference objects should, whenever possible, be common both to the chart and rendered sheets.

3. As a general rule the Sailing Directions applicable to a survey will be covered by only a few pages in the published volume, but care must be taken to check the general information in Chapter 1 as well as any of the appendices which may be relevant to the area being surveyed or to adjacent localities.

4. Sailing Directions should always be checked whilst on passage or when visiting a new port and all changes reported to LINZ by Hydrographic Note.

10.8 Amendments to Sailing Directions

1. The surveyor should always be prepared to be more expansive in the text than is likely to be necessary for the published book. The Navigation Specialist will then be able to get a fuller picture of the area and will be able to condense or revise the proposed amendments with more authority.

2. Surveyors should write amendments to the Sailing Directions in their own words whilst adhering to the following principles:

    a. Treat the area in strict geographical sequence following the general direction of the published book unless this is obviously very illogical or inconvenient. In general, deal with matter in the order in which it will be sighted or used by a mariner arriving from seaward, or taking passage along the coast.

    b. Bear in mind that Sailing Directions are intended as a brief for the stranger arriving at a place for the first time. Set out in words a methodical description of the area step by step. Emphasis should be placed on describing waterways rather than coasts, eliminating information from the text which is not directly relevant and which can be obtained from the published chart. Remarks should start with a general description of the area, covering topography and landmarks, together with any other information of a general nature, such as tidal streams, affecting the entire area. Thereafter it should be broken down into sections of 10 to 30 miles, depending on the amount of information available, with the larger ports being treated as individual sections. Particular attention should be paid to

information which is difficult or impossible to show on the Standard Sheet or in other records.

c. When amending an existing text it is important to realise that the Navigation Specialist needs to know the detail of the new information and that which has changed as well as that which is no longer correct and should be deleted. Additions shall be denoted by the used of *blue italics* and deletions shall be denoted by the use of ~~red strikethrough~~.

d. Important navigational marks are to be fully described in the Sailing Directions. Leading lines, recommended tracks, and measured distances are also to be fully described, and should include appropriate pilotage advice.

e. Whenever possible, any structure specifically mentioned in Sailing Directions should be illustrated by photographs (see Section 12.1.5) and general views (photographic or manuscript). These are especially valuable in the approaches to ports, and along recommended leading lines.

f. Directions for channels, approaches and entrances to harbours should always be given just as an embarked pilot would advise a mariner when approaching for the first time. Such directions should have been used in practice, or obtained from local pilotage sources, and not merely written up from an inspection of the survey after leaving the area.

g. Ports and harbours must be fully described as an *aide memoir*. To avoid unnecessarily long descriptions of large ports it will often suffice if copies of port brochures and regulations are obtained and forwarded with the Sailing Directions. Attention is also drawn to Section 3.9 Coastal and Harbour Facilities.

h. Where applicable, details of several shoals in a given locality may be indicated by a general statement referring the reader to the chart, e.g. "Within 1.5 miles NNE of Cape Best a number of shoals exist, the positions of which can best be seen on the chart". It is most important that ambiguous and vague statements be avoided, e.g. "Another shoal lies a little further to the west".

i. Tidal streams, overfalls, and currents in the area should be described. There is no need to produce tidal stream tables that would result from observations and shown on some charts, but a semi-tabular layout is often possible and preferable to lengthy sentences in the text.

j. Metric units are to be used for depths, heights and distances on land, whilst distances at sea are to be given in nautical miles and decimals. Cables are not to be used.

k. Positions should be quoted to two decimal places e.g. 41°17′.20S., 174°46′.53E, (DD MM.MM).

10.9 Amendments to Other Publications

1. The following publications are also to be checked for any errors or omissions during the course of the survey. Proposed amendments are to be included in the ROS:

    a. New Zealand Nautical Almanac NZ 204,

b. Admiralty List of Radio Signals,

c. New Zealand Light List,

d. Admiralty List of Lights Volume K.

10.10 Photographic Views

1. Photographic views should be utilised to show navigational hazards and significant bathymetric features when awash/dry.

2. Whilst NP100 specifically describes the methods to be employed for illustrating Sailing Directions, the same techniques should be applied to the illustrations in the ROS in order to assist the cartographer in interpretation of significant features in the survey area which are not appropriate to Sailing Directions. Thus panoramic views of a coastline to illustrate cliff lines and prominent features or to illustrate that certain charted features are not visible to the mariner, should be obtained in a similar fashion and rendered with the ROS.

3. It should be remembered that photographic views of low-lying coastlines may not be particularly effective; in these circumstances a hand-drawn view using an expanded vertical scale will often be preferable. It will often be useful, however, to obtain a photographic view from the same position as a hand-drawn sketch for comparison purposes.

4. Photographic views should be utilised to show navigational hazards and significant bathymetric features when awash/dry.

11 Processing and Rendering of Data

11.1 General Principles

1. The care and attention devoted to work in the field must be extended to all aspects of preparing the fair data, and to the careful and legible annotation of all original material. The underlying principle to be observed in compiling records of any survey is that they must be entirely intelligible to any person having a sound knowledge of the type of survey concerned, and who may be required to process either the final data, or the original field data. The preparation of all data in the established manner, neatly, concisely and accurately, is absolutely vital.

2. The SIC has a prime and very personal responsibility to ensure that the records being prepared by all personnel are compiled in accordance with established practices, that they are fully and independently checked by personnel who are entirely familiar with those practices, and that they are accurate and legible. The SIC is to sign all major items of written data rendered, and by so doing accepts that they are of a sufficiently high standard to be accepted by LINZ and subsequently published for use by mariners. Material which does not require a signature must nevertheless be prepared to the same standards, and the fact that it is being forwarded under cover of a ROS or similar document carries the same implications and obligations.

3. Inadequate or erroneous data will be returned to the Contractor for correction at the Contractor's cost.

11.2 Custody and Security of Survey Data

1. The SIC is to ensure that there are positive measures in force to ensure the safe custody of all original and survey data in whatever form, and that there is a place of safety that the data can be taken to should the compartments on board or on-shore drawing offices be threatened by fire, flood or other damage.

11.3 Collection, Collation and Checking of Data

1. A rigorous and thoroughly documented QC and checking procedure must exist throughout the survey.

2. The SIC must establish regular routines for checking that the logging system is recording the same figures that are being displayed on peripherals such as nav-aids, echo sounder recorders, and other instruments. They must ensure that the data is recorded correctly and they must ensure that the manual inputs (such as system configuration changes, navigation system data changes, C-O corrections, etc.) are inserted accurately. Such changes must always be approved by the SIC and recorded appropriately.

3. As data is recorded, whether automatically or manually, the surveyor must constantly monitor whether it appears consistent with adjacent data already collected. Any apparent inconsistency must be investigated promptly and appropriate corrective action taken. Whenever records are transposed into another form by calculation or transcription, it is essential that they be fully checked by an independent surveyor. The SIC must ensure that fail safe arrangements exist for such checking processes.

4. In particular, when the final fair records of the survey are being prepared, whether on digital media or as a graphic, report or form, it is vital not only that the physical transcription should be checked but that all related documents are examined for consistency and accuracy.

5. In preparing survey records the following general considerations should be borne in mind:

    a. Much of the final data will be unique, will form the basis for amending and maintaining charts and publications until the area is re-surveyed (probably very many years in the future) and will become part of the national archives as a public record.

    b. Where practicable, 'field' records should be rendered as 'final' records; this will be possible only if they have been neatly prepared and presented in the form required with all necessary additional information inserted. Deletions are not to be erased, but ruled through. Copying from one form to another for the sake of slightly improved neatness, or typing a form which in manuscript was sufficiently clear already, should not normally be necessary and introduces the possibility of transcription errors. Where it is deemed necessary to transcribe original field notes, originals are to be forwarded.

    c. The number of graphics should be kept to the minimum, and their sizes should not exceed that of an A1 sheet.

    d. Compilation of survey data should be progressed concurrently with field work in order that it can be rendered as expeditiously as possible.

    e. All Reports of Survey (ROS) must be comprehensive, detailed, but concise. The ROS is the vehicle whereby the SIC can explain in full all aspects of the survey which would not otherwise be clear.

6. In a sound Quality Control (QC) environment, all alterations or adjustments to data will be documented and approved by a checker. In practical terms this means that:

    a. Checkers must be nominated and accountable.

    b. Any changes to data must be justified and recorded. Suitable annotations or notes on relevant traces and printouts or remarks in a Post Processing Log are required.

    c. Checkers must ensure that corrective actions taken as a result of the QC process have been satisfactorily carried out before the work is approved; this can be achieved by authenticating signatures incorporated on data sheets and in processing logs.

7. The formal checking of manuscript records against references and original data, the independent checking of computations and the signing of graphics and records that have traditionally taken place are all manifestations of proper quality control.

11.4 Data to be rendered to LINZ

1. Unless otherwise stated in the survey contract, the following data and reporting in DRAFT format is to be rendered on completion of the survey for LINZ comment, in digital form, i.e. Microsoft Word, PDF and GeoTIFF, as appropriate:

    a. Report of Survey

b. Standard Sheet(s)

c. Ancillary Sheet(s)

d. Tidal Data Pack

e. Geodetic Data Pack

f. Quality Assurance Data Pack

g. Digital media

h. Field Records (calibration data, log books, field plots, QA Checklists and subsidiary Hydrographic Forms).

2. On completion of any remedial works highlighted by LINZ, the following FINAL data and reporting is to be rendered in digital form i.e. Microsoft Word, PDF and GeoTIFF, as appropriate:

   a. Report of Survey

   b. Standard Sheet(s)

   c. Ancillary Sheet(s)

   d. Tidal Data Pack

   e. Geodetic Data Pack

   f. Quality Assurance Data Pack

   g. Digital media

3. All documents should be clearly labelled with the version i.e. **DRAFT** or **FINAL**, survey project title, project number, contract number, dates of survey and the contractor's name. Field records are to be fully annotated to a level which will allow data to be tracked from date of collection to final sounding on sheets. Wherever relevant, the forms in Annex A are to be used for presenting data.

4. The title pages of all rendered documents must include the text "Crown Copyright Reserved".

5. Rendering of survey graphics, reports, supporting data and documentation are to be approved and signed by the SIC.

11.4.1 Mobilisation Report

1. A comprehensive Mobilisation Report documenting the Integrated Survey System, the methodology, raw results obtained and processed results of the calibrations is to be rendered to LINZ for approval. Ideally this should occur prior to commencement of the survey work proper, however, survey work may proceed before acceptance of the report on the understanding that any errors detected by LINZ may result in re-acquisition or re-processing of collected data. This report is to contain evidence of compliance with this Standard to validate the SBES/MBES performance for the Order of Survey being undertaken. A copy of the report is also to be included in the QADP.

2. The Mobilsation Report is to follow the structure outlined in the following sections. The Title Page layout should be based along on the following example:

Project Number/Title of Survey
Contract Number
Surveyed by (Name of Company & Surveyor-in-Charge)
Surveyed for Land Information New Zealand
Inclusive Dates

MOBILISATION REPORT

Version

Date of Report

2.1 Introduction - The introduction should include an overview of the procedures conducted for the installation and calibration of equipment that comprise the Hydrographic Survey System.

2.1.1 Background and Outline of Events – A narrative giving an overview and timeline for the set-to-work of the survey platform(s).

2.1.2 Platform(s) – A description of, and justification for, the survey platforms chosen to undertake the survey.

2.1.3 Geodetic Control – Provide the geodetic parameters for the control survey, station diagrams and descriptions outlining the Geodetic control utilised for the survey.

2.2 Equipment – Provide a summary of equipment that forms the HSS as installed on the survey platforms, including all relevant offsets and calibrations.

2.2.1 Hardware – A summary of the hardware relating to data acquisition including manufacturer, model and serial number is to be tabulated.

2.2.2 Software – A summary of the acquisition and processing software, including version numbers is to be tabulated.

2.2.3 Sensor mounting systems – A description of the mounting system utilised for data acquisition is to be provided, e.g. pole mount, gondola, moon pool etc.

2.2.4 Sensor offsets – The measurement method and results for the dimension control that determine the relationship between the measurement sensors and the platform CRP are to be provided. Sensor offsets may be annexed to the report.

2.2.5 MRU Heading Checks.

2.3 Underway calibrations – The checks and calibrations of platform when underway are to be outlined. These may include:

2.3.1 Acoustic Sensor Bar Checks

2.3.2 Draft, Settlement and Squat

2.3.3 Primary & Secondary positioning

2.3.4 Patch Test – When MBES is used the method undertaken, and results of the patch test for the pitch, roll and heading bias are to be calculated and rendered.

2.3.5 Reference Surface – Difference Statistics between manoeuvring lines and the reference surface are to include; beam number; mean, maximum and minimum differences and standard deviation.

2.3.6 Target Detection – The ability of the HSS to meet the target detection criteria of the specified LINZ order are to be demonstrated.

2.3.7 Acoustic Interference Check – The results of the pre-survey Acoustic Interference Check are to be rendered.

3. All calibration reports, digital files and plots which have been used to validate the MBES system at any time during the survey are to be rendered as part of the Quality Assurance Data Pack (QADP).

11.4.2 Report of Survey

1. The ROS must give a clear and comprehensive account of how the survey was carried out, the results achieved, any difficulties and shortcomings encountered.

2. The Title Page layout should be based along on the following example:

Project Number/Title of Survey
Contract Number
Surveyed by (Name of Company & Surveyor-in-Charge)
Surveyed for Land Information New Zealand
Inclusive Dates
Scale Rendered

REPORT OF SURVEY

Version

Date of Report

3. The Title of the Report is to be consistent with that of the contract and other rendered data, including Standard and Ancillary Sheets. The Title section should also include an A4 size chartlet depicting the completed survey area. This chartlet should appear immediately after the Title Page and is to include sufficient topographic and geographic detail to be readily understandable without reference to any other source.

4. The ROS should be in two parts:

   Part One (Descriptive)

   Part Two (Technical Annexes)

5. A digital version of the report should be rendered to the LINZ Contract Manager.

6. The ROS is to be based along the following guidelines:

11.4.3 Part 1 (Descriptive)

(The SIC is required to comment on all sections listed below)

Introduction

1. Give start and finish dates. Remark on the scope of the survey, any particular difficulties encountered plus any non-surveying activities which interrupted the progress of the survey.

2. Give a general statement on the weather, including the seasonal climate and variations experienced. Comments on weather are essential when surveying unstable, critical areas which require optimum hydrodynamic conditions to determine the absolute minimum depth over each feature. Comments are also required on how the weather affected the quality of data - e.g. vessel motion, stability of nav-aid in storms, etc.

3. Provide a general overview and statement regarding the performance of the platforms deployed and their respective Hydrographic Survey Systems.

4. Comment on any extraneous activities (e.g. commercial fishing) which affected the conduct of the survey. Mention whether the strength of the tidal stream caused any particular difficulties. Mention any logistic problems.

5. Give an overall opinion of the completeness of the survey. Identify any areas which require further investigation. Include opinion of thoroughness of survey with regards to coverage, including line spacing as appropriate.

Geodetic Control

1. State the horizontal datum, projection, spheroid and grid used.

2. State how much existing geodetic control was used and briefly describe how any new control was established; give a general statement on the degree of uncertainty achieved.

3. Include a description of the GNSS observations for geodetic control. The description is to cover parameters, problems, solutions of any observations, either static or kinematic. A full description of geodetic observations is to be included in the Geodetic Data Pack.

Digital Surveying System

1. State the acquisition and processing components of the Hydrographic Survey System.

2. Briefly describe any difficulties experienced and venture an opinion of the effectiveness of the systems used.

Position-Fixing Systems

1. Briefly describe the types and operating modes of the systems used.

2. Give an opinion of the quality and reliability of the equipment.

3. For DGNSS, include a brief description of the system and the parameters used.

Bathymetry

1. State the type of echo sounders used and the transmission frequencies, especially where multi-frequency sets are used. State the results of squat and settlement trials conducted and how corrections for vessel squat were applied.

2. State the type of motion sensor used and give a brief summary of its performance.

3. State the sounding line direction, line spacing and average speed of advance. For shoal investigations, etc., state the density of the soundings and the seabed footprint of the echo sounder beam. Give a general statement of how the bathymetry meets the standards of uncertainty required by the contract and note the uncertainty of soundings achieved. Detail those periods when the uncertainty standard was not achieved and explain why.

4. For MBES operations state the logged format of the backscatter and provide an overview of any processing that has taken place.

Side Scan Sonar

1. State the types of sonar used and the transmission frequencies.

2. Mention the type and frequency of confidence checks carried out (cross reference to details described in the Quality Data Pack). Include an opinion of the quality and reliability of the sonar equipment.

3. State the choice of sonar line direction, line spacing, sonar range, and mean speed of advance.

4. State the sector sweep adopted for hull-mounted sonars; give an estimate of the effective ranges achieved.

5. State the allowance made for side-scan sonar layback at the end of lines and whether or not an extra line was run outside the required survey area limits to achieve a full search.

6. Give an opinion of the thoroughness of the sonar coverage and a definitive statement of the extent and category of side-scan search achieved.

7. State the logged format of the backscatter and provide an overview of any processing that has taken place

Seabed Sampling

1. Briefly describe the method of sampling used and mention any problems with the equipment or the recovery of seabed samples. State the sampling interval and any particular samples obtained from interesting features. Quote the number of samples retained (if any).

Seabed Topography and Texture

1. Give a description, which may include images, of the seabed topography of the surveyed area. Provide a statement in relation to all significant features, their nature and distribution throughout the survey area, including seabed characteristics and sediment types e.g. mud, silt, sand waves, gravel beds, rocky areas etc. State the reason if unable to investigate a shoal as thoroughly as desired and estimate the

reliability of the least depth obtained; identify the extra work needed to ascertain the absolute least depth.

2. Give an opinion of the comparison with previous surveys and any doubts on the detection of all existing (charted) shoal depths, or recommendations for retaining previously surveyed depths. Comment on any movement of sand waves when compared with previous surveys.

Tides and Sounding Datum

1. State where each tidal station was sited, how sounding datum was established, and why the sounding datum was chosen. Explain any transfer of datum involved and the use of co-tidal models.

2. State the types of sea level recording equipment used and the periods of use.

3. Mention any tide gauge malfunctions and any difficulties in obtaining tide readings, such as impounding or surge.

4. Quote the standard port used for reference purposes.

5. Provide an opinion as to the uncertainty of

   a) the method used to establish sounding datum,

   b) the tidal reductions.

6. An assessment of the scrutiny of cross-line intersections is useful.

7. Give a brief outline of the methodology used to reduce depth data to the sounding datum.

Tidal Streams

1. State the location, time (UTC) and method where tidal stream observations were carried out.

2. State what analysis has been carried out. Give an opinion as to the uncertainty of the observations.

Wrecks and Obstructions

1. Briefly describe the method of investigating wrecks and obstructions.

2. Provide a general statement on details obtained from fishermen or others with local knowledge.

Lights and Buoys

1. State whether or not light sectors or buoys were checked in the survey area or on passage, referring (if necessary) to a more detailed description in Annex J.

2. Whenever possible, the authority responsible for establishing any new light or buoy should be quoted.

3. Describe how the position of each buoy was fixed on the flood and ebb and quote the spread of position about the final accepted mean.

4. Give an opinion on the uncertainty of the observations to determine light sectors and positions of buoys.

Coastline, Topography and Conspicuous Objects

1. State whether these features were fixed or checked in the field and, if so, by what method, or whether they were adopted from another source, which is to be specified.

2. State how heights were determined. Comment on any significant changes such as foreshore erosion or significant soft sediment build-up.

3. Comment on any new man-made facilities such as marinas or jetties (which are also to be included in amendments to Sailing Directions).

4. Remark on those objects considered to be conspicuous. Include these in amendments to Sailing Directions and in Annex L .

Sailing Directions and Nomenclature

1. Remark on how views were observed. Remark as to whether charted names have been checked giving details of how this was done. Remark on any new names proposed. Comment should also be made as to whether amendments are required. Detailed information is to be included at Annex L .

Radio Stations

1. Provide a general statement on the reliability of the information published in ALRS. Specific detail is to be included at Annex N.

Annex N Ancillary Observations

1. Briefly outline any ancillary observations that were undertaken. These may include:
    a. fresh water springs;
    b. overfalls, eddies and tide rips (a marked up chart showing these, together with the validity of any previously reported observations is required);
    c. leading lines;
    d. measured distances;
    e. photography;
    f. transparency/water colour;
    g. any special scientific observations requested by the contract (e.g. magnetic variation, bottom photography, ocean currents, water sampling);
    h. recommended tracks.
2. Give an opinion of the usefulness of c, d and h and any recommendations for improving their direction and appearance.

Miscellaneous

1. Comment on any other facets of the execution and results of the survey which may be of value to LINZ or of historic interest when reviewed in future years.

11.4.4 Part II (List of Annexes: Technical)

1. Each Annex should commence on a separate page. Separate pages indicating Nil Return are required and should be noted in the List of Annexes within Part I as 'NA'.

Annex A - Accompanying Documents

1. List all the documents accompanying the ROS. Such items must include:
    a. Standard Sheet(s)
    b. Ancillary Sheet(s)
    c. Geodetic Data Pack
    d. Tidal Data Pack
    e. Quality Assurance Data Pack
    f. Field Records
    g. Digital Data
    h. Environmental Assessment (predicted and actual)
    i. Daily Narrative
2. The daily narrative listed above is to be kept by the SIC from the day of contract signing to the submission of the final deliverables. Items to be included are:
    - Record of daily activity.
    - A record of difficulties encountered together with actions taken.
    - A record of the progress of the project against the time-line.
    - A record of the weather, wind direction, wind speed, sea-state, swell directions and heights and any adverse weather which prevented survey activities.
    - A record of all data collection, data reduction, data processing and final deliverable parameters used during the course of the project with any difficulties or changes.
    - Any comments or observations that may be relevant to the project or compilation of the chart.
    - Provide adequate justification to support any decision to cease data collecting due to personnel, environmental or technical constraints.

Annex B - Digital Surveying System

1. Include a detailed description of system architecture for both acquisition and processing of data; system hardware; software version number, software packages; main software functions; suggested improvements (if appropriate); diary of defects.

2. List the offsets applied in the software for the vessels 'datum point'.

3. Outline all the parameters used in the post processing of data (e.g. heave compensation, attitude corrections, product creation e.g. sounding selections), and any significant issues encountered.

Annex C - Geodetic Records

1. List the co-ordinates and heights of all geodetic stations and other marks used to control the survey. Give details of how survey marks were fixed if this was done during the course of the survey. Include the source (i.e. authority) of all marks used. Mention any survey marks which no longer exist.

Annex D - Position Fixing Systems/Nav-aid Calibration Results

1. State the types of position fixing systems used for the survey. List all calibration results (C-O).

2. List the results of any confidence checks.

Annex E - Sound Velocity and Bar-Check Observation Results

1. State the method of obtaining sound velocity (SV) measurements.

2. List the dates, times, positions and results obtained for SV and bar-check observations. Render SV results separately as a Microsoft Excel spreadsheet. Render all components of the acquired SV Profile i.e. temperature, salinity and conductivity in its proprietary format.

3. When mean sound velocities have been calculated from XBT observations, the consecutive numbers of the XBT observations and the assumed salinity values used must be included.

Annex F - Levelling and Tidal Observations

1. Quote the levelling results in the form of a diagram, and state clearly the value of Sounding Datum established, referred to benchmarks and MSL.

2. List the tidal stations and briefly describe the application of tidal observations to reduce soundings.

3. Give an opinion of the uncertainty of the tidal/tidal stream observations with particular reference to the effects of the weather on data quality.

4. A detailed list of levelling and tidal information should be covered within the TDP.

Annex G - Uncertainty of Sounding and Horizontal Positions of Soundings

1. Tabulate uncertainty sources and likely uncertainty magnitudes (See Section 6.1 Total Propagated Uncertainty).

2. Give an estimation of the overall uncertainty of soundings.

Annex H - Significant Bathymetric Features (Shoal Summary) and Significant Charted Differences

1. Significant Bathymetric Features shall be presented in a table with following columns:
    - Identification
    - Latitude in the form DD-MM.MMMS
    - Longitude in the form DDD-MM.MMME/W
    - Depth / height observed
    - Description
    - SIC Comments / Recommendations
    - Method (how the depth / height was determined i.e. MBES, SBES, diver, levelling, low water inspection)

    Each entry listed should be given a unique identifying number. This number should appear in the geographic location on any graphic rendered showing significant features (see Section 11.4.8 "Ancillary Sheets"). The table shall also be rendered separately as an Excel spreadsheet.

    Example:

Unique ID	Latitude	Longitude	Depth/ Height	Description	SIC Comments	Method
SBF-01	36-11.402S	175-18.572E	1.2	Isolated dangerous rock. Charted as 2.7m	Substitute charted depth	MBES

2. List all features which differ from the surrounding depths by more than 10%. Explain briefly the reasons for the differences from charted depths.

3. In complex areas, such as a rocky seabed or sand wave areas only the really significant differences in depth need be listed. In such cases the controlling depth in the local area must be clearly identified.

4. Where significant differences occur between the present and previous depths and/or positions, the SIC must present a firm recommendation as to the charting action to be taken. It may be convenient to use a marked-up copy of the published chart or a print of the Standard Sheet to clearly convey this information.

5. Significant Charted Differences shall be presented in a table with the following columns:
    - Identification
    - Latitude in the form DD-MM.MMMS
    - Longitude in the form DDD-MM.MMME/W
    - Depth / height of existing charted feature
    - Description of charted feature
    - SBF ID (as required)
    - Charting Recommendations

Example:

Unique ID	Latitude	Longitude	Depth/ Height	Description of Charted Feature	SBF ID	Charting Recommendation
SCD-01	34-52.961S	173-17.088E	n/a	Group of dangerous underwater rocks of unknown depth	SBF-05	Rocks do not exist in charted position. Substitute with SBF-05 and soundings as depicted on standard sheet.

6. Data gathered as part of the Low Water Inspection, Coastlining and Survey operations is to be compared against the most recent edition of the charts which cover the survey area. Where charted features are found to be in error, the SIC is to provide a firm charting recommendation. If the charted difference is linked to a SBF discovered during the survey it is to be cross-referenced.

Annex I - Wrecks and Obstructions

1. Provide a detailed description of the methods used (e.g. diving or wire sweeping) to investigate wrecks and obstructions. Comment on any problems encountered with obtaining the least depths. Describe any disproving searches conducted in accordance with Section 6.6 Disproving Searches.

2. Provide details of the areas considered for each disproving search.

Annex J – Aids to Navigation/List of Light Amendments

1. Describe how AtoNs (beacons, buoys, lights and sectors) were checked and positioned. If any new AtoN has been established it should be fully described using the format in the NZ Light List, and the method of determining its position stated. List all discrepancies found between information shown in the NZ Light List and published on charts (updated for T and P notices).

2. List all AtoNs by name, light list number (where appropriate), characteristics and position (mean of flood and ebb fixes for buoys).

Annex K - Conspicuous Objects

1. List all objects currently charted as conspicuous by name and position, with comment on whether the description is still appropriate, together with objects considered conspicuous but not formerly charted as such.

Annex L - Sailing Directions Amendments and Nomenclature

1. Render amendments in accordance with Section 10.8 Amendments to Sailing Directions. Give recommendations for pilotage through the survey area (if appropriate). All charted names should be checked in so far as this is possible. List separately any proposed new names, with full explanation of the reasoning behind the need to name the feature and the selection of the proposed name.

Annex M - Views

1. Views, photographic or hand drawn, are to be listed and rendered in accordance with Section 10.10 Photographic Views.

Annex N - Radio Signals Amendments

1. List amendments for the appropriate ALRS Volume.

Annex O - Ancillary/Miscellaneous Observations

1. Provide details in as clear and concise a format as possible (preferably tabular).

Annex P - Reports of Dangers and Hydrographic Notes

1. List all reports of dangers and enclose copies of any Hydrographic Note raised.

Annex Q - Personnel

1. Provide a list of all key personnel and their role in the survey, with dates of their involvement.

Annex R - Diary of Notable Events

1. List all significant events (with dates) which have influenced the conduct of the survey. These may include:
   a. Establishing control
   b. Pre-survey checks/calibrations
   c. Start of fieldwork
   d. Post-survey activities

11.4.5 The Geodetic Data Pack

1. A digital copy of the Geodetic Data Pack is to be rendered for all surveys.

2. All sheets in the pack are to be numbered consecutively and initialled by a checker where appropriate.

3. The Geodetic Data Pack should include all hard-copy and electronic deliverables which are required by "*Specifications for Order 5 Surveys for Hydrographic Control - V 1.0"* (see Related Standards and Publications).

11.4.6 The Tidal Data Pack

A digital copy of the TDP is to be rendered to the LINZ Contract Manager for all surveys in which observations of tidal height and/or tidal streams have been made. It should consist of the sections listed below. Digital tidal and/or stream records are to be rendered as part of the TDP. An Interim TDP is to be rendered once 35 days of tidal data has been recorded.

1. Introduction

1.1. The introduction should include a full narrative of the procedures conducted for the establishment of tide stations, calibration of equipment, determination of datum and recording of tides and tidal streams.

2. Level Observations

2.1. This part of the report will describe the levelling between the benchmarks and the tide pole(s) or GNSS base station if a GNSS tide buoy is deployed.

2.2. Evidence shall be provided of the reliability of any recovered benchmarks.

2.3. Station descriptions and diagrams of all benchmarks used are to be included.

2.4. The type of level used and results of instrument checks are to be stated.

2.5. Reduced levels are to be tabulated and a diagram showing the relationship of the benchmarks to the Sounding Datum and other tidal levels is to be included.

2.6. Observation sheets are to be rendered as part of the report.

3. Transfer of Sounding Datum

3.1. This part of the report will describe the method used for any transfer of sounding datum that may have been undertaken.

3.2. The information used as the basis for selecting the reference port for each primary tidal station is to be presented in the report.

3.3. A summary of all observations and calculations is to be rendered.

3.4. Observations made to check the level of sounding datum (e.g. by inspection of the coastline and drying heights) are also to be rendered.

4. Gauge Calibrations

4.1. This section will describe how the relationship between the tide gauge zero and the BMs at each tide station was defined and how this relationship was verified throughout the period that tide gauge was operating, or has been altered and reconfirmed in the event of equipment failure.

4.2. All documentation relating to the tide gauge calibration is to be rendered. Details of the location, make, model and serial number of the tide gauge, the period covered by the calibration and the linear regression results are to be included.

4.3. All calibration observations are to be presented in tabular form.

5. Record of Tidal Observations

5.1. This section will provide details of the tidal measurements including dates of observation, frequency of observations and any significant breaks in the recorded data.

5.2. Digital tide gauge data are to be rendered as comma delimited text files.

5.3. The following metadata is to be supplied for each file:

- File Name
- Gauge Location
- Start and End Dates/Times (UTC) of Data
- Equipment details (make, model, type, serial number)
- Sampling details
- Factory Gauge Calibration Offset(s), if any

5.4. The body of the file will contain the original raw tide gauge data, one record per row, in a standard delimited format. Each record will include, as a minimum, fields

for Date, Time and Gauge Reading. Other fields, such as Notes, may be added if desired.

5.5. The row immediately preceding these records will state, in the same delimited format, the names of all fields included in each record.

6. Processing and Analysis of Tidal Data

6.1. The report is to summarise the quality control measures applied to the raw data and any edits made.

6.2. The contractor is to supply LINZ with a minimum of 35 days of tidal data, in the format outlined in 11.4.6 for analysis and determination of SD.

6.3. Discuss any derivation of tidal levels that has been undertaken as well as any use made of tide predictions.

7. Tidal Stream Observations

7.1. This section will provide details of the tidal stream measurements including dates of observations and the method(s) used to confirm the operation of the equipment used.

7.2. Digital tidal stream data are to be rendered as comma delimited text files.

7.3. The following metadata is to be supplied for each file:

- File Name
- Location
- Purpose (equipment check or stream survey)
- Start and End Dates/Times (UTC) of Data
- Equipment details (make, model, type, serial number)
- Frequency, cell size and depth, etc.
- Sampling details
- Factory Calibration Offset(s), if any

7.4. The body of the file will contain the original raw stream data, one record per row, in a standard delimited format. Each record will include, as a minimum, fields for Date, Time, Current Direction and Rate. Each record in an ADCP data file will also include the Depth, Latitude and Longitude. Other fields, such as Notes, may be added if desired.

7.5. The row immediately preceding these records will state, in the same delimited format, the names of all fields included in each record.

8. Tidal Stream Analysis and Processing

8.1. The report is to summarise the quality control measures applied to the raw data and any edits made.

8.2. A description of the software used to process the tidal stream data.

8.3. An analysis of the results obtained from the tidal stream measurements should be provided in the report.

8.4. Tidal stream outputs to be rendered will be specified in the contract and may include tidal diamond information and current details (for charting purposes), tidal stream animation, graphics.

8.5. This section should also present any additional information that might increase navigational safety. This information would generally be of a descriptive nature and include observations of phenomena such as eddies, overfalls and any unusual current conditions.

11.4.7 Quality Assurance Data Pack

1. The Quality Assurance Data Pack (QADP) must provide a continuous audit trail of quality control from initial signing of the hydrographic survey contract to the delivery of the final survey products to LINZ. The QADP must provide all necessary evidence that data gathered during the survey is of the required quality.

2. The QADP must be signed and approved by the SIC.

3. The cover of the QADP must be of a similar format to the ROS.

4. Hardcopy records (e.g. signed calibration records) should be scanned and included in QADP.

5. The QADP must be divided into the following sections:
    - Introduction
    - List of survey personnel
    - Equipment Bench Tests (Pre-Mobilisation)
    - Mobilisation Report
    - Periodic Calibrations
    - Integrity Monitoring System Checks
    - Data Processing Checks
    - QC Checks of Sheets
    - Reports

11.4.8 The Standard Sheet

(Ref. IHO INT1 - Symbols, Abbreviations and Terms used on Charts)

General

1. Digital versions of Standard Sheets are to be rendered as per Section 12.1.4 Digital Copies of the Signed Standard Sheets.

2. All Ancillary Sheets are to be presented in a format similar to the Standard Sheets.

3. Each sheet is to be signed by the SIC.

4. All Standard Sheets and Ancillary Sheets are to be rendered at A1 size.

5. Each Standard Sheet should depict the following information:
    - Shoal biased true position sounding selection
    - Contours

- Indicative coastline

6. All work on the Standard Sheet is to be completed in black ink. Care must be taken to ensure that all work is clearly legible and the minimum figure size is to be not less than 1 mm.

7. Sheets are to be identified by survey index and serial numbers. The survey project number is to be adopted as the index number and a logical serial numbering of sheets determined by the surveyor.

8. The Standard Sheet is to be drawn north-up with the title block along the bottom edge.

9. Grid and geographical intersections (ticks) are to be shown at an interval appropriate to the rendered scale; symbology should be chosen to readily differentiate between Grid and Geographical marks.

10. A border depicting grid and geographical labels is to be inserted around the extent of the sheet. The border must ensure that grid and geographical co-ordinates can be easily scaled off the sheet.

Symbols to be used on Standard Sheets

1. The symbols to be used on Standard Sheets should comply with the format within IHO INT1. Further guidelines are listed in the following paragraphs to this section.

Title Block

1. All Standard Sheets are to contain a title panel along the lower border of the sheet. The title panel must be fully completed for all Standard Sheets of a series.

2. It is important that information portrayed in the title block is relevant for the sheet it is printed on and not a carry-over from a previous sheet. Care should be taken not to use the same title block for all sheets as this may provide misleading or erroneous information on some sheets.

3. The title block should include the following headings and information as a minimum:

   Title:
   Client:
   Surveyed by:
   Date:
   Spheroid:
   Projection:
   Grid:
   Scale:
   Chart Limits (Grid):
   Chart Limits (Geographical):
   Depths in:
   Accompanying Tracings / Ancillary Sheets:
   Sounding Datum:
   Drawn by:
   Checked by:
   Crown Copyright Reserved

4. The following notes are issued to aid compilation of the title panel:

- **Title Section**: Insert project number, contract number and name of survey.
- **Surveyed By**: Include the name of prime contracting company and primary vessel used. The logo of the prime contracting company or the vessel logo may also be included if desired.
- **Client**: Insert the following logo (electronic copy available from LINZ):

- **Date:** Include the dates for the full period of the survey, from the first until the last survey activity at sea.
- **Spheroid, Projection and Grid (Zone):** Are to be completed if applicable.
- **Scale:** Clearly state the scale of the standard sheet together with a scale bar in kilometres. If the chart is a Mercator projection, state the mid-latitude and ensure that the scale is correct for the mid-latitude.
- **Chart Limits (Grid):** Insert the extreme grid extents of the standard sheet (see example):

	235000 N	
175000 E		185000E
	230000 N	

- **Chart Limits (Geographical):** Insert the extreme geographical extents of the standard sheet (see example):

	35° 25’ S	
178° 10’ E		178° 30’ E
	35° 35’ S	

- **Depths in:** Insert units (i.e., metres and decimetres) and specify the cut-off value for showing decimetres (normally 30m or 31m).
- **Coastline/Topography:** Is to include a brief description of how the depiction of the coastline and other topographic detail on that sheet was derived. Leave blank if no coastline/topography shown.
- **Accompanying Tracings / Ancillary Sheets:** A note is to be placed on the parent Standard Sheet directing reference to the Ancillary Sheet. e.g. See also sheet 147/3A - Accompanying Tracing.

- **Sounding Datum:** Is to describe the relationship between Sounding Datum and the tide pole and bench marks at the tidal site for which the soundings were reduced, e.g.: "Sounding Datum is 1.506m on the tide pole at Main Wharf, and 5.325m below BM 1/98, a hexagonal bolt set into the northern side of the Main Wharf, and 6.342m below BM 2/98, a steel plate set in concrete at the root of the Main Wharf". This description should be the same as that stated in the ROS and TDP.

- **Drawn by and Checked by:** Show printed names of the people responsible for compilation and checking.

- **Approved By:** Is for the signature by the SIC only.

- **Chart Number:** Chart number is to be divided into two distinct boxes. "Index Number" is to be the LINZ project number. "Serial Number" is to be allocated in a logical fashion by the contractor.

- **Crown Copyright Reserved:** This phrase is to be inserted close to the edge of the title block.

Index Sheet

1. Where more than two Standard Sheets are required to cover a survey area, an Index Sheet is to be drawn showing the coverage and layout of the Standard Sheets.

2. This Index Sheet is to be drawn on a Standard Sheet at a convenient scale e.g. that of an existing chart and is to show the following information:
   a. Borders of the Standard Sheets.
   b. Serial number of each sheet.
   c. Limits of the Survey area.
   d. Approximate coastline (pecked line).

3. Geographical ticks.

4. Geographical border.

The Meridian

1. The direction of True North is to be shown on the sheet in a convenient place. An arrow should be used to indicate the direction with the letter 'N' drawn above its tip. All Standard Sheets are to be drawn north-up.

Geodetic Stations

1. Primary Stations should be shown on the sheet as circles 6 mm diameter enclosing an equilateral triangle.

2. Secondary stations should be shown as circles 4 mm diameter if scale permits.

3. Sounding Marks should be shown as circles 2 mm diameter.

4. The station's distinguishing letter or LINZ Special Code (as detailed in the Geodetic Pack) should be written beside its symbol.

5. Circles and triangles are to be masked as necessary where they cross the HW line or any other detail.

Tidal Stream Information

1. The position of tidal stream observations is to be shown on the Ancillary Sheet as a tidal stream diamond drawn upright and containing a reference capital letter.

2. If the density of soundings precludes the insertion of the tidal stream diamond it may be shown on an accompanying tracing.

3. If full tidal stream observations have not been conducted but sufficient information has been gathered to warrant depiction on the Ancillary Sheet this should be in the form of tidal stream arrows.

Depths

1. Depths are to be truncated as follows:
    - to one decimal place between 0.1m and 30.9m, e.g. 4.68 becomes 4.6
    - to the whole metre (i.e. integer) for depths > 31m, e.g. 32.8 becomes 32
2. Drying heights are to be rounded up to the nearest decimetre, e.g. -0.31m becomes -0.4

3. Depths are to be drawn in Univers 55 Italic 'north-up'. Where sounding lines run in a due east/west direction depths may be drawn 'west-up'.

4. Soundings are amongst the most important data shown on the sheet and other detail must not interfere with their legibility.

5. Drying soundings (including soundings of 0m) are to be indicated by a horizontal line under the metre figure of the sounding. Isolated drying features such as pinnacle rocks are to be depicted by the appropriate symbol with the drying height in brackets beside it.

Determining the Gravity Position (Node) of a sounding

1. The centre of gravity of the sounding figures is to be derived as shown below.

Density of Soundings

1. For depths less than 99m, no more than 25 soundings per 2cm x 2cm square are to be plotted on the Standard Sheet. This also includes decimetre figures (see Figure 4). Density of soundings should be increased for examinations.

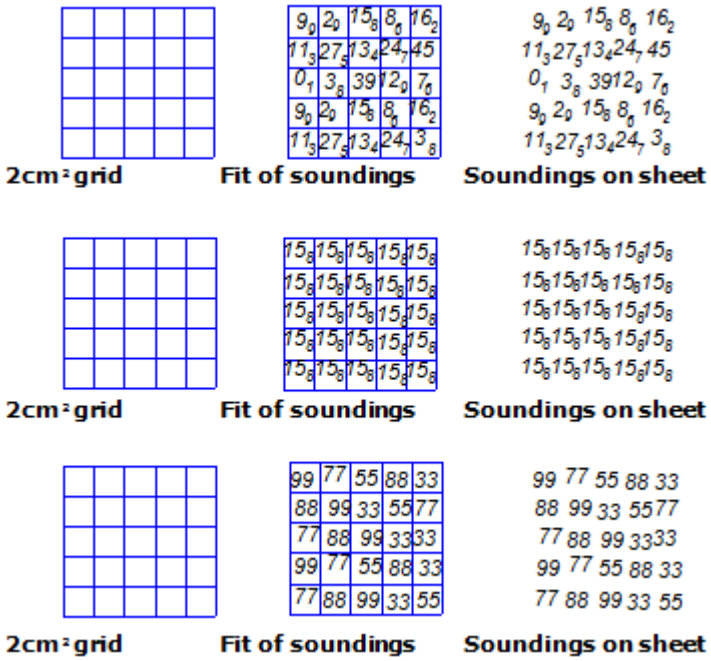

Figure 4: Density of soundings on standard sheet based for depths less than 99m

2. For depths greater than 100m, no more than 16 soundings per 2cm x 2cm square are to be plotted on the Standard Sheet. Decimetre figures are not required (see Figure 5). Density of soundings should be increased for examinations.

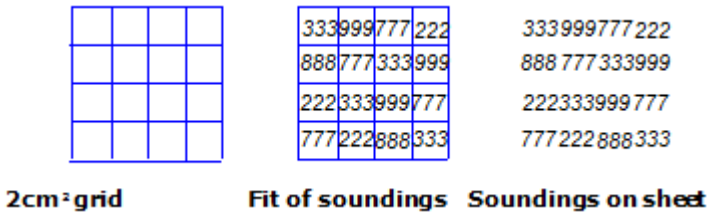

Figure 5: Density of soundings on standard sheet based for depths greater than 100m

Contours

1. Contours are to be plotted on to the same sheet as the soundings and supplied separately as per Section 12.1.2.

2. Contours are drawn as smooth curves broken as necessary where they pass written soundings. Where there are adjacent soundings of the exact value of the contour, the contour should pass through the centre of gravity of the sounding on the deeper side. However 'spot' shoals with the exact value of the contour should be encircled with a contour. A 'spot' deep with the exact value of the contour should not be contoured.

3. In intricate areas some contours (not the shoalest) may be omitted in the interest of clarity.

4. The following contours (none of which are to be labelled) are to be inserted:

   0.099, 2.099, 5.099, 10.099, 15.099, 20.099, 30.0499, 50.999, 100.999, 200.999, 500.999, 1000.999m and then at 1000.999m intervals

5. Where a contour is imperfectly defined it should be shown as a pecked line.

6. Contours are to be drawn in red ink.

The Drying Line

1. The drying line should be inserted as a continuous line where it is well determined and as a pecked line where it is not fully defined. Where it is formed by a particular feature, e.g. rocks, coral etc. the appropriate symbol from IHO INT1 should be used.

Coastline

1. The coastline, which is the line of MHWS, should always be drawn on the Standard Sheet.

2. If the coastline has been surveyed in the field or taken from aerial imagery, it should be inserted as a continuous line. A pecked line should be used if the coastline source is unconfirmed or it is imperfectly known e.g. the edge of mangroves.

Topography

1. Only topographic detail that has been surveyed in the field, or checked for uncertainty if from another source, is to be inserted on the Ancillary Sheet.

Conspicuous Objects

1. The positions of conspicuous objects are to be marked on the Ancillary Sheets using a circle 2 mm diameter with a central dot. The name of the object (if any) and its description e.g. tower, chimney etc. are to be written beside the symbol in upright capitals.

2. Other features whose positions are known and are useful for fixing, but are not considered conspicuous are to be marked with a circle 2 mm in diameter with a central dot. The name and description of the feature should be written alongside the symbol in upright lowercase.

Names and Legends

1. Names and legends on the Ancillary Sheet may be stencilled using the Univers style or written in stump. The following lettering styles should be used:

   Univers 55 Upright Capitals - prominent names on land.
   Univers 55 Upright - less prominent names on land.
   Univers 55 Sloping Capitals - prominent names in the sea.
   Univers 55 Sloping - less prominent names in the sea.
   Univers 45 - for all legends and other descriptive and less prominent writing both on land and sea.

2. All sloping styles should be at an angle of about 15°.

3. Where names are written on a curve, the curvature should be moderate and regular, and should either follow the shape of the feature or should trend away from the object towards the horizontal.

4. Where names or legends are written in a straight line they should be horizontal, unless written along a channel whose axis is straight, e.g. in a narrow dredged area, or along a leading line, recommended track, railway or other straight line.

5. Soundings and important detail must never be obscured by names or legends. When words have to be woven through soundings it is essential that the first and last letters are in the open and that the tops of all letters are complete.

6. If the density of sounding precludes the insertion of an important name on the Ancillary Sheet it may be inserted on an accompanying tracing.

7. The use of punctuation marks within the body of the Ancillary Sheet is to be avoided.

Measured Distances

1. The distance shown on the Ancillary Sheet between the terminals of 'Measured Distances' should be the spherical distance between those terminals.

Area Surveyed at Another Scale

1. The limits of areas surveyed at a scale different to that of the Standard Sheet are to be indicated with pecked lines and the legend 'Surveyed at (scale)' with year of survey underneath in brackets, e.g. Surveyed at 1:10,000 (2015).

Ancillary Sheets

1. Each Standard Sheet must be accompanied by an Ancillary Sheet. Ancillary Sheets are to be at the same scale and similar presentation to the Standard Sheet. Ancillary Sheets are to depict the following information:
    - Nature of the bottom, including seabed sample locations
    - Names and legends
    - Secchi Disk locations where applicable
    - Significant Bathymetric Features and identification number
    - Fixed and floating navigational marks, light characteristics and sectors
    - Leading lines or recommended tracks (including true bearing of leading lines)
    - Recommended alternatives to unsuitable leading lines or recommended tracks
    - Tidal streams and currents
    - Eddies and overfalls
    - Coastline with surveyed topographic detail
    - Conspicuous objects
    - Spoil grounds, dredged areas and sand-wave areas
    - Limits of sounding datums used

- Limit of the specified survey area (shown as black line labelled 'Survey Area Limit'
- Area swept by sonar or wire
- Depiction of swath extents (for MBES operations)
- Depiction of side scan sonar coverage
- Match-lines between Standard Sheets (match-lines should be black solid lines and should be labelled with the name of the adjoining Standard Sheet)

2. Where necessary for clarity, required information may be rendered on multiple Ancillary Sheets.

Checking Standard Sheets and Other Graphics

1. The contractor must produce documentation (e.g. check-lists) to demonstrate that a rigorous procedure has been followed in checking final Standard Sheets and other graphics. Completed checking documentation is to be included in the QADP.

11.4.9 Graphical and Other Data

Accompanying Tracings

1. If data cannot be depicted on the Standard Sheet or Ancillary Sheet (for example due to constraints of scale), then it may be presented as an 'Accompanying Tracing'. Information on such tracings may include:
    - Shoal Investigations
    - Disproving Searches
    - Areas swept by side-scan or wire
    - Nav-aid calibration data
    - Other information not able to be depicted on Standard Sheets or Ancillary Sheets
2. Where necessary a legend is to be provided on Accompanying Tracings to interpret symbols used.
3. The decision to render an Accompanying Tracing is at the discretion of the SIC. In certain circumstances flexibility may be exercised in determining the scale of such a tracing e.g. co-tidal factors and nav-aid calibration data may be shown more clearly at a scale smaller than that of the parent Standard Sheet.
4. A note is to be placed on the parent Standard Sheet directing users to the Accompanying Sheet, e.g. See also sheet 1200/3A - Accompanying Tracing depicting shoal investigation of "Rag Rock".
5. Accompanying Tracings must be of a format similar to the Standard Sheet. They may, however, be rendered at A2 or A3 size as appropriate.

Photographs

1. Digital images should be used to illustrate many aspects of surveying data, e.g. trig stations, BMs, leading lines, views for Sailing Directions, nav-aids etc. All digital images should be rendered to LINZ in JPEG format as taken by a modern digital

camera, to a suitable resolution to assist in further identification of features. All images are to be listed in a table identifying subject and file name.

2. In the case of photographic views for Sailing Directions, the following additional information is to be supplied:
    - Date and time (UTC)
    - Position of the camera in latitude and longitude (±0.1 mile)
    - Bearing and distance of a prominent charted feature (to within ±0.5° and ±0.1 mile, respectively if possible, especially if a leading line or similar view is being illustrated)
    - Other features, charted or uncharted, identified as described below
    - Height of camera above sea level
    - Type of camera
3. Where it is desired to draw attention to a particular feature on an image it may be accurately marked on a duplicate of that image

Field Records

1. All field records are to be rendered to the LINZ Contract Manager. Such records will include (but not limited to) the following:

    Plotting Sheets
    Track-plots
    Tidal Curves
    Notebooks
    Raw working graphics
    Calibration Records

2. Documentation is to be maintained and field records annotated with sufficient detail to allow the reconstruction of the survey at a later date. The following indicates some which will be required to be rendered:

    a. Logs for consecutively numbered and labelled echograms and side scan sonar records.

    b. Logs for processing of digital data by file name and correction applied.

12 Digital Data

1. All digital data obtained during the course of the survey is to be rendered. This includes raw, processed and rendered data.

2. An index of rendered digital data is to be produced together with a description of any proprietary file formats, headers used etc.

12.1 Types of Digital Data

1. Digital hydrographic data are required to be rendered for any hydrographic survey undertaken on behalf of LINZ as follows:

Raw Data

- Data: 100% of all data collected, no corrections applied but gross errors removed.
- Format: Proprietary.
- Media: Digital storage.

Processed Data Set (All pings)

- Data: The raw data with corrections for vessel motion, position, tide, draught, and sound velocity applied. All soundings are to be included in the data-set. Any soundings filtered or edited as erroneous are to be flagged as 'rejected' in the GSF file format.
- Format: GSF and comma separated ASCII XYZt, where:

  X is Longitude in WGS84 (+/-DDD.DDDDDDDD)
  Y is Latitude in WGS84 (-DD.DDDDDDDD)
  Z is corrected depth in metres (DDDD.DD)
  t is UTC date/time (DD:MM:YYYY HH:MM:SS)

- Media: Digital storage.
- File Size: The ASCII format data should be split into separate files not exceeding 1Gb in size.

12.1.1 Rendered Data Set (Thinned)

- Data: The shoal depth, true position sort of the processed data as rendered on the Sounding Sheet.
- Format: Comma separated ASCII XYZ, where:
  X is Longitude in WGS84 (+/-DDD.DDDDDDDD)
  Y is Latitude in WGS84 (-DD.DDDDDDDD)
  Z is corrected depth in metres (DDDD.DD)
- Media: Digital storage.
- File Size: The processed data set should be split into separate files not exceeding 1Gb in size.

12.1.2 Rendered Data Set (Contours)

- Data: Seabed contours.
- Format: DXF (real world co-ordinates).
- Media: Digital storage.

12.1.3 Mobilisation Visit Deliverables

1. Patch Test & Reference Surface manoeuvring lines:

- Data: Patch Test data files with angular offsets to zero and outliers removed.

  Reference Surface manoeuvring lines with angular offsets applied.
- Format: Bathymetry in proprietary format. To be accompanied by Predicted Tides (.csv), SVP (proprietary format) and motion data (proprietary format).
- Media: Digital storage.

2. Reference Surface:

- Data: Processed Reference Surface as outlined in 8.8.1.3.
- Format: GSF.
- Media: Digital storage.

12.1.4 Digital Copies of the Signed Standard Sheets

- Data: Digital copy of the signed authoritative Standard Sheets at the required density level.
- Format: High resolution GeoTIFF at 300 DPI.

  PDF.
- Media: Digital storage.

12.1.5 Digital Photographs

- Data: All original digital photographs for views, seabed samples etc.
- Format: JPEG.
- Media: Digital storage.

ANNEX A Hydrographic Forms

Examples of the following forms are enclosed for use by Contractors. In all cases where relevant data are collected, these forms or close copies of them must be rendered as a deliverable:

Form Number	Description
LHS F3	Level Observations
LHS F6	Transfer of Sounding Datum
LHS F4	Hydrographic Note
LHS F5	Hydrographic Note for Port Information

TRANSFER OF SOUNDING DATUM

(where tide is 'mainly semi-diurnal')

Date and time of 1st LW observation. _____

	At Established Station:					At New Station:				
	Heights above Chart Datum			Contributions for		Heights above zero of pole			Contributions for	
	H.W.	L.W.	Factor	H.W.s	L.W.s	H.W.	L.W.	Factor	H.W.s	L.W.s
a	-		1	-		-		1.000	-	
b		-	1		-		-	1.000		-
c	-		3	-		-		3.000	-	
d		-	2		-		-	2.000		-
e	-		3	-		-		3.000	-	
f		-	1		-		-	1.000		-
g	-		1	-		-		1.000	-	
Sums of contribution										
Observed MHW and MLW										

(Observed MHW = sum of HW contributions / 4)
(Observed MHW = sum of HW contributions /8)

Observed Mean Range (R) = _____ (r) = _____
Observed Mean Level (M') = _____ (m') = _____

(Obs. Mean range = Obs MHW-Obs MLW)
(Obs Mean Level = 1/2(Obs MHW+Obs MLW)

CALCULATION OF SOUNDING DATUM (d) AT NEW GAUGE

(A) Where 'True Spring ML' at established station is known

From Tide Tables (ATT or NZTT)

MHWS _____ m
MLWS _____ m
Half sum m=M
(True Spring M.L.)

d = m'-(M'-M)-M(r/R)

d = metres above zero of pole

(B) Where 'True Spring ML' at established station is not known

d = m'-(M'r/R)

d = metres above zero of pole

Lat _____ Long _____ Lat _____ Long _____

CONNECTION BETWEEN FIXED MARKS
AND CHART DATUM AT ESTABLISHED STATION

CONNECTION BETWEEN FIXED MARKS
AND SOUNDING DATUM AT NEW STATION

Remarks

_____

Date.

LEVEL OBSERVATION

LHS F3

Project:	Date.	Observer
Locality:	Time. Map No.	Recorder
BM'S:	Weather	Inst. No.
		Staff No.

Staff Station	**Distance**		**Back Reading**	**Delta Height**	**Inter Reading**	**Forward Reading**	**Delta Height**	**Rise**	**Fall**	**Reduced Level**	**Remarks**
		T **M** **B**									
		T **M** **B**									
		T **M** **B**									
		T **M** **B**									
		T **M** **B**									
		T **M** **B**									
		T **M** **B**									
		T **M** **B**									
		T **M** **B**									
Check Totals											**Traverse length (K)** ________ **km**
Reduced **Checked**					**Delta Height**						**Allow. M' close** ________ **mm** **Actual M'close** **mm**

HYDROGRAPHIC NOTE

Forwarding Information for Charts and Hydrographic Publications

Note: An acknowledgement of receipt will be sent and the information then used to the best advantage, which may mean immediate action or inclusion in a revision in due course. When a Notices to Mariners is issued, the sender's ship or name is quoted as authority unless (as sometimes happens) the information is also received in a foreign Notices to Mariners. An explanation of the use of contributions from all parts of the world would be too greater task and a further communication should only be expected when the information is of outstanding value or has unusual features.

INSTRUCTIONS:

1. Mariners are requested to notify New Zealand Hydrographic Authority, Land Information New Zealand, 155 The Terrace, PO Box 5501, Wellington 6145, New Zealand, when new or suspected dangers to navigation are discovered, changes observed in aids to navigation, or corrections to publications seem to be necessary. The *Admiralty* publication, *The Mariner's Handbook* (NP 100), Chapter 4, gives general instructions.
2. This form and its instructions have been designed to help both the sender and the recipient. It should be used, or followed, closely, whenever appropriate. Copies of this form may be obtained gratis from the New Zealand Hydrographic Authority at the address above, or in PDF format directly from the LINZ website, www.linz.govt.nz/hydro. Hydrographic Notes can also be sent from mobile devices using the Hydrographic Notes Application available for Android and Apple devices.
3. When a position is defined by sextant angles or bearings (true or magnetic being specified) more than two should be used in order to provide a check. Distances observed by radar should be quoted. However, when there is a series of fixes along a ship's course, only the method of fixing and the objects used need to be indicated. Latitude and longitude should only be used specifically to position the details when they have been fixed by astronomical observations or GNSS and a full description of the method, equipment and datum used should be given.
4. Paper Charts: A cutting from the largest scale paper chart is the best medium for forwarding details, the alterations and additions being shown thereon in red. When requested, a new copy will be sent in replacement of a chart that has been used to forward information, or when extensive observations have involved defacement of the observer's chart. If it is preferred to show the amendments on a tracing of the largest scale chart (rather than the chart itself) these should be in red as above, but adequate detail from the chart must be traced in black ink to enable the amendments to be fitted correctly.

   Electronic Navigational Charts (ENCs): A screen dump of the largest scale usage band ENC with the alterations and additions being shown thereon in red.
5. When soundings are obtained, *The Mariners Handbook* (NP 100) should be consulted. The echo sounding trace should be marked with times, depths, etc., and forwarded with the report. It is important to state whether the echo sounder is set to register depths below the surface, or below the keel; in the latter case the vessel's draught should be given. Time and date should be given in order that corrections for the height of the tide may be made where necessary. The make, name, and type of echo sounder set should also be given.
6. Modern echo sounders frequently record greater depths than the set's nominal range, e.g. with a set whose maximum is 500m a trace appearing at 50m may

in fact be 550m or even 1,050m. Erroneous deep soundings beyond the sets nominal range can usually be recognised by the following:

(a) The trace being weaker than normal for the depth registered

(b) The trace appearing to pass through the transmission line

(c) The "feathery" nature of the trace.

7. Reports which cannot be confirmed or are lacking in certain details should not be withheld. Shortcomings should be stressed and any firm expectation of being able to check the information on a succeeding voyage should be mentioned.
8. Reports of shoal soundings, uncharted dangers and navigational aids out of order should, at the mariner's discretion, also be made by radio to the nearest coast radio station. The draught of modern tankers is such that any uncharted depth under 30 metres or 15 fathoms may be of sufficient importance to justify a radio message.

Land Information New Zealand
Toitū te whenua

HYDROGRAPHIC NOTE

(For Instructions, see reverse)

LINZ
New Zealand Hydrographic Authority
Level 7,Radio New Zealand House
155 The Terrace
PO Box 5501
Wellington 6145
New Zealand

Te: 0800 655 463 or +64 (0)4 460 0110
Email: ntm@linz.govt.nz

Date ..... Ref.No. .....

Name and address of ship or sender

....

....

Tel/ /Email of sender ....

General locality ....

Subject ....

Position. (see Instruction 3) Lat. .....Long. .....

Position fixing system used..... .....

Datum ....

Charts affected ..... Edition .....

Dated .....

Latest Notice to Mariners held ....

Publications affected (Edition No. and date of latest supplement, page no, ID no. etc).....

Details:

A replacement copy of Chart No. ....
is required (see Instruction 4).

Signature of observer/reporter..... .....

HYDROGRAPHIC NOTE FOR PORT INFORMATION

Name of Ship or Sender:	
Address:	
Reference Number:	
Date:	
Signature of Observer / Reporter:	

1	**Name of Port**	
2	**General Remarks** Principal activities and trade Latest population figures & Date Number of ships & tonnage handled per year Maximum size of vessel handled. Copy of Port Handbook if available	
3	**Anchorages** Designation, depths, holding ground, shelter afforded	
4	**Pilotage** Authority for requests. Embarkation position Regulations	
5	**Directions** Entry and berthing information. Tidal Streams Navigational Aids	
6	**Tugs** Number available and max. h.p.	
7	**Wharves** Names. Numbers or positions Lengths Depths alongside Heights above chart datum Facilities available	
8	**Cargo Handling** Containers, lighters, Ro-Ro etc	
9	**Cranes** Brief details and max. capacity.	
10	**Repairs** Hull, machinery and underwater Ship and boat yards. Docking or slipping facilities. Give size of vessels handled or dimensions. Hards & Ramps. Divers.	
11	**Rescue and Distress** Salvage, lifeboat, Coastguard etc.	
12	**Supplies**	

	Fuel with type and quantities available. Fresh water with rate of supply. Provisions.	
13	**Services** Medical, De-ratting. Consuls, Ship Chandlery, Compass adjustment, Tank cleaning, Hull painting.	
14	**Communications** Road, rail and air services available Nearest airport or airfield. Port radio and information services with frequencies and hours of operation.	
15	**Port Authority** Designation, address and telephone number.	
16	**Small Craft Facilities** Information and facilities for small craft (e.g. yachts) visiting the port. Yacht Clubs, berths, etc.	
17	**Views** Photographs (where permitted) of the approaches, leading marks, the entrance to the harbour etc. Picture postcards may also be useful.	

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