

ATTACHMENT EIGHT

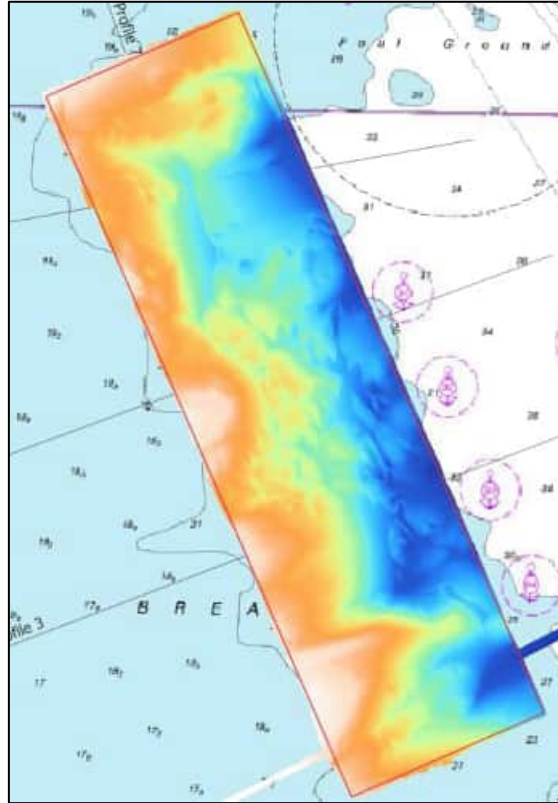
Te Ākau Bream Bay Sand Extraction: Coastal Process Effects Assessment (T&T)



Appendix B DLM survey report

REPORT OF SURVEY

Bream Bay – Bathymetric Survey



REPORT PREPARED FOR:



REPORT PREPARED BY:

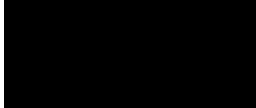


Surveyed by:
Surveyor in Charge:
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Report date:
Report version:

Discovery Marine Ltd.
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02 April 2024 – 08 April 2024 & 13 May 2024
17 May 2024
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Contents

1. Executive Summary	1
2. Weather & Sea Conditions	2
3. Survey Vessel and equipment	3
4. Survey Control	5
4.1 Horizontal Datum	5
4.2 Vertical Datum.....	5
4.2.1 Summary of Levels	5
4.3 Connection to datum	6
5. Conduct of Survey.....	6
5.1 Pre-Deployment Calibrations	6
5.2 Field Survey Methodology.....	6
5.3 On Site Verification and Accuracy Checks	7
5.3.1 Patch Test	7
5.3.2 Reference Surface.....	7
5.3.3 Crossline Checks	8
6. Data Post Processing	9
6.1.1 Vessel Positioning	9
6.1.2 MBES Data Processing	10
7. Quality Checks And Adjustments.....	11
8. Difficulties Encountered	12
9. Total Propagated uncertainty.....	12
10. Comments & Results	15
11. Deliverables	17
12. Retention of Data	18
Appendix A – metadata	18

Table 1: Specifications of Survey Vessel Tupaia	3
Table 2: Hydrographic Survey System Equipment	4
Table 3: LINZ CORS Station Coordinates	6
Table 4: Surface Comparisons - Tupaia March 2024 vs Tupaia April 2024	11
Table 5: Reference Surface Verification Lines	11
Table 6: Crossline Statistics	11
Table 7: Deliverables List	17
Figure 1: Survey Areas	1
Figure 2: Survey Coverage Achieved.....	2
Figure 3: DML Survey Vessel – <i>Tupaia</i>	3
Figure 4: MBES Sonar stern mounted strut in deployed position.	4
Figure 5: Summary of Levels.....	5
Figure 6: Reference Surface and Verification Track-lines	7
Figure 7: Post Processed Positioning Network	9
Figure 8: IAPPK Post Processed Positioning Estimated Position Accuracy	10
Figure 9: showing deviation from profile line due to fisherman	12
Figure 10: Vertical Uncertainty - A Posteriori TPU	13
Figure 11: Horizontal Uncertainty - A Posteriori TPU	14
Figure 12: Application area displaying the bathymetry on the left and backscatter data on the right.....	15
Figure 13: Control area displaying the bathymetry on the left and backscatter data on the right.....	16

1. EXECUTIVE SUMMARY

Discovery Marine Ltd (DML) was contracted by McCallum Brothers to conduct a bathymetric survey of the seabed in Bream Bay, New Zealand. The purpose of the survey is to accurately determine the bathymetric depths along Bream Bay in 2 main areas the application area and the control area. There is also a requirement to run 6 bathymetric transects into the coastline. The location and extent of the survey area is shown in Figure 1.

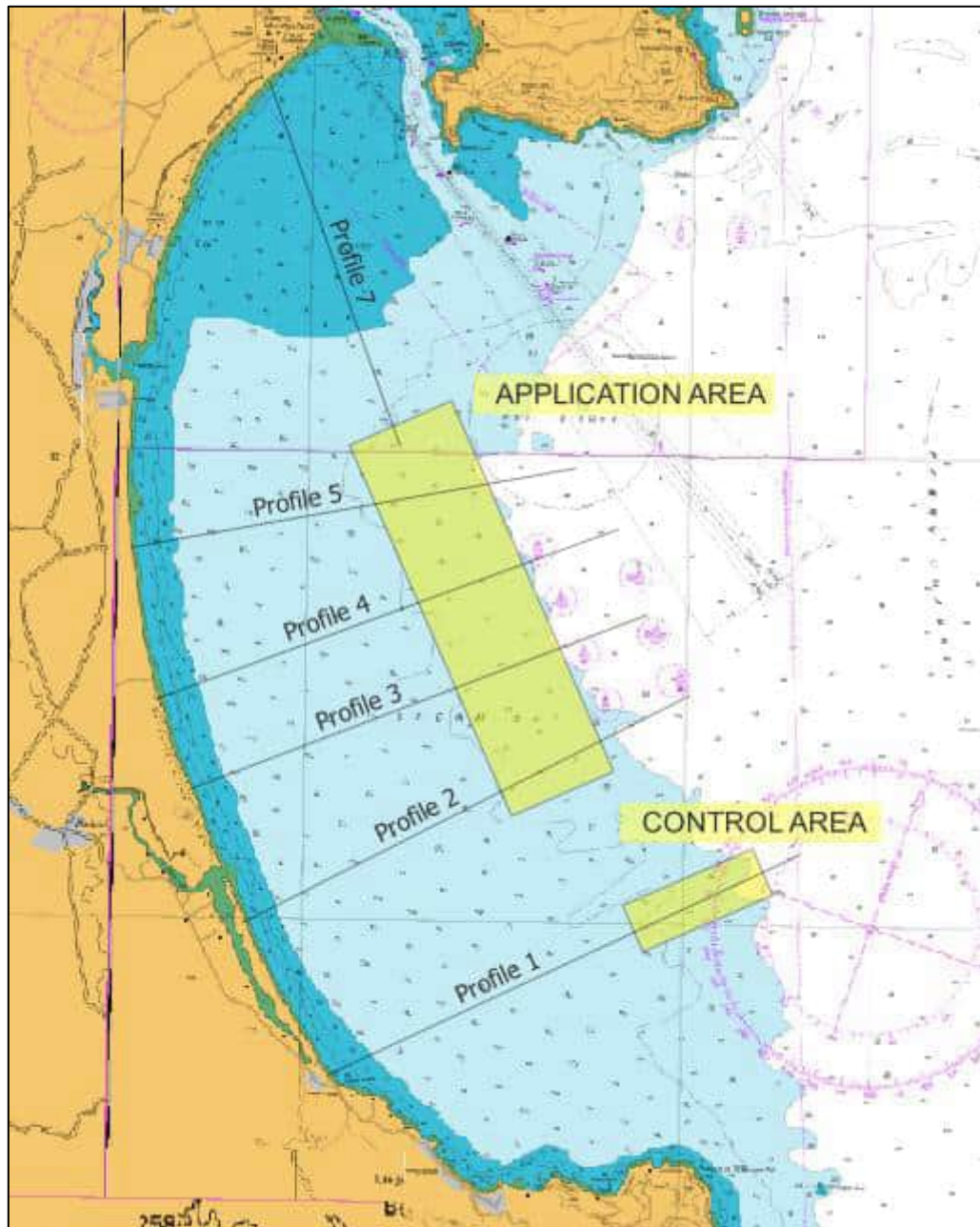


Figure 1: Survey Areas

Vessel setup and calibration verified was conducted in Calliope Bay off Marsden Point on the 02 April 2024. *Tupaia* was onsite conducting survey operations between 02 – 08 April 2024. 4 remaining transects were completed on the 13 May 2024. Data post processing and reporting was completed at DML's office in Tauranga between 09 – 17 April & 16 – 17 May 2024.

The survey coverage achieved is shown in Figure 2.

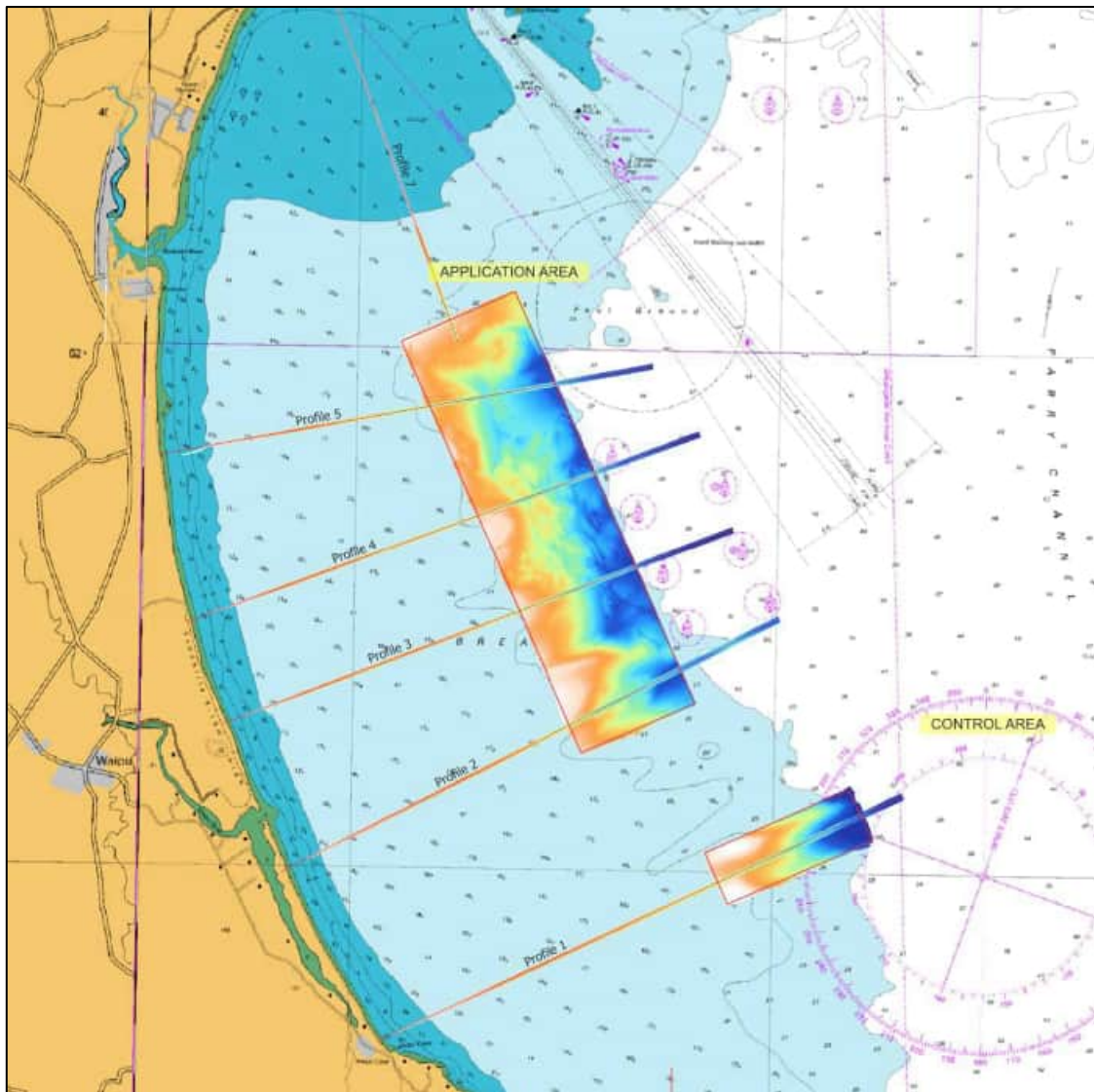


Figure 2: Survey Coverage Achieved

The Survey was undertaken in accordance with the Maritime New Zealand “Good practice guidelines for Hydrographic Surveys in Ports and Harbours” as well as the hydrographic survey principles and standards outlined in LINZ HYSPEC V 2.0. Weblinks to the two specification guideline docs are provided below.

<https://www.maritimenz.govt.nz/commercial/ports-and-harbours/documents/Hydrographic-surveys-guidelines.pdf>

<https://www.linz.govt.nz/sea/charts/standards-and-technical-specifications-for-our-chart-and-hydrographic-work>

2. WEATHER & SEA CONDITIONS

The survey was completed under favourable weather conditions. The first 3 days between 2 – 4 April 2024 saw data captured in light winds and small to no swell. Afternoon sea breezes were accounted each day up to 12kts from the NE. Friday the 5 April 2024 saw winds from the S-SW gusting up to 20kts. On 08 April 2024 the survey was abandoned due to increasing wind and wave conditions causing a degradation in the data quality. The survey was recommenced on the 13 May 2024 when the weather was favourable with light variable winds and 0-0.5m swell.

The tidal range between high water and low water at Bream Bay averaged 2.4m during the survey.

The weather and sea conditions experienced did not affected the overall quality of the final survey data.

3. SURVEY VESSEL AND EQUIPMENT

The platform selected for the fieldwork was *Tupaia* (Figure 3). *Tupaia* is a 7.7m (length), 2.49m (beam), Senator 770. Typically, *Tupaia* was manned by a skipper and two hydrographic surveyors. Vessel particulars are provided in Table 1.



Figure 3: DML Survey Vessel – *Tupaia*

Table 1: Specifications of Survey Vessel *Tupaia*

Name	<i>Tupaia</i>
MNZ Number	142238
Owner	Discovery Marine Limited
Type	Senator 770
Year Built	2019
Dimensions	Length: 7.7m, Beam: 2.49m, Draught: 0.7m
Propulsion	Twin Mercury 150HP 4 stroke outboard engines
Electrical	12V DC and 230V AC (1500w inverter)
Survey Class	MNZ Survey for 8 Pax – Inshore Waters, (within 12nm) and Enclosed Waters
Health & Safety Considerations	Operates under the direction of the vessel skipper and within MNZ MOSS requirements, MBES and SVP deployment and recovery SOP.
Operating Hours	12-hour operations (daylight), with provision and safety equipment for overnight sounding.

The vessel was fitted with a modern survey suite comprising a high accuracy POS MV Wavemaster II positioning and inertial motion system and high-resolution, Reson SEABAT T50 Multibeam Echosounder (MBES). The MBES is mounted on a custom-built strut on the stern of the vessel as shown in Figure 4.



Figure 4: MBES Sonar stern mounted strut in deployed position.

All data was logged into the Qinsy hydrographic acquisition and navigation software package (v9.6.1).

The survey equipment used is listed in Table 2

Table 2: Hydrographic Survey System Equipment

EQUIPMENT	MAKE / MODEL /TECHNICAL SETTINGS
Vessel GNSS / Motion compensation system	Applanix POS MV Wavemaster II
	Integrated Fugro MarineSTAR G4+ real-time Precise Point Positioning (PPP). 0.15m 3D accuracy)
	Inertial aided post processed kinematic (IAPPK) positioning applied during post processing.
	Motion data rate: 100Hz
Multibeam Echo Sounder	Teledyne RESON SeaBat T50 R Multibeam Echo Sounder
	Operating Frequency: 300khz
	Operating Depth Range: 2m -500m
	Maximum Swathe Angle: Limited to 130° for this survey
	Beam Forming: 800 beams, 1.5° beam width at 300khz.
	Mode: Equidistant Sounding Spacing
	Roll Stabilisation: Real-time
	Depth Resolution: 6mm
Speed of sound sensor	AML -3 SVPT (Sound velocity, pressure, temperature sensors)
	Resolution: 0.001m/s
	Precision: 0.006m/s

4. SURVEY CONTROL

4.1 HORIZONTAL DATUM

The survey was completed on the NZGD2000 Datum, NZTM 2000, EPSG:2193.

4.2 VERTICAL DATUM

ASCII data (XYZ format) for the survey are provided as depths below New Zealand Vertical Datum 2016 (NZVD2016) and depths below Chart Datum (Marsden Point).

- NZVD16 depths are reduced from the GRS80 ellipsoid to NZVD2016 in real time using the NZGeoid2016 Geoid separation model applied in the Qinsy acquisition software.
- Chart Datum (Marsden Point) is documented as 1.746m below NZVD2016. Therefore, Chart Datum depths are reduced by deducting 1.746m from the NZVD16 depths.
- Chart Datum (Marsden Point) is described as: *Marsden: Point 4.816m below the RNZN benchmark (LINZ code DJM9), an iron bolt set in concrete near the base of the light standard on the inshore east end of the Northport Ltd. pier near the launch steps.*

4.2.1 Summary of Levels

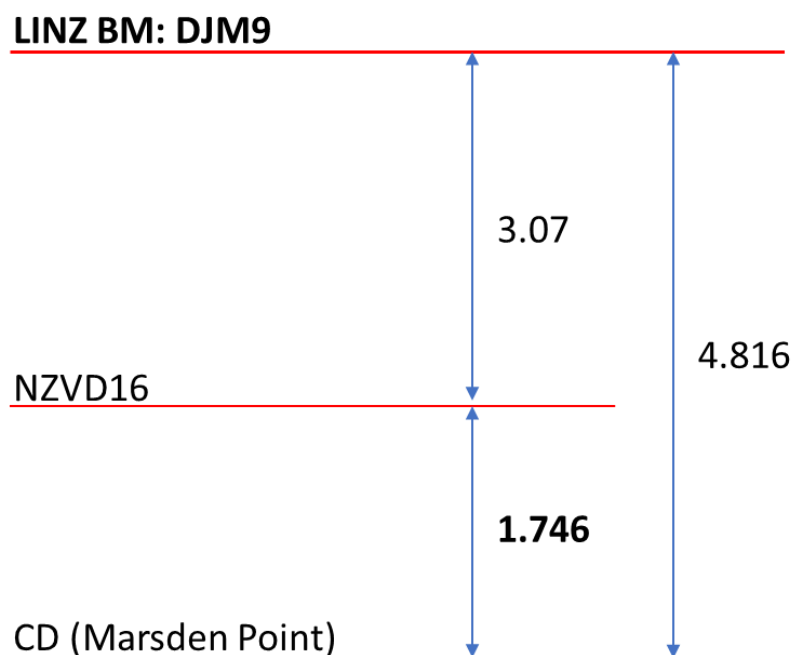


Figure 5: Summary of Levels

4.3 CONNECTION TO DATUM

POSPAC 'Smart Base' Inertial Aided Post Processed Kinematic Positioning (IAPPK), Smoothed Best Estimate of Trajectory (SBET). The coordinates of the LINZ Continuously Operating Reference Stations (CORS) used in the calculation are in shown in Table 3

Table 3: LINZ CORS Station Coordinates

LINZ CORS Station	Latitude	Longitude	Ellipsoid Height
AUCK	S36°36'10.24073"	E174°50'03.78764"	132.681
WARK	S36°26'03.89165"	E174°39'46.00568"	111.273
WHNG	S35°48'13.57788"	E174°18'52.43929"	172.770
CORM	S36°51'55.55985"	E175°44'58.40635"	170.242

5. CONDUCT OF SURVEY

5.1 PRE-DEPLOYMENT CALIBRATIONS

Tupaia is permanently mobilised. Verifications and vessel checks conducted for the original vessel mobilisation consisted of the following.

- Patch test confirming the existing values used on the Northport survey in March 2024.
- MBES Reference surface was surveyed at DML common reference surface in Calliope Bay which is used for Northport surveys (Results compared against previous survey Northport March 2024).

5.2 FIELD SURVEY METHODOLOGY

Tupaia was launched at Marsden Cove Marina at 1500 02 April 2024, calibrations and verifications were carried out. Mainline sounding commenced 03 April and survey was partly completed by 08 April 2024. Deteriorating weather conditions and an unfavourable forecast required a pause in survey operations with four transects remaining.

Survey operations were recommenced on 13 May 2024 at 0600 with *Tupaia* launched at Gulf Harbour Marina before a 2-hour transit to Bream Bay. Survey of the four remaining transects was complete by midday and *Tupaia* returned to Gulf Harbour Marina that afternoon.

During both campaigns the survey area was systematically mapped running lines parallel to the general contours. Real-time MBES coverage was generated in QINSY data acquisition software and displayed for the helmsman, allowing lines to be run based directly off the previous line's swath edge (maintaining at least 20% overlap between adjacent swaths). Survey vessel speed was maintained at approximately 6.5 – 7.0kts.

Sound velocity profiles were conducted regularly throughout the survey to account for any geographical or temporal variations of the speed of sound through the water column. The profiles only fluctuated by minor amounts of 1 to 2 m/s.

Data quality was observed in real time and rejection criteria for horizontal position data and depth logging were established to cease data logging if data fell below these standards.

5.3 ON SITE VERIFICATION AND ACCURACY CHECKS

5.3.1 Patch Test

A MBES Patch Test was conducted onsite to determine any angular MBES mounting errors. Multiple sets of reciprocal survey lines were run perpendicular to a prominent feature. A rock located opposite Marsden Point at 6033611mN,1735435mE. Reciprocal lines over the feature were used for pitch calibration, offset lines in the same direction over the feature were utilised for yaw calibration, and reciprocal lines over the flat featureless seabed adjacent to the feature were utilised for roll calibration.

5.3.2 Reference Surface

A reference surface exists in Calliope Bay off Marsden Point. This is North of the survey extents located at 1736486mE, 6033200mN and is regularly used during Northport / Whangarei Harbour hydrographic survey works.

The reference surface was surveyed to compare against the March 2024 Northport survey and verification lines were run over the reference surface in a dynamic motion to check for any systematic errors and as a vertical reference check (see Figure 6). The reference surface comparison results are presented in Section 7 below.

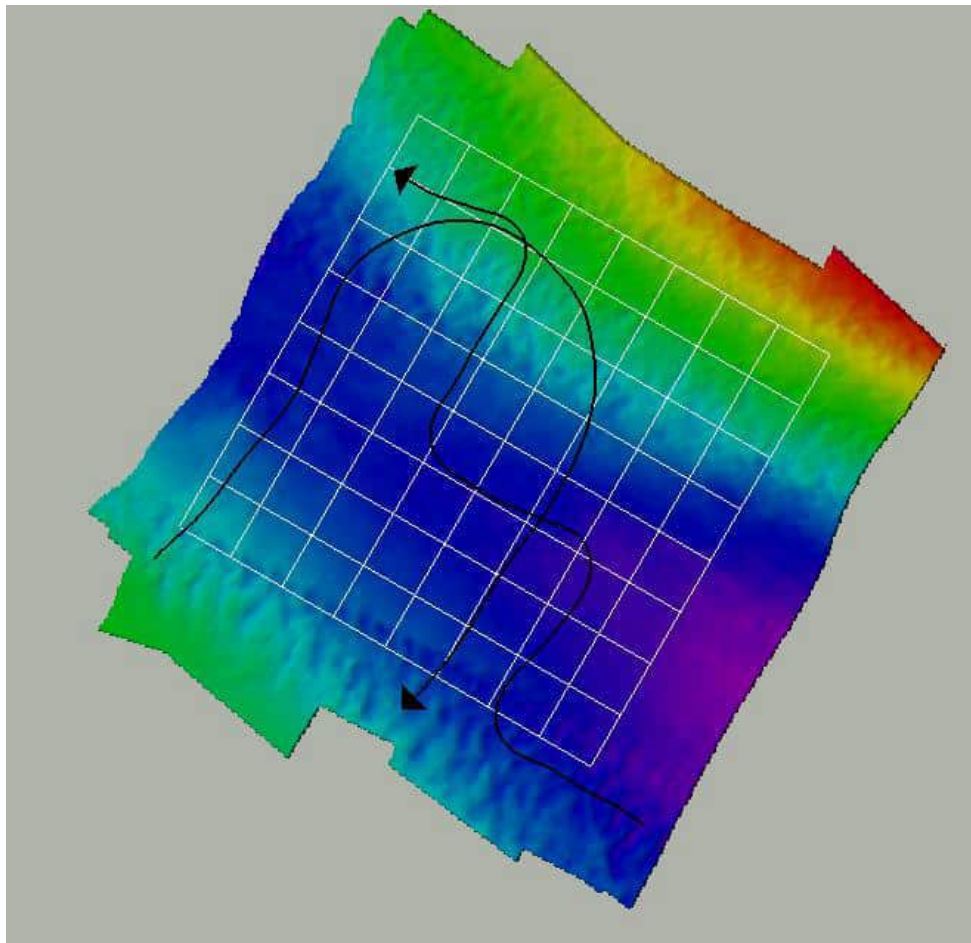


Figure 6: Reference Surface and Verification Track-lines

5.3.3 Crossline Checks

One transect line was been used as crossline, being perpendicular to the main sounding lines. Crossline check is to provide a check on vertical height application and data integrity. A summary of the crossline statistical analysis is provided in Table 6. The crossline passed the test for bathymetric data repeatability within LINZ Special Order limits.

6. DATA POST PROCESSING

6.1.1 Vessel Positioning

Vessel positioning data was post processed by a method known as Inertial Aided Post Processed Kinematic Positioning (IAPPK). The IAPPK processing was completed using Applanix POSPac MMS 9.0 software. The software utilises real time recorded GNSS positioning, inertial motion, and heave measurements and post processes them using finalised satellite orbits and a network of continuously operating GNSS reference stations (CORS).

The CORS stations utilised in the PPK solution for the survey were Whangarei (WHNG), Warkworth (WARK), Auckland (AUCK) and Coromandel (CORM), depicted in Figure 7. Positional accuracies achieved by this method are in the order of 5cm 3D. Total survey uncertainty is discussed further in Section 9.



Figure 7: Post Processed Positioning Network

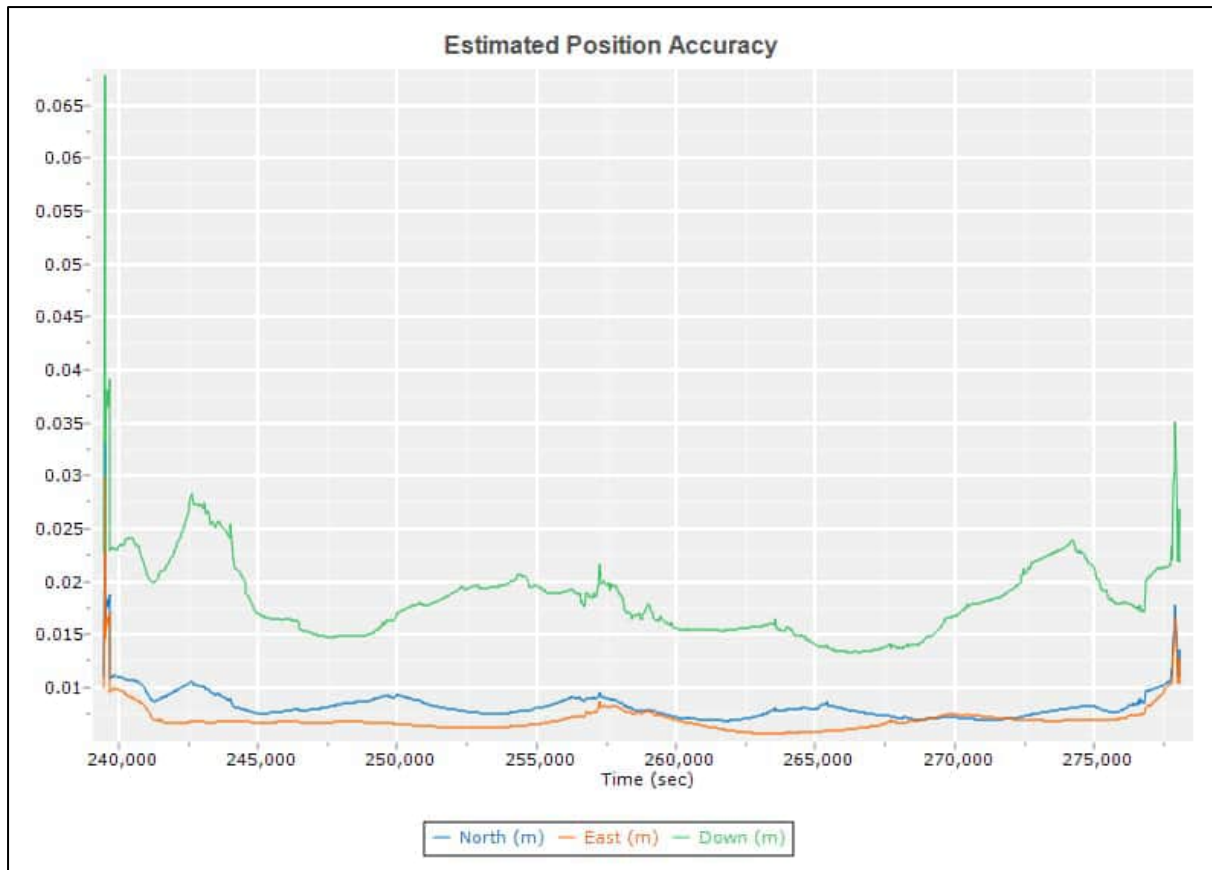


Figure 8: IAPPK Post Processed Positioning Estimated Position Accuracy

6.1.2 MBES Data Processing

Bathymetric data has been processed and validated using Qimera v2.6.2. The final processed MBES bathymetry dataset has been supplied as a 1m x 1m cell resolution average seafloor surface.

7. QUALITY CHECKS AND ADJUSTMENTS

The reference surface verification lines and crossline results were then examined and all meet specification with excellent standard deviation results at 95% Confidence Interval (2σ Std. Dev.). The reference surface was then compared to a previous hydrographic survey undertaken by DML in March 2024. Results of the reference surface and crossline comparisons are displayed in Table 4 to Table 6 below.

Table 4: Surface Comparisons - Tupaia March 2024 vs Tupaia April 2024

Area	Mean Diff. between Surfaces	Std. Deviation	Difference - Range	LINZ Special Order TVU Error Limit	Error Limit PASS or FAIL
Calliope Bay Reference Surface Tupaia March 2024 vs Tupaia April 2024	0.06	0.02	-0.93 to 0.22	0.27	PASS

Table 5: Reference Surface Verification Lines

Line	Reference Surface mean depth	Mean Diff. from main bathy Surface	Std. Dev. (Verification line to Surface)	2σ Std. Dev. (Verification line to Surface)	Difference to Bathy Surface - Range	LINZ Special Order TVU Error Limit	Error Limit PASS or FAIL
U-turn	-19.23	-0.02	0.01	0.04	-0.17 to 0.09	0.28	PASS
Zig Zag	-19.31	-0.02	0.01	0.06	-0.25 to 0.41	0.28	PASS

Table 6: Crossline Statistics

Line	Bathy Surface mean depth	Mean Diff. from main bathy Surface	Std. Dev. (X-line to Surface)	2σ Std. Dev. (X-line to Surface)	Difference to Bathy Surface - Range	LINZ Special Order TVU Error Limit	Error Limit PASS or FAIL
Transect Profile 2	-29.34	-0.07	0.08	0.23	-11.67 to 26.76	0.33	PASS

8. DIFFICULTIES ENCOUNTERED

The survey was completed without any major interruptions or difficulties. Profile number 5 had to divert off the planned line due to a fishing Kontiki directly on the line. See Figure 9 below showing the deviation.



Figure 9: showing deviation from profile line due to fisherman

9. TOTAL PROPAGATED UNCERTAINTY

The accuracy of the MBES bathymetry captured for this survey is assessed as $\pm 0.15\text{m}$ or better. The uncertainty value was attained by combining all potential systematic and environmental error sources and computing an A Posteriori Root Mean Square (RMS) error assessment. Results of the A Posteriori Horizontal and Vertical Total Propagated Uncertainties (THU, TVU) are provided in Figure 10 and Figure 11.

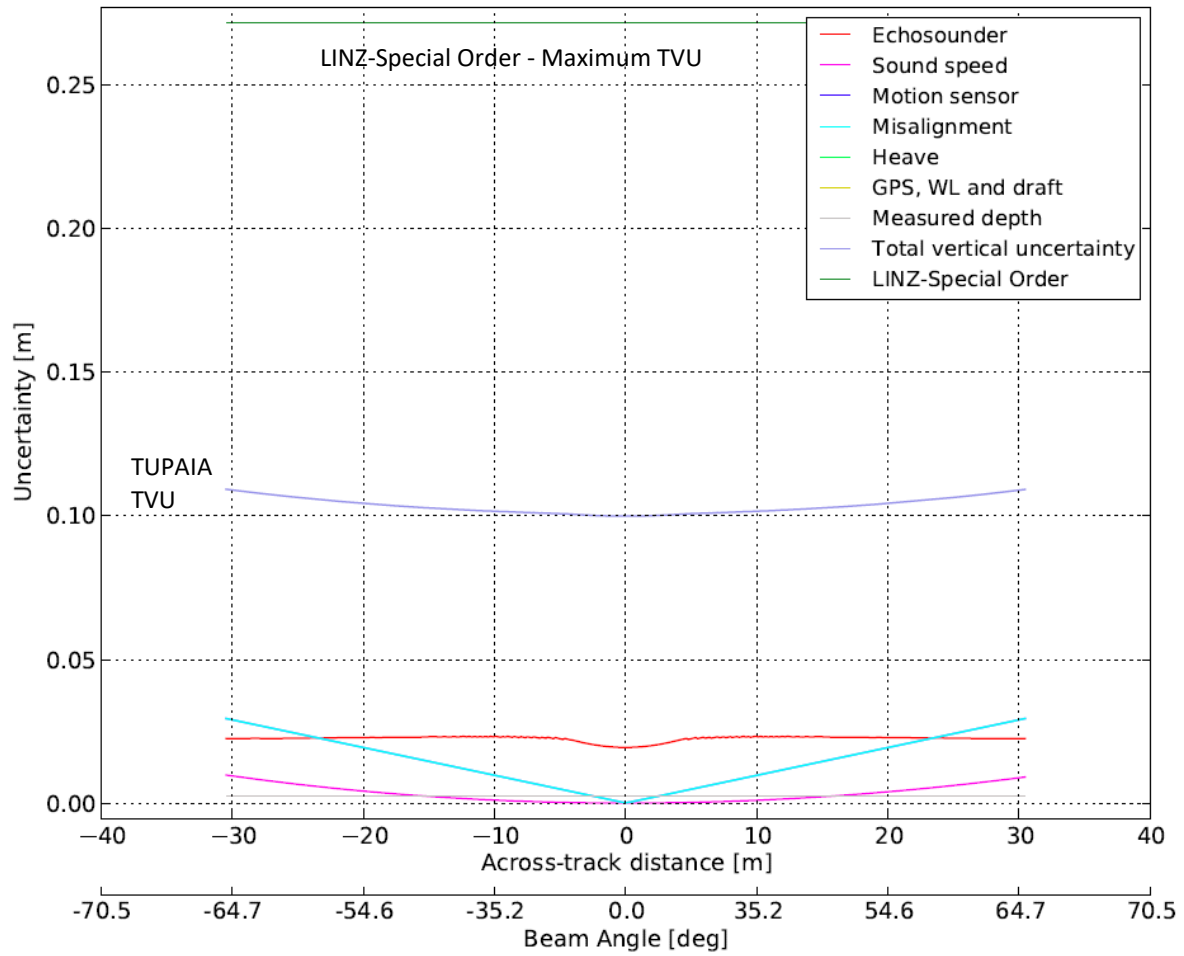


Figure 10: Vertical Uncertainty - A Posteriori TPU

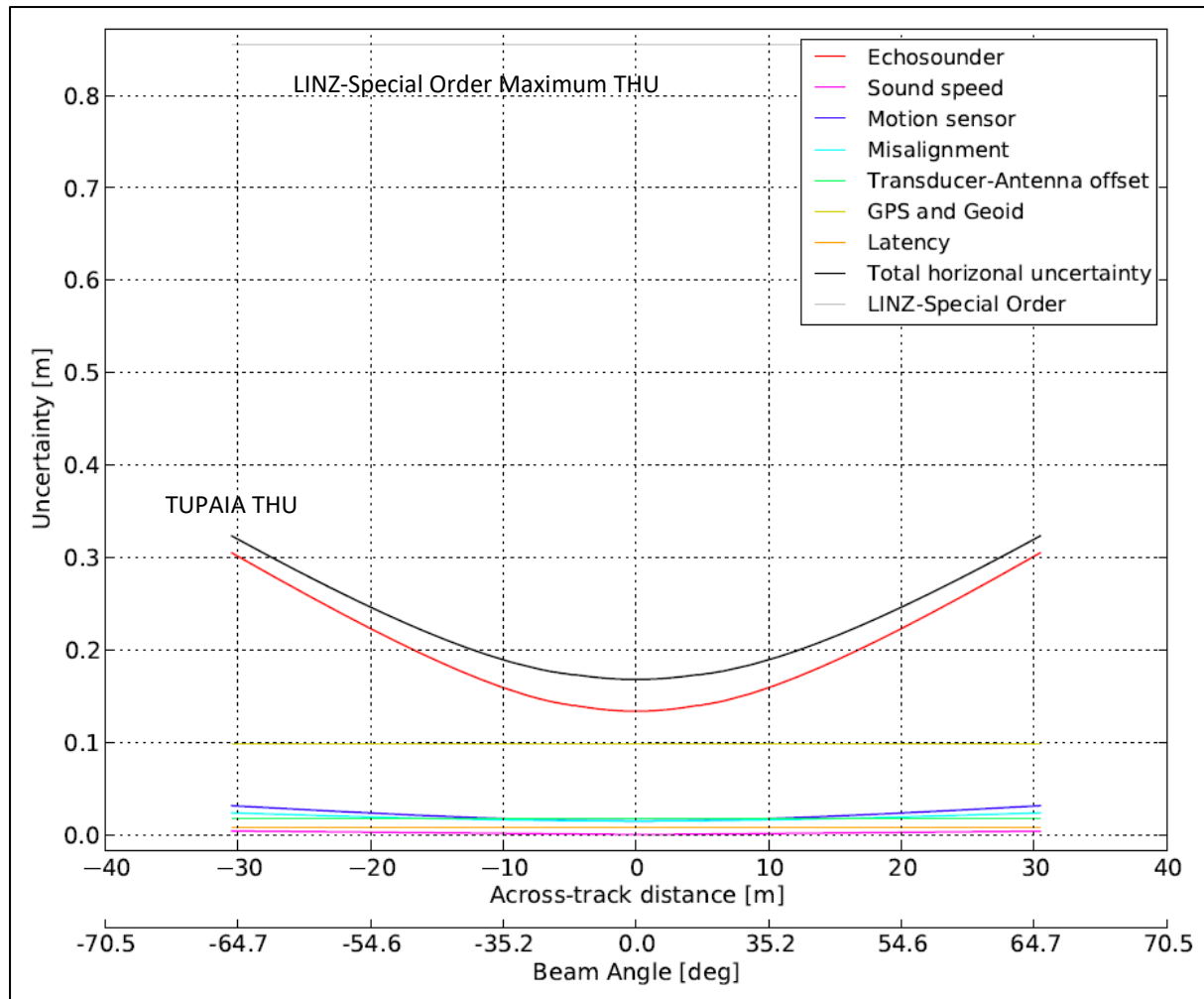


Figure 11: Horizontal Uncertainty - A Posteriori TPU

10.COMMENTS & RESULTS

The MBES bathymetric survey completed the application area, control area and six bathymetric transects within specification.

The seabed in the application area is generally shoaling from east to west and shows evidence of low-lying abstract features. The low-lying features are defined by sharp vertical change to the seabed bathymetry and can be seen in the backscatter mosaic.

The backscatter mosaic delivered alongside this report (and shown at Figure 12) depicts the spatial organisation of seafloor areas with common acoustic response. The backscatter mosaic does not provide a direct measurement tool for seabed characteristics, and hence the backscatter cannot directly provide an objective information about the seabed. However, it does provide visual indication of relative scale of change to the backscatter response across a general area. The mosaic can be ground truthed through physical sampling of the seabed (sediment cores or grabs) and assessed visually through camera or video techniques.

The lighter areas in the mosaic (higher backscatter response level) could indicate areas of larger particle grain size, higher density (highly consolidated) or seabed roughness. The darker areas (lower backscatter response) could be particles of a smaller grain size, lower density (loosely consolidated). A real-world example would suggest higher backscatter response from a coarse sand and lower backscatter response from mud.

Figure 12 below shows the bathymetry and backscatter in the application area.

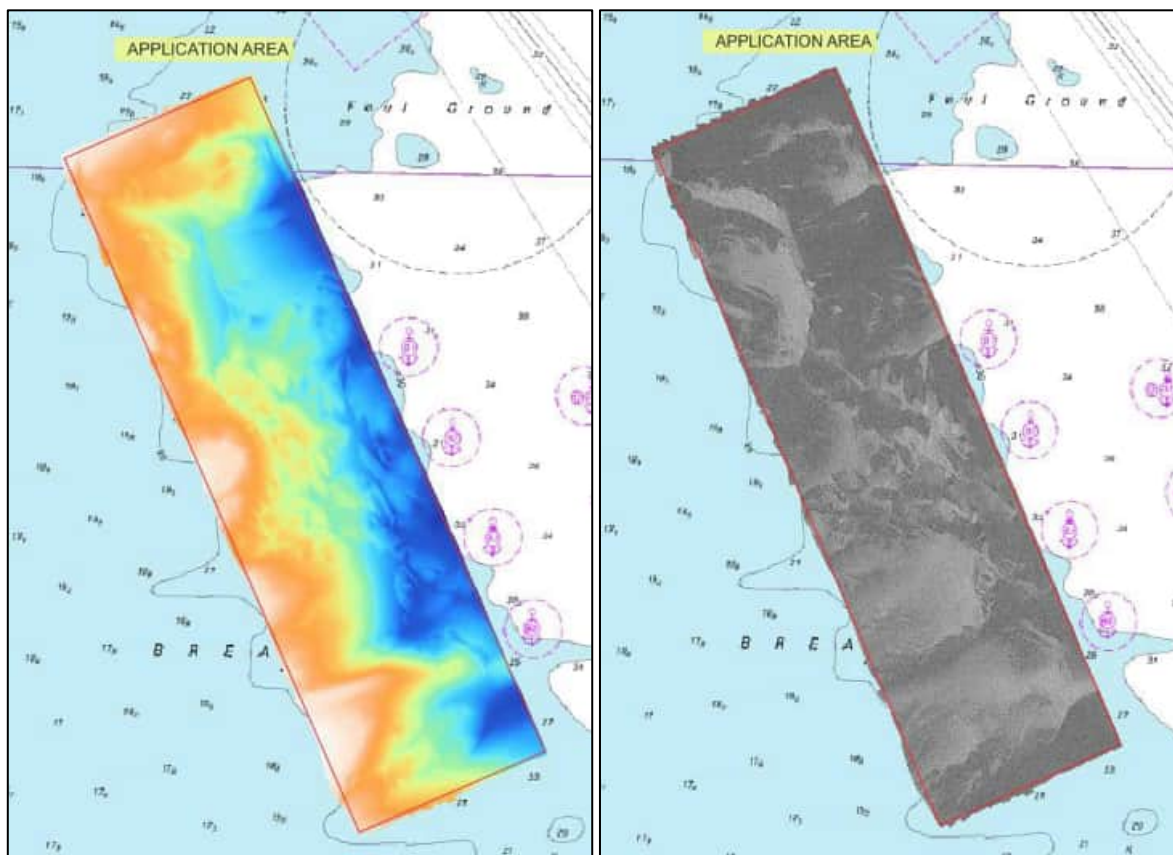


Figure 12: Application area displaying the bathymetry on the left and backscatter data on the right

The seabed in the control area shoals on a gentle slope towards the west and shore. The seabed appears to be relatively homogeneous displaying no significant seabed features. (see Figure 13).

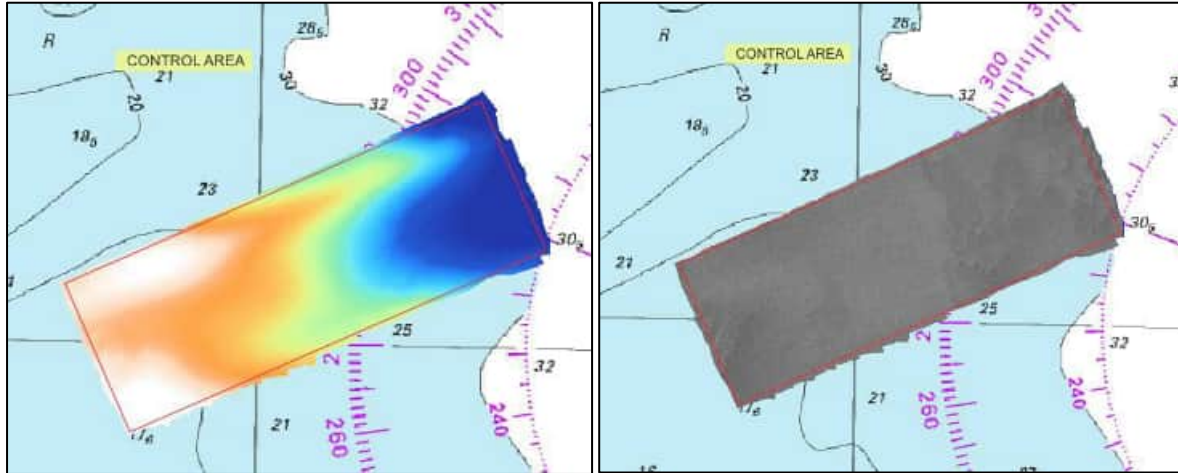


Figure 13: Control area displaying the bathymetry on the left and backscatter data on the right

11.DELIVERABLES

The table below contain the deliverables and naming convention. Area names have been shortened to reduce the file name characters:

- Application area: APPL
- Control Area: CONT
- Transects: TRAN

Table 7: Deliverables List

XYZ
2422_BATHY_CONT_1M_AVE_NZGD2000_CD_REV1.xyz
2422_BATHY_APPL_1M_AVE_NZGD2000_CD_REV1.xyz
2422_BATHY_TRAN_1M_AVE_NZGD2000_CD_REV1.xyz
2422_BATHY_TRAN_1M_AVE_NZGD2000_CD_REV2.xyz
2422_BATHY_CONT_1M_AVE_NZGD2000_NZVD16_REV1.xyz
2422_BATHY_APPL_1M_AVE_NZGD2000_NZVD16_REV1.xyz
2422_BATHY_TRAN_1M_AVE_NZGD2000_NZVD16_REV1.xyz
2422_BATHY_TRAN_1M_AVE_NZGD2000_NZVD16_REV2.xyz
TIFS
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2422_BATHY_APPL_1M_AVE_NZGD2000_CD_REV1.tif
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Plans
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2422_BATHY_APPL_A3_REV1.pdf
2422_BS_APPL_A3_REV1.pdf
2422_BS_CONT_A3_REV1.pdf
2422_BATHY_TRAN1-3_A1_REV1.pdf
2422_BATHY_TRAN4-7_A1_REV1.pdf

12.RETENTION OF DATA

DML will retain copies of the project deliverables, including source data files, on its servers for a period of 12 months from completion of the project. The data will then be archived to a digital medium and retained for 7 years. After the initial 12-month period client requests to access and supply project data will incur a fee.

DML wishes to thank McCallum Bros. Ltd for the opportunity to undertake this project and looks forward to working with McCallum Bros. Ltd again in the future.

APPENDIX A – METADATA

Survey Company	Discovery Marine Ltd		
Project Name	Bream Bay Bathymetric survey		
Project Number	2422		
Location	Bream Bay, New Zealand		
Client	McCallum Bros. Ltd		
Contract Number	-		
Survey Start Date	02/04/2024	Survey End Date	08/04/2024/ 13/05/2024
Surveyor In Charge	ORO		
Field Personnel	ORO, AMC, JMD,BJ		
Office Personnel	ORO		
Horizontal Datum and Projection	NZGD2000 – EPSG 2193		
Vertical Datum	NZVD2016 – Offset to Chart Datum 1.746m		
Sea Level Reduction	N/A	Tide Stations: N/A	
Origin of Coordinates and Levels	PPK Network solution from CORS reference stations WHNG, AUCK, WARK, CORM. Survey referenced utilising ellipsoid to NZVD20216 separation model.		
Survey Vessel	TUPAIA		
Positioning System	POSMV + MarineSTAR G4+ real-time PPP. Post processed POSPAC IAPPK		
Sonar System	Teledyne Reson T50 R MBES		
Sonar System Freq.	300kHz Fixed Frequency		
Acquisition Software	Qinsy v9.6.1		
Processing and Delivery Software	POSPac MMS 9.0, Qimera v2.6.2		
Data Collected	Bathymetry		
Coverage Achieved	Full seafloor		
Accuracy Standard Achieved	Yes		
Bathymetric Gridded Surface Method	Average surface		
Gridded Surface Resolution	1m x 1m		
Seafloor backscatter file type	GSF, processed to 0.5m x 0.5m grid resolution mosaic.		
File Format	GTIFF		
Data Custodian Contact Details	DML		

REPORT OF SURVEY

Bream Bay Extension Area



REPORT PREPARED FOR:



REPORT PREPARED BY:



Surveyed by:
Surveyor in Charge:
Survey dates:
Report date:
Report version:

Discovery Marine Ltd.
Dillon Shields, MS+SNZ, CPHS2
10 December 2024 – 13 December 2024
21 February 2025
1.0

REPORT OF SURVEY – BREAM BAY APPLICATION AREA - EXTENSION

1. EXECUTIVE SUMMARY

Discovery Marine Ltd (DML) was contracted by McCallum Brothers to conduct a bathymetric survey of the seabed at the Extension area located off Bream Bay, Northland, New Zealand. The purpose of the survey was to cover an extension area to be added to the original dataset collected in April 2024. The location and extent of the survey area is shown in Figure 1.

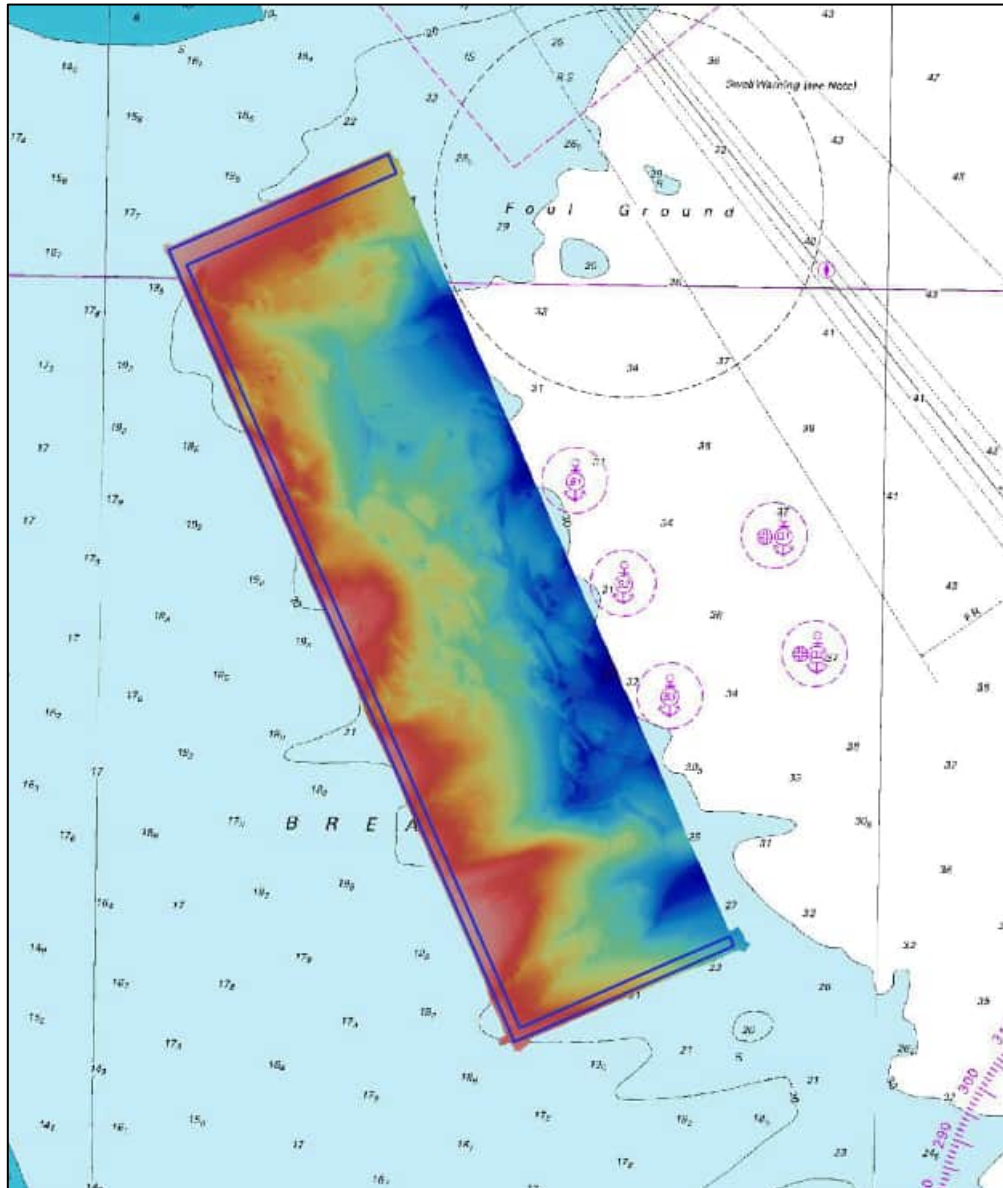


Figure 1: Survey Area

Vessel setup and calibration was conducted in Tauranga between 31 October - 06 November 2024 during mobilisation for LINZ Hydrographic Survey HS79. A copy of the Mobilisation Report for this project can be provided if requested. *TRANQUIL IMAGE* was onsite conducting survey operations between 11 – 13 December 2024. Data post processing and reporting was completed at DML's office in Tauranga between January 13 – February 19, 2025.

The survey coverage achieved is shown in Figure 2.

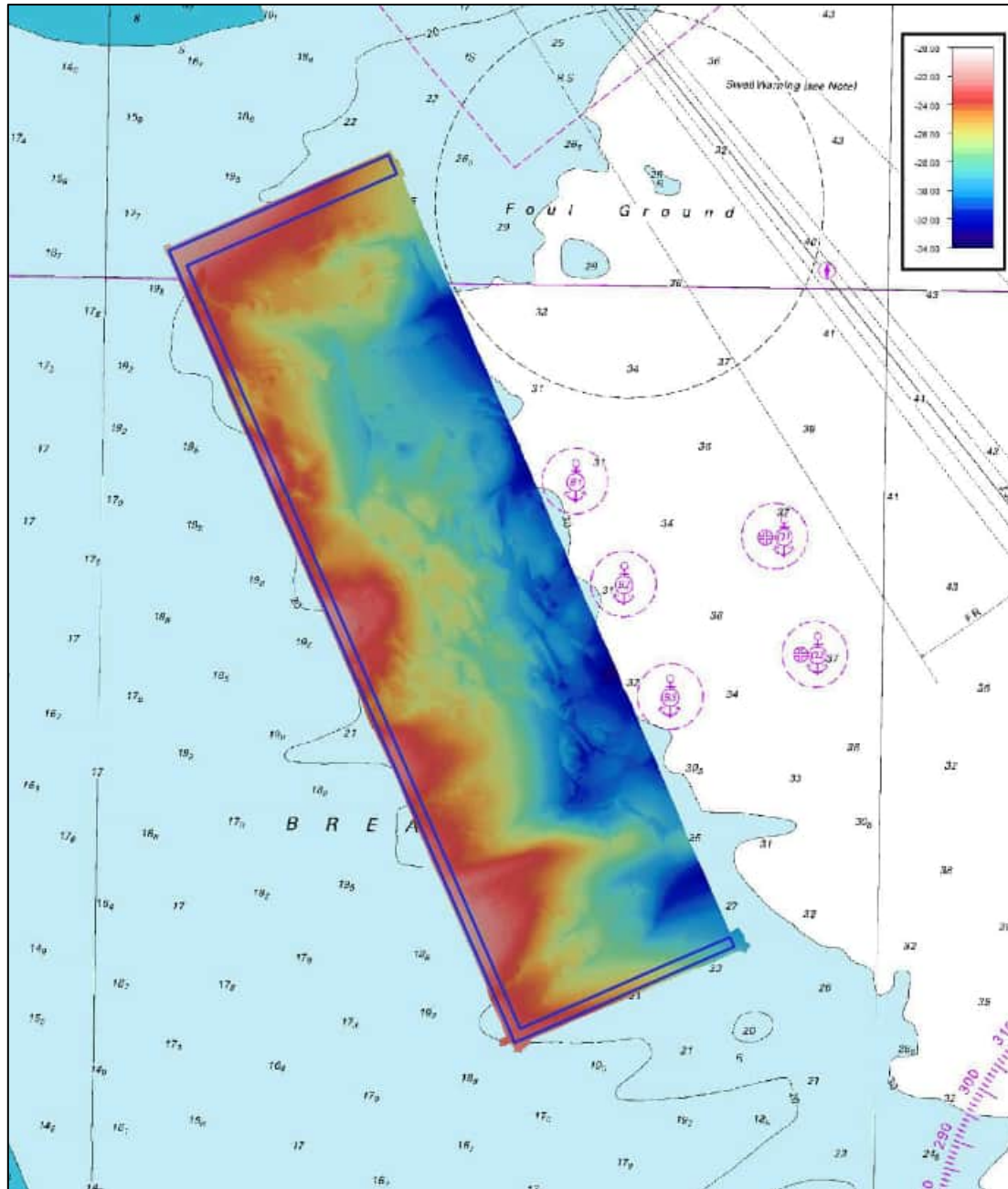


Figure 2: Survey Coverage Bream Bay Application Extension 2024

The Survey was undertaken in accordance with the Maritime New Zealand “Good practice guidelines for Hydrographic Surveys in Ports and Harbours” as well as the hydrographic survey principles and standards outlined in LINZ HYSPEC V 2.0. Weblinks to the two specification guideline docs are provided below.

<https://www.maritimenz.govt.nz/commercial/ports-and-harbours/documents/Hydrographic-surveys-guidelines.pdf>

<https://www.linz.govt.nz/sea/charts/standards-and-technical-specifications-for-our-chart-and-hydrographic-work>

2. WEATHER & SEA CONDITIONS

The survey was completed under favourable weather conditions. Light winds and a calm sea with little swell were experienced on arrival at site and throughout the duration of the survey.

The tidal range between high water and low water over the survey period averaged 1.7m.

Weather and sea conditions experienced did not affect the overall quality of the final survey data.

3. SURVEY VESSEL AND EQUIPMENT

This survey was undertaken using the survey vessel *TRANQUIL IMAGE*, a 24m workboat owned by Western Workboats and operated in accordance with Maritime New Zealand Operator Safety System (MOSS).



Figure 3: Western Workboats Survey Vessel – *TRANQUIL IMAGE*

The vessel was fitted with a modern survey suite comprising a high accuracy POS MV Wavemaster II positioning and inertial motion system and high-resolution, Reson SEABAT T50 Multibeam Echosounder (MBES). The Inertial Motion Unit (IMU) and MBES were mounted on an over the side pole mount as shown in Figure 4.



Figure 4: MBES Sonar and Motion unit (left) and over the side mount (right)

All data was logged into the QINSY hydrographic acquisition and navigation software package (v9.7.2).
The survey equipment used is listed in Table 1

Table 1: Hydrographic Survey System Equipment

EQUIPMENT	MAKE / MODEL /TECHNICAL SETTINGS
Vessel GNSS / Motion compensation system	Applanix POS MV Wavemaster II
	Integrated Fugro MarineSTAR G4+ real-time Precise Point Positioning (PPP). 0.15m 3D accuracy)
	Inertial aided post processed kinematic (IAPPK) positioning applied during post processing.
	Motion data rate: 100Hz
Multibeam Echo Sounder	Teledyne RESON SeaBat T50 R Multibeam Echo Sounder
	Operating Frequency: 300khz
	Operating Depth Range: 2m -500m
	Maximum Swathe Angle: Limited to 120° for this survey
	Beam Forming: 800 beams, 1.5° beam width at 300khz.
	Mode: Equidistant Sounding Spacing
	Roll Stabilisation: Real-time
	Depth Resolution: 6mm
Speed of sound sensor	AML -3 LGR SVPT (Sound velocity, pressure, temperature sensors)
	Resolution: 0.001m/s
	Precision: 0.006m/s

4. SURVEY CONTROL

4.1 HORIZONTAL DATUM

The survey was completed on the **NZGD2000 Datum, Transverse Mercator projection** (NZTM2000, EPSG:2193).

4.2 VERTICAL DATUM

Results for the survey are provided as **depths below New Zealand Vertical Datum 2016 (NZVD2016)**.

Depths were reduced from the GRS80 ellipsoid to NZVD2016 using the NZGeoid2016 Geoid separation model applied in the Qimera processing software.

NZVD2016 is an approximate Mean Sea Level Datum. Noting that previous surveys in the area have been reduced to Chart Datum, it should be noted that Chart Datum (CD) is approximately 1.746m below NZVD2016. Therefore, a value of 1.74m needs to be deducted from NZVD2016 depths to refer them to Chart Datum. A summary of levels diagram is displayed for the Marsden Point Tide Station in Figure 5.

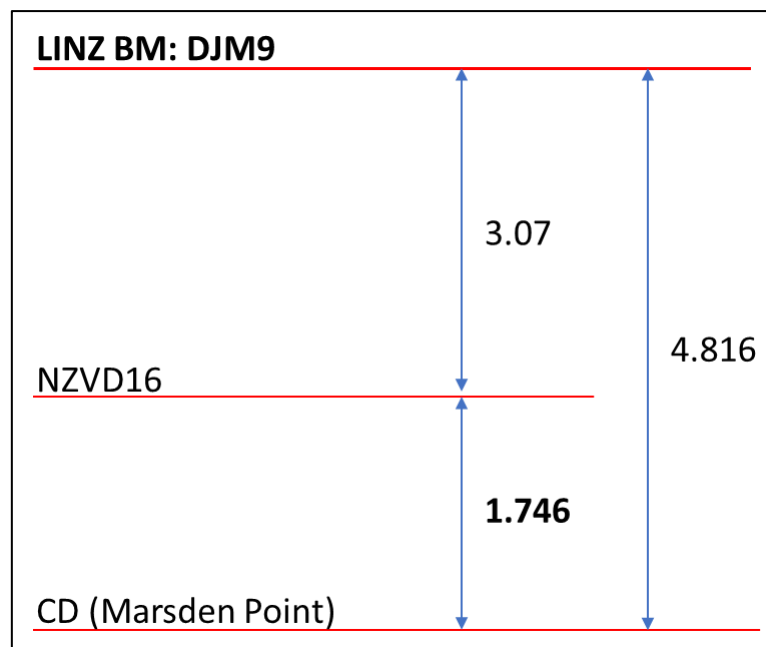


Figure 5: Marsden Point Chart Datum Summary of Levels

4.3 CONNECTION TO DATUM

POSPAC 'Smart Base' Inertial Aided Post Processed Kinematic Positioning (IAPPK), Smoothed Best Estimate of Trajectory (SBET). The coordinates of the LINZ Continuously Operating Reference Stations (CORS) used in the calculation are in shown in Table 2

Table 2: LINZ CORS Station Coordinates

LINZ CORS Station	Latitude (DD MM SS.sssss)	Longitude (DD MM SS.sssss)	Ellipsoid Height (m)
AUCK	S36°36'10.24053"	E174°50'03.78754"	132.691
WARK	S36°26'03.89157"	E174°39'46.00553"	111.282
WHNG	S35°48'13.57790"	E174°18'52.43924"	172.781

5. SURVEY STANDARD

The survey was required to meet the LINZ-1 order of survey standard. Details of LINZ-1 can be found in the LINZ HYSPEC 2.0. LINZ-1 is considered appropriate for the location of the survey area, the operational environment and the required outputs.

6. CONDUCT OF SURVEY

6.1 PRE-DEPLOYMENT CALIBRATIONS

TRANQUIL IMAGE has been permanently mobilised for DML's use since November 2024. Calibrations and vessel checks conducted for the original vessel mobilisation consisted of the following.

- Dimensional Control Survey,
- GAMS/Heading test,
- MBES Patch test,
- Draught checks (Bar check and Lead Line check),
- Settlement and Squat trials,
- Target Detection/Object Box In check,
- Positioning/height check against a known LINZ BM ashore,
- MBES Reference surface was surveyed at DML/Ocean Infinity common reference surface at Motiti Island (Results compared against previous surveys).

6.2 FIELD SURVEY METHODOLOGY

TRANQUIL IMAGE departed Tauranga Harbour at 11:00 10 December 2024, arriving onsite at Pakiri Beach at 22:15 on 10th December. After initial field calibrations and system tests, mainline sounding commenced at 00:15 on 11th December and ran continuously until completion at 14:30 on 12 December.

The survey area was systematically mapped running lines parallel to the general contours where practicable. Real-time MBES coverage was generated in Qinsy data acquisition software and displayed for the helmsman, allowing lines to be run based directly off the previous line's swath edge (maintaining at least 25% overlap between adjacent swaths). Survey vessel speed was maintained at approximately 6.5 – 7.0kts.

Sound velocity profiles were conducted regularly throughout the survey to account for any geographical or temporal variations of the speed of sound through the water column. The profiles only fluctuated by minor amounts of 2 to 3 m/s.

Data quality was observed in real time and rejection criteria for horizontal position data and depth logging were established to cease data logging if data fell below these standards.

6.3 ON SITE VERIFICATION AND ACCURACY CHECKS

A Common reference surface exists at the Southern extent of the Pakiri site, located at 399367mE, 872241mN, measuring approximately 325m x 325m with an average depth of 36m. The reference surface was resurveyed to compare against the November 2023 survey and verification lines were run over the reference surface in a dynamic motion to check for any systematic errors and as a vertical reference check (see Figure 6). The reference surface comparison results are presented in Section 7 below. Although the reference surface is not located near the Bream Bay survey area it provides a check between systems used and confirmation of correct height application.

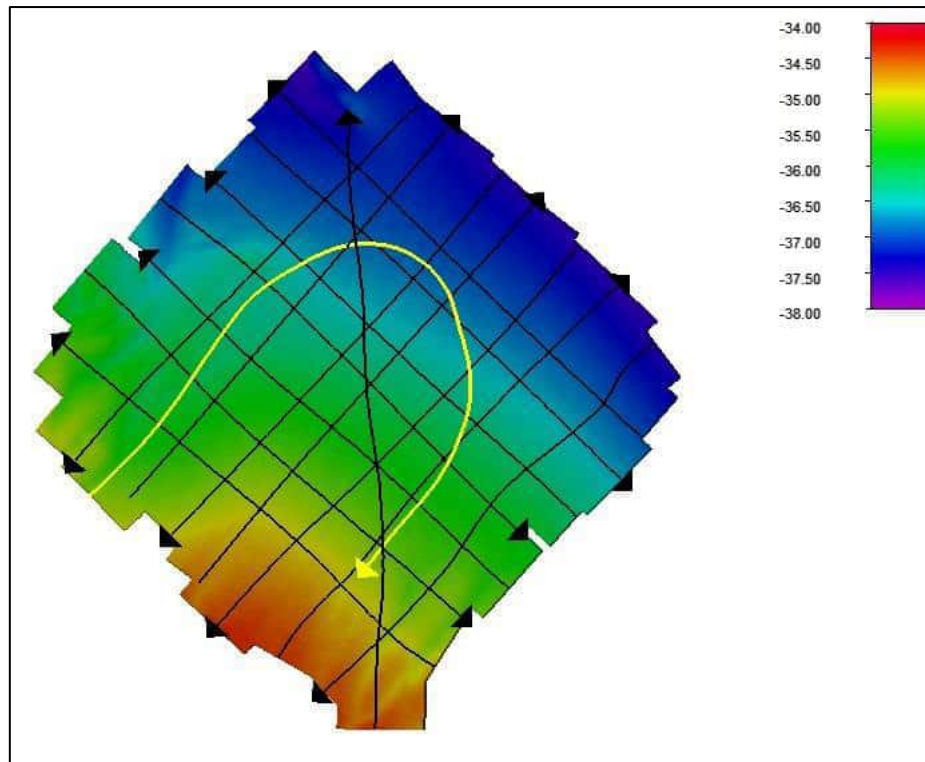


Figure 6: 2024 Reference Surface and Verification Track-lines

A MBES Patch Test was conducted during mobilisation prior to being onsite to determine any angular MBES mounting errors. Multiple sets of reciprocal survey lines were run perpendicular to a prominent feature. Reciprocal lines over the feature were used for pitch calibration, offset lines in the same direction over the feature were utilised for yaw calibration. While onsite, reciprocal lines over flat featureless seabed adjacent to the survey area were utilised for a roll calibration.

A total of 3 MBES crosslines were run perpendicular to the main sounding lines spread evenly across the survey area to provide a check on vertical height application and data integrity. A summary of the crossline statistical analysis is provided in

Table 5. All crosslines passed the test for bathymetric data repeatability within LINZ Special Order limits.

7. DATA POST PROCESSING

Vessel positioning data was post processed by a method known as Inertial Aided Post Processed Kinematic Positioning (IAPPK). The IAPPK processing was completed using Applanix POSPac MMS 9.2 software. The software utilises real time recorded GNSS positioning, inertial motion, and heave measurements and post processes them using finalised satellite orbits and a network of continuously operating GNSS reference stations (CORS).

The CORS stations utilised in the PPK solution for the survey were Whangarei (WHNG), Warkworth (WARK), Auckland (AUCK) and Coromandel (CORM), depicted in Figure 7. Positional accuracies achieved by this method are in the order of 5cm 3D. Total survey uncertainty is discussed further in Section 10.

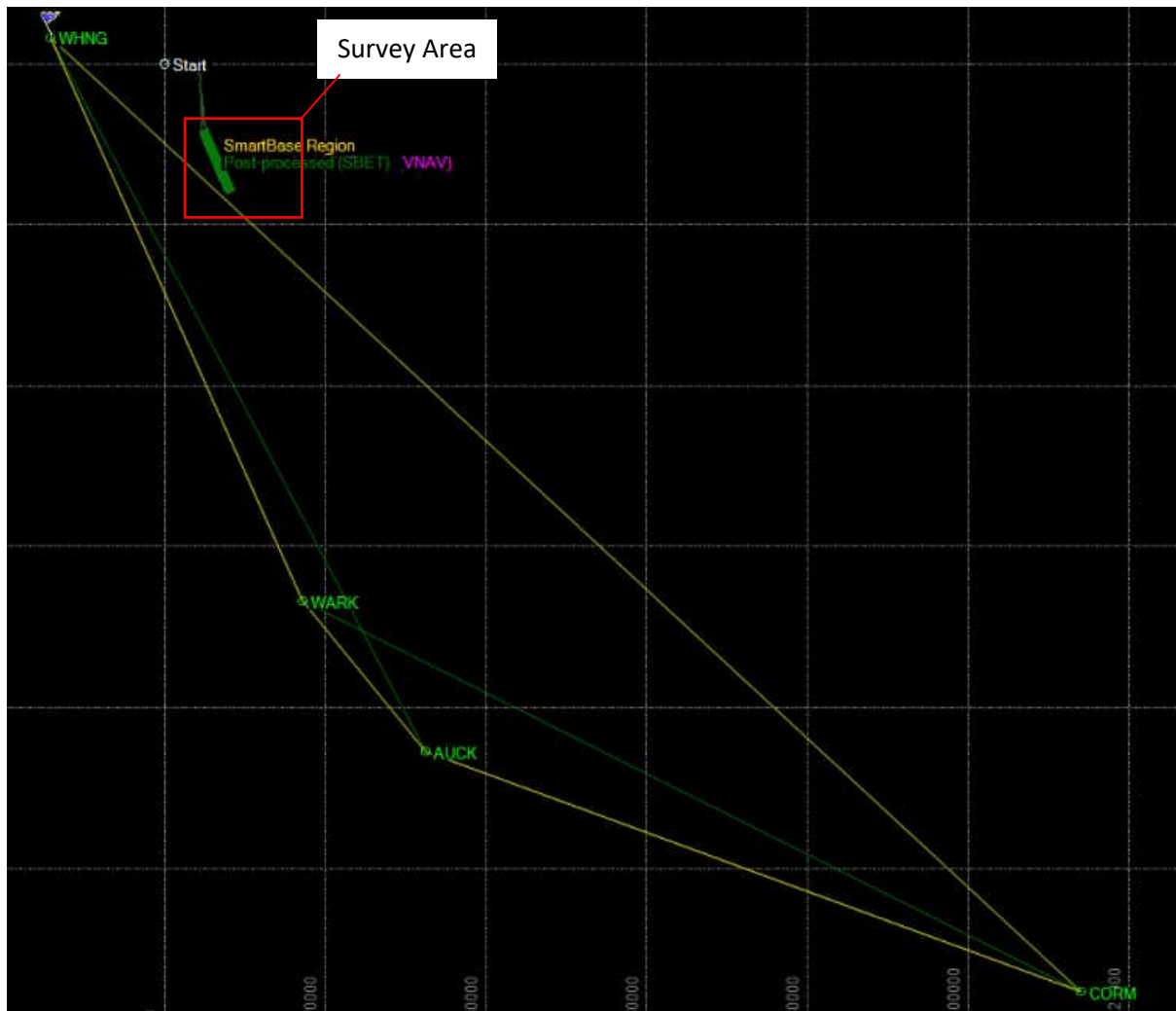


Figure 7: Post Processed Positioning Network

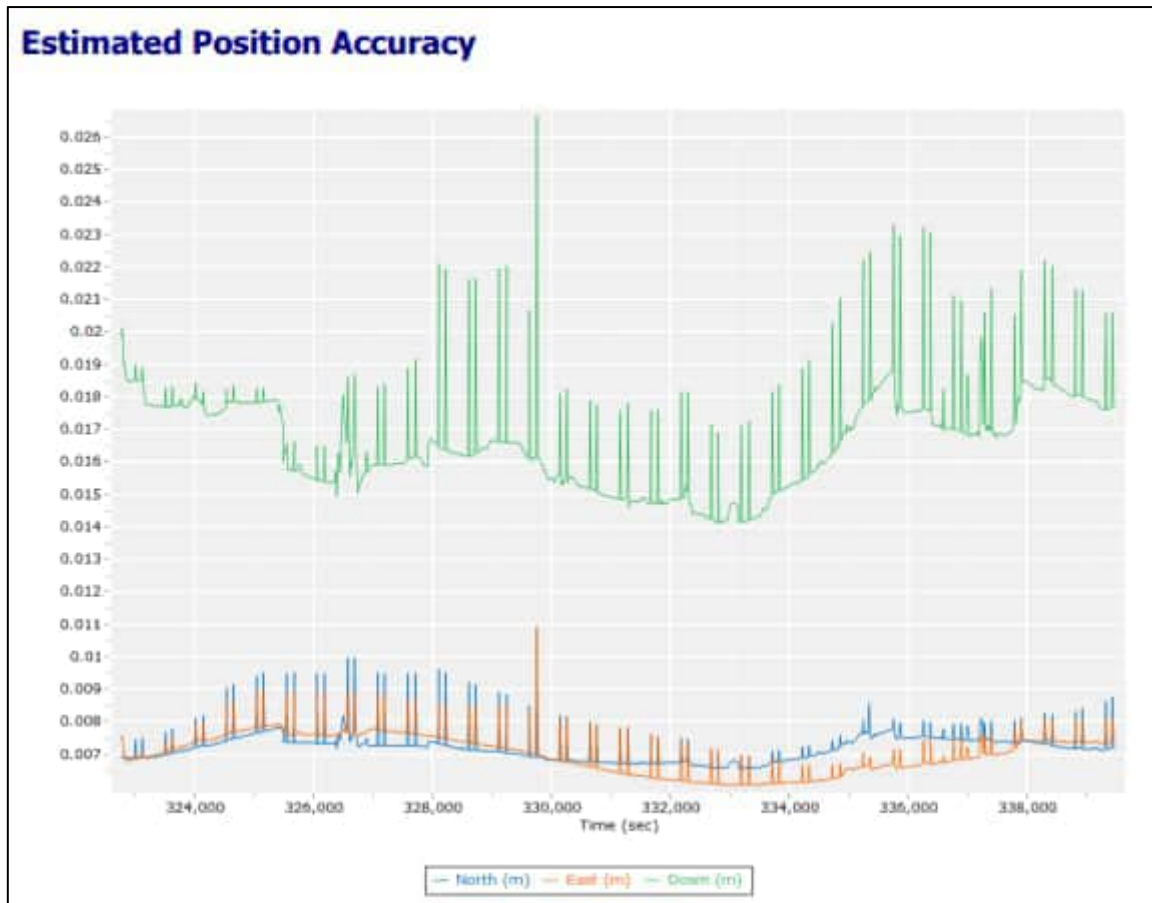


Figure 8: IAPPK Post Processed Positioning Estimated Position Accuracy – Bream Bay

Bathymetric data has been processed and validated using Qimera v2.7.1. The final processed MBES bathymetry dataset has been supplied as a 1m x 1m cell resolution average seafloor surface.

8. QUALITY CHECKS AND ADJUSTMENTS

Once data processing was complete, the bathymetric surface were compared to the previous survey of the area in April 2024. Results of the comparisons show good agreement at the decimetre level.

The reference surface verification lines and crossline results were then examined and all meet specification with excellent standard deviation results at 95% Confidence Interval (2σ Std. Dev.). Results of the reference surface and crossline comparisons are displayed in Table 3 to Table 5 below.

Results are compared to the higher LINZ-Special order of survey (LINZ HYSPEC 2.0) due to the final survey methodology achieving much better than LINZ-1 order final uncertainties.

Table 3: Surface Comparisons - Tranquil Image 2023 vs Tranquil Image 2024

Area	Mean Diff. between Surfaces (m)	Std. Deviation	Max Difference (Range) (m)	LINZ Special Order TVU Error Limit	Error Limit PASS or FAIL
Pakiri Reference Surface Tranquil Image Nov. 2022 vs TI Dec. 2024	0.01	0.03	-0.21 to 0.12	0.37	PASS
Southern Control Area	0.12	0.06	-0.06 to 0.36	0.37	PASS

Tranquil Image Nov. 2023 vs TI Dec. 2024					
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Table 4: Reference Surface Verification Line

Line	Reference Surface mean depth	Mean Diff. from main bathy Surface	Std. Dev. (Verification line to Surface)	2 σ Std. Dev. (Verification line to Surface)	Difference to Bathy Surface (Range) (m)	LINZ Special Order TVU Error Limit	Error Limit PASS or FAIL
U-turn	-36.14	0.00	0.01	0.05	-0.12 to 0.11	0.37	PASS

Table 5: Crossline Statistics

Line	Bathy Surface mean depth	Mean Diff. from main bathy Surface	Std. Dev. (X-line to Surface)	2 σ Std. Dev. (X-line to Surface)	Difference to Bathy Surface - Range	LINZ Special Order TVU Error Limit	Error Limit PASS or FAIL
Xline 1	-22.81	0.00	0.01	0.02	-0.24 to 0.12	0.30	PASS
Xline 2	-25.14	0.00	0.01	0.02	-0.09 to 0.07	0.31	PASS
Xline 3	-23.01	0.00	0.00	0.01	-0.07 to 0.09	0.30	PASS

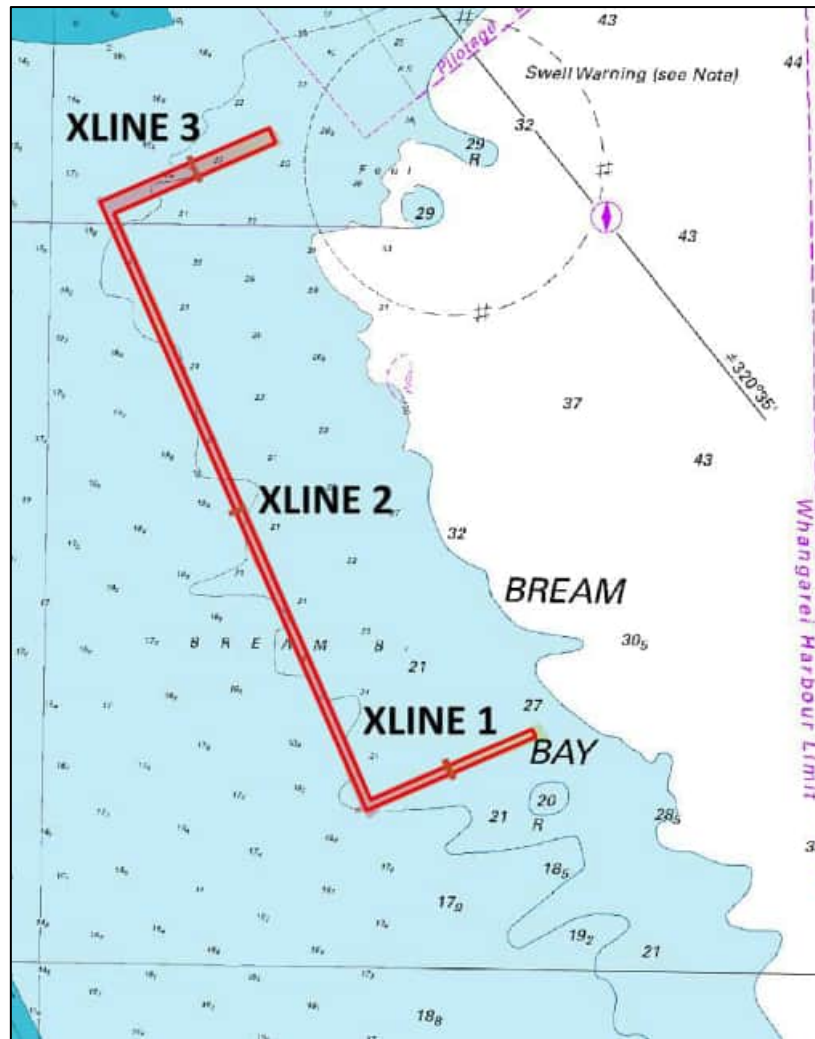


Figure 9: Crossline Locations

9. DIFFICULTIES ENCOUNTERED

The survey was completed without any major interruptions or difficulties.

10. TOTAL PROPAGATED UNCERTAINTY

Results of the A Priori (pre) Horizontal and Vertical Total Propagated Uncertainties (THU, TVU) are provided in Figure 10 and Figure 11.

The final uncertainty of the MBES bathymetry captured for this survey is assessed as 0.15m at the 95% CI. This is considered the worst case for the entire survey area. Final relative uncertainty between previous surveys is presented at Section 8 and is considered to be more precise at between 0.08m and 0.1m at the 95% CI. The uncertainty value was attained by assessing final systematic, random and environmental error sources combined with cross line and reference surface information.

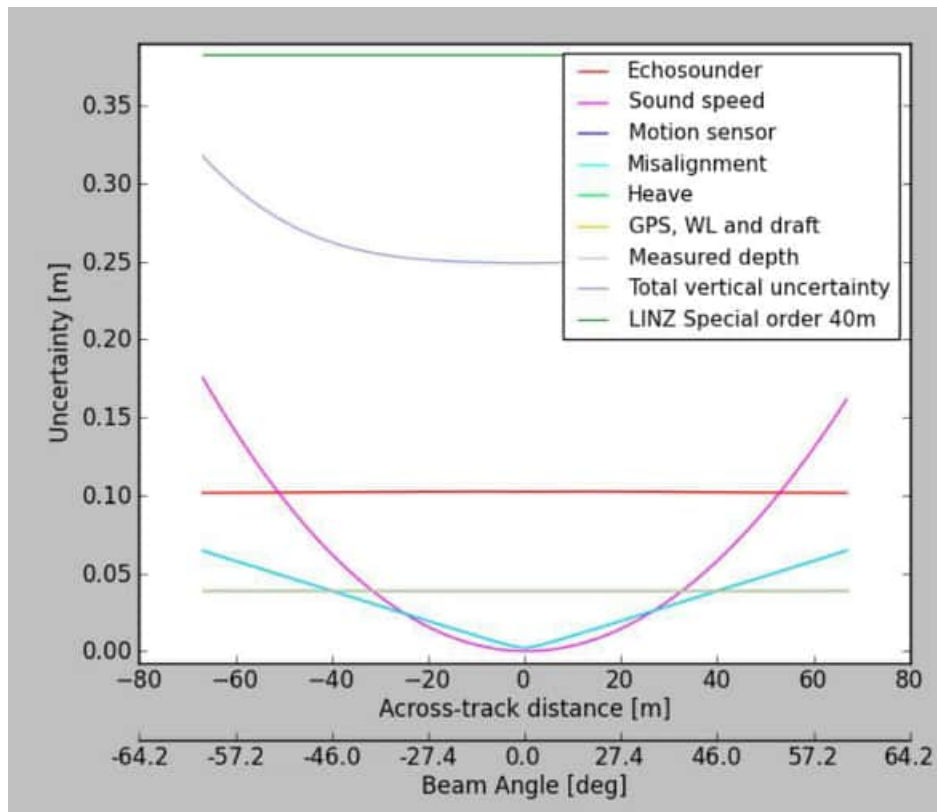


Figure 10: Vertical Uncertainty - A Posteriori TPU

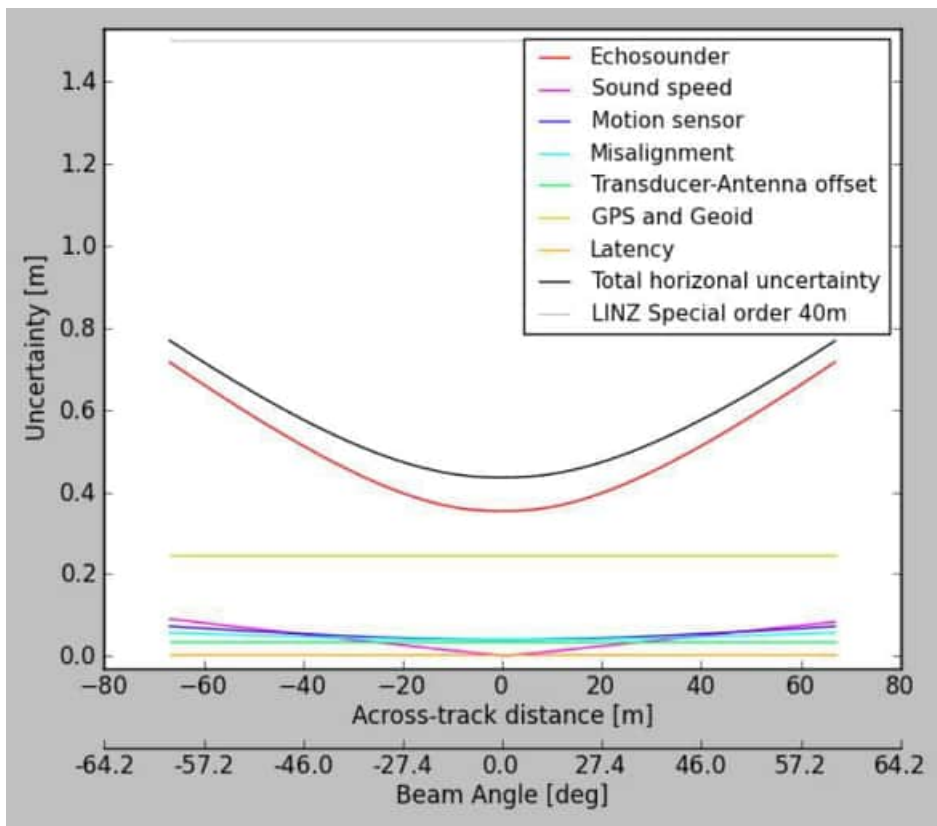


Figure 11: Horizontal Uncertainty - A Posteriori TPU

11.COMMENTS & RESULTS

The MBES bathymetric survey completed all objectives within specification.

As found in previous surveys, the seabed is generally flat with few significant seafloor features. The depth contours gently slope away from the shore.

The backscatter mosaic delivered alongside this report (and shown at Figure 12) depicts the spatial organisation of seafloor areas with common acoustic response. The backscatter mosaic does not provide a direct measurement tool for seabed characteristics, and hence the backscatter cannot directly provide an objective information about the seabed. However, it does provide visual indication of relative scale of change to the backscatter response across a general area. The mosaic can be ground truthed through physical sampling of the seabed (sediment cores or grabs) and assessed visually through camera or video techniques.

The lighter areas in the mosaic (higher backscatter response level) could indicate areas of larger particle grain size, higher density (highly consolidated) or seabed roughness. The darker areas (lower backscatter response) could be particles of a smaller grain size, lower density (loosely consolidated). A real-world example would suggest higher backscatter response from a coarse sand and lower backscatter response from mud.

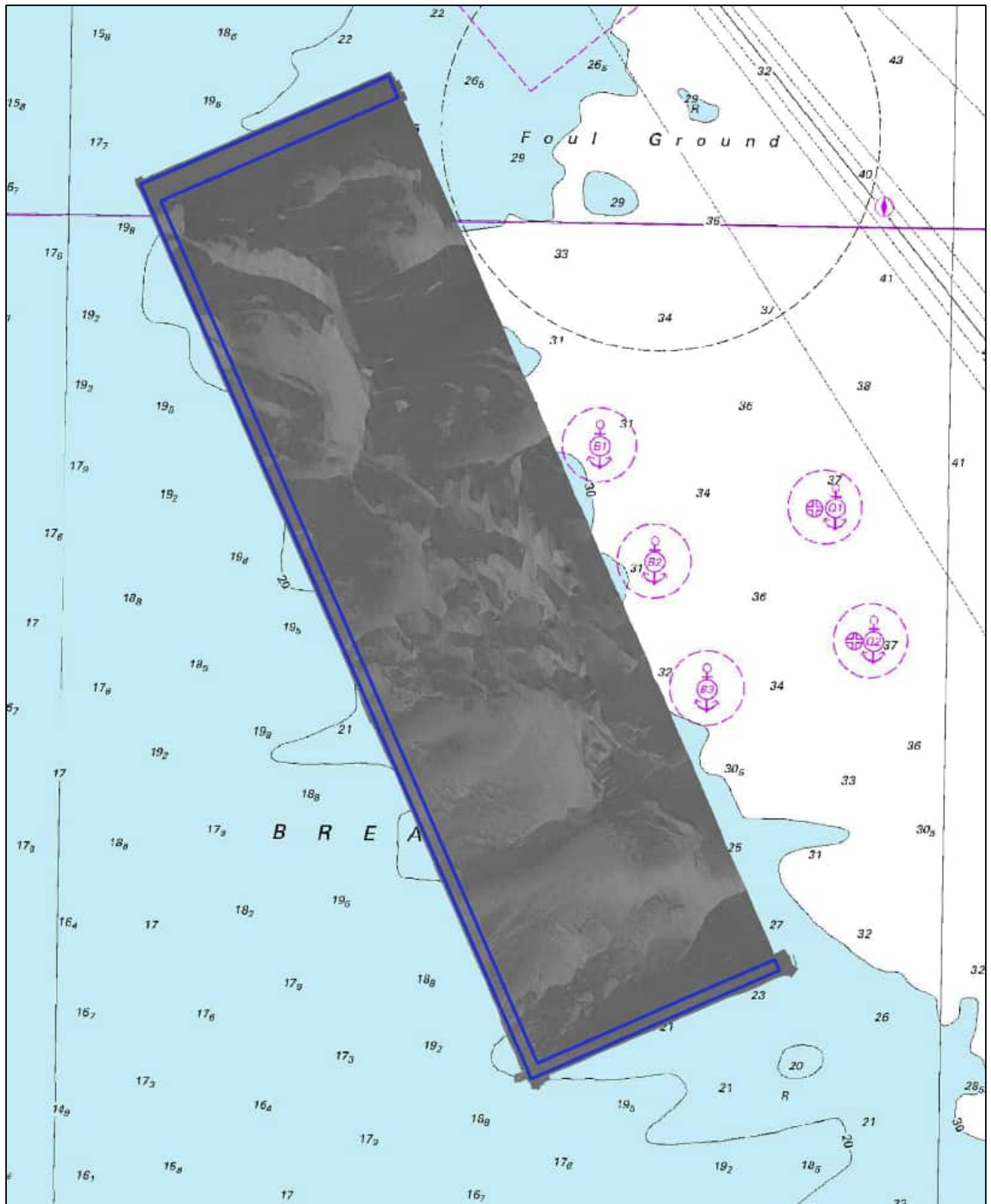


Figure 12: Bream Bay Extension Area Backscatter

12.RETENTION OF DATA

DML will retain copies of the project deliverables, including source data files, on its servers for a period of 12 months from completion of the project. The data will then be archived to a digital medium and retained for 7 years. After the initial 12-month period client requests to access and supply project data will incur a fee.

DML wishes to thank McCallum Bros. Ltd for the opportunity to undertake this project and looks forward to working with McCallum Bros. Ltd again in the future.

For Discovery Marine Ltd

Authored by		Date:20 Feb 2025
	Dillon Shields (CPHS2, MS+SNZ)	
Approved by		Date: 21 Feb 2025
	Declan Stubbing (BSURV, CPHS1)	CEO

APPENDIX A – METADATA

Survey Company	Discovery Marine Ltd		
Project Name	Bream bay Extension Area		
Project Number	2456		
Location	Bream bay, Northland, New Zealand		
Client	McCallum Bros. Ltd		
Contract Number	-		
Survey Start Date	10/12/2024	Survey End Date	12/12/2024
Surveyor In Charge	DS		
Field Personnel	DS, RN, DH		
Office Personnel	DS, RN, DJS		
Horizontal Datum and Projection	EDEN2000		
Vertical Datum	NZVD2016		
Sea Level Reduction	N/A	Tide Stations:	N/A
Origin of Coordinates and Levels	PPK Network solution from CORS reference stations WHNG, AUCK, WARK, CORM. Survey referenced utilising ellipsoid to NZVD20216 separation model.		
Survey Vessel	TRANQUIL IMAGE		
Positioning System	POSMV + MarineSTAR G4+ real-time PPP. Post processed POSPAC IAPPK		
Sonar System	Teledyne Reson T50 R MBES		
Sonar System Freq.	300kHz Fixed Frequency		
Acquisition Software	Qinsy v9.7.2		
Processing and Delivery Software	POSPac MMS 9.1, Qimera v2.7.1		
Data Collected	Bathymetry		
Coverage Achieved	Full seafloor		
Accuracy Standard Achieved	Yes (LINZ-1, LINZ-Special for TPU)		
Bathymetric Gridded Surface Method	Average surface		
Gridded Surface Resolution	1m x 1m		
Seafloor backscatter file type	GSF, processed to 1m x 1m grid resolution mosaic.		
File Format	GTIFF		
Data Custodian Contact Details	[REDACTED]		