

Pakiri Sands Multibeam Echo-Sounder Survey December 2018

Report of Survey

Prepared for Kaipara Ltd



Unit 4, 517 Mt. Wellington Highway,
Auckland, New Zealand
T: +64 (0)9 9486491
E: cad@surveyworx.co.nz

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Dec 2018

Report status

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TABLE OF CONTENTS

Contents

1. CHARTLET.....	Error! Bookmark not defined.3
2. INTRODUCTION.....	5
2.1. Survey operations.....	5
2.2. Survey Results November 2015	5
3. GEODETIC CONTROL.....	6
4. DIGITAL SURVEYING SYSTEMS.....	6
5. POSITION FIXING SYSTEMS.....	6
6. BATHYMETRY	6
7. SONAR.....	7
9. SEABED TOPOGRAPHY AND TEXTURE.....	7
10. TIDES AND SOUNDING DATUM	7
11. TIDAL STREAMS	7
12. WRECKS AND OBSTRUCTIONS.....	7
13. LIGHTS AND BUOYS	7
14. COASTLINE, TOPOGRAPHY AND CONSPICUOUS OBJECTS	7
15. SAILING DIRECTIONS AND NOMENCLATURE	7
16. RADIO STATIONS.....	7
17. ANCILLARY OBSERVATIONS.....	7
18. COMPARISON TO PREVIOUS DATA SETS.....	8
19. ANNEX A: ACCOMPANYING DOCUMENTS	9
20. ANNEX B: DIGITAL SURVEYING SYSTEMS	10
21. ANNEX C: ACCURACY OF SOUNDINGS & HORIZONTAL POSITIONS OF SOUNDINGS	11
22. ANNEX D: SURVEY PLAN LONG SECTIONS.....	13
23. ANNEX E: ECHOSOUNDER AND MOTION SENSOR DATA SHEETS.....	14

LIST OF FIGURES

Figure 1: Locations and extents of survey areas.....	4
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LIST OF TABLES

Table 1: Control Site Boundaries	6
Table 2: Sounding Error Budget.....	11

1. CHARTLET

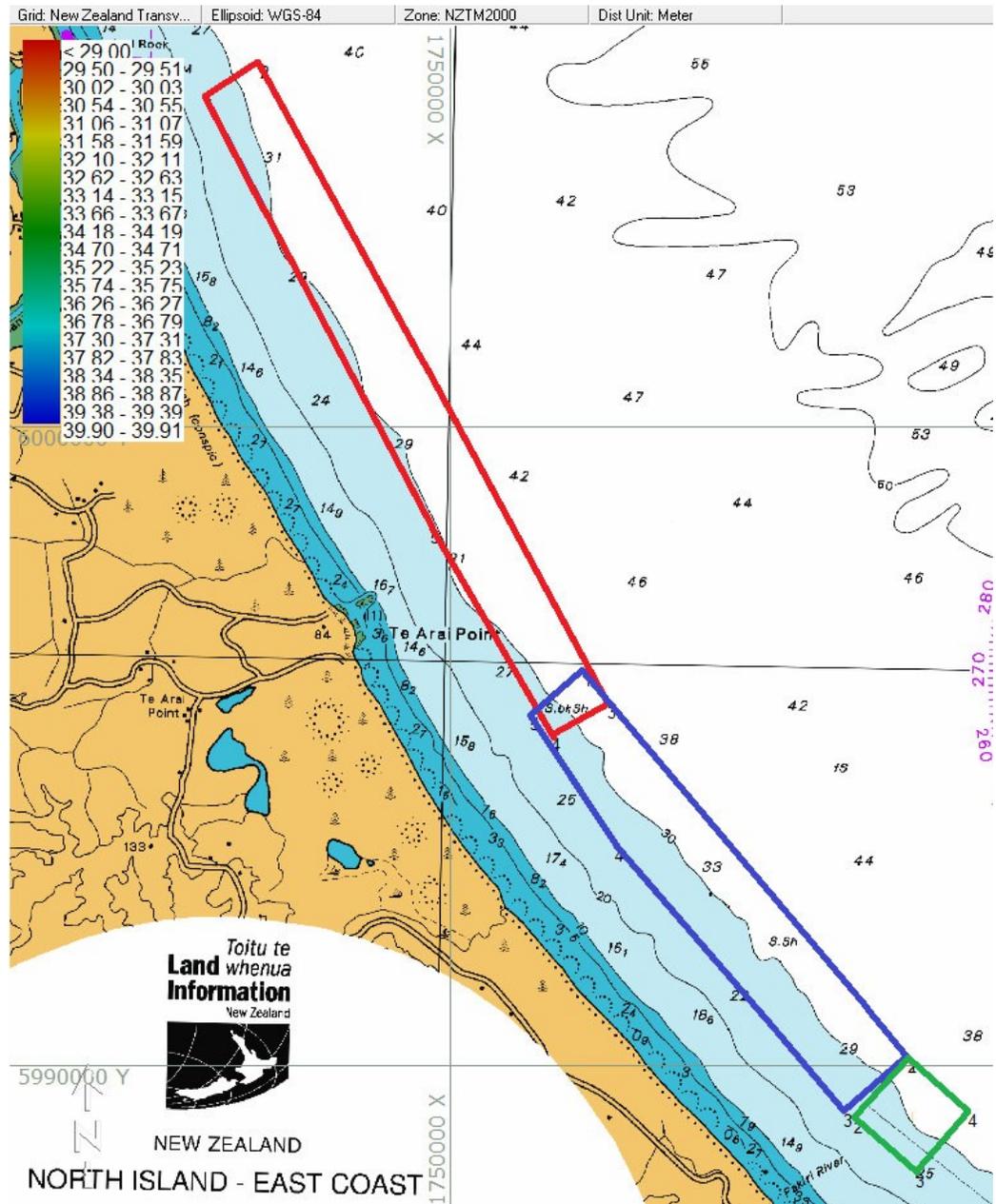


Figure 1: Locations and extents of survey areas.

Control Site in green, Area 1 in blue and Area 2 in red all surveyed on 07.12.2018

2. INTRODUCTION

Kaipara Ltd commissioned SurveyWorx Ltd (SWX) to undertake a hydrographic survey of three areas offshore of Pakiri beach, New Zealand. The survey was performed on the 7th of December 2018, using a WASSP WMB 3250 Multibeam and SMC IMU108 motion sensor mounted on vessel Ten Seventy. The purpose of the survey was to acquire bathymetric datasets as requirements for Kaipara Ltd's resource consents for sand extraction.

The 3 areas to survey were, from South to North (Figure 1):

- "Control Site". an approximately 1280m x 1280m square area adjacent to Area 1, defined as per recommendations. Boundaries of the area are listed in Table 1.
- "Area 1". Survey as part of Environmental monitoring Management Plan (EMMP) requirements.
- "Area 2". Survey as part of Environmental monitoring Management Plan (EMMP) requirements.

2.1. Survey operations

Instruments were installed aboard Ten Seventy during 2015. The sensors (WASSP, GPS antenna and motion sensor) were positioned on mounts manufactured specifically for the installation of the equipment by Electronic Navigation Limited. Data for system calibration (sonar head angle Offsets, and GPS latency, i.e. patch test) were acquired on the 27th of October, 2015, over and around a reef located north of Waiheke Island.

Control Site Area 1 and Area 2 was surveyed on the 7th of December 2018. There was a northerly 0.2m swell on site. The magnitude of the heave movement of the vessel was known to be within tolerances of the motion sensor. Conditions were well suited to completing the survey.

It was chosen to complete the entire survey in two long days approximately 24hours rather than multiple trips

Data was acquired along north south lines starting in the southern corner farthest from shore heading north. Line spacing was set to increase regularly with each line from 120m (offshore) to 90m (inshore) in order to ensure slight overlap of outer beams. Some 10 lines were planned in area 2 for a total distance of 111,884 m. 3 crosslines per area was acquired for quality control and assessment of potential errors in tidal corrections or sonar head angle offsets.

Figure 1 shows the extent of the survey areas.

Table 1. Shows the control site boundaries used to cross reference against other surveys

2.2. Survey Results December 2018

Whilst bearing in mind the accuracies of the adopted survey a comparison was made to the dataset received from a previous survey completed in 2015 for Area 2 and 2011 for Area 1 and the Control Site. The results are illustrated in the accompanying drawings numbered 2957-705-1 1 of 13 and 2 of 13. The variance in bathymetry to the previous surveys are shown with the accompanying long sections 3 of 13 to 13 of 13. This is by way of 7 longsections shown at 2km intervals along the area.

Bound point location	Latitude (WGS84)	Longitude (WGS84)
South	36° 14.209' S	174° 45.014' E
East	36° 13.760' S	174° 44.358' E
West	36° 13.721' S	174° 45.524' E
North	36° 13.275' S	174° 44.874' E

Table 1: Control Site Boundaries

3. GEODETIC CONTROL

The survey was carried out using the standard GPS datum and geographic coordinate system (WGS 84, based on the GRS 80 spheroid). The entire survey was undertaken in network, using radio base stations. No geodetic controls on land were used.

4. DIGITAL SURVEYING SYSTEMS

The WASSP was operated from a survey computer running WASSP Controller software.

The data output by the WASSP firmware on the network (including soundings, position and motion sensor data) were recorded and processed with Hypack/Hysweep 2010 survey software. The original datagrams were recorded in the Simrad .all format, while the processed data were recorded in the .asc file types.

5. POSITION FIXING SYSTEMS

Vessel position was measured by a Trimble R6 model 3 GPS receiver, computing a Network (RTK GPS) solution from radio corrections. Data were sent in the NMEA 0183 format (GGA, ZDA, VTG, and HDT tags) to the WASSP Processing Unit and the survey computer by serial ports. Good quality GPS data was received during the entire survey.

6. BATHYMETRY

Bathymetry data were acquired with the WASSP. No other echo sounder was used during this survey. The WASSP typically transmits a pure tone pulse of 160 kHz and 150 ms long within a swath of 120° (across-track) per 1.5° (along-track), at a ping rate varying with water depth. On receive, the signal is sampled at a rate of 15 kHz, and 224 beams are formed using the Fast Fourier Transform (FFT) algorithm. The receiving beam width in the across-track plane varies with the beam steering angle from 1.5° at normal incidence up to 3.0° at 60°.

No squat and settlement trials using total station were carried out for preparation to this survey. An estimation of the dynamic draught of the vessel was measured by computing the mean difference between data acquired (1) at survey speed and (2) while static, over a flat calibration area near compass dolphin (Port of Auckland). The measured difference was 0.06 m. and also from detailed design drawings for the boat

Vessel attitude and heave during survey were measured by a SMC IMU 108 3250 motion sensor, and input directly into the WASSP Processing Unit for integration by

the WASSP firmware. Sea conditions at time of acquisition were within tolerances of the motion sensor.

7. SONAR

No sidescan sonar was used during the survey.

8. SEABED SAMPLING

No seabed sampling was conducted during the survey.

9. SEABED TOPOGRAPHY AND TEXTURE

The seabed on all areas surveyed is known to consist principally in sand. Bedforms could be expected in places, as well as dredging marks on Area 2.

10. TIDES AND SOUNDING DATUM

No tidal station or pole was used for this survey. Tidal corrections were obtained from tide models provided by Electronic Navigation Limited. These corrections are referred to MSL. In order to keep with previous surveys this methodology was adopted.

11. TIDAL STREAMS

No tidal streams observations were carried out.

12. WRECKS AND OBSTRUCTIONS

No wrecks and obstructions observations were carried out.

13. LIGHTS AND BUOYS

No light sectors or buoys were present in the survey area.

14. COASTLINE, TOPOGRAPHY AND CONSPICUOUS OBJECTS

NIL

15. SAILING DIRECTIONS AND NOMENCLATURE

NIL

16. RADIO STATIONS

NIL

17. ANCILLARY OBSERVATIONS

No additional observations were made.

18. COMPARISON TO PREVIOUS DATA SETS

A comparison in bathymetry is made to previous surveys of the area and cross referenced to illustrate the depth of the sea floor within the subject site.

This was completed in civil 3d (a survey software package) and drawings and associated long sections were produced to illustrate the relationship between surveys (refer to Drawing 2957-705-01 to 13).

The comparison is displayed in longsection form to illustrate the relative difference in the sea floor from previous surveys to current conditions. The results show there has not been an average change in bathymetry exceeding 1.5m over Area1 or 2 as well as the control site. In addition large areas of possible accretion were also noted in places as well as erosion.

ANNEX A: ACCOMPANYING DOCUMENTS

The following digital data accompany this report of survey:

Bathymetry in XYZ ASCII files. XY in New Zealand Transverse Mercator and Z referenced to MSLSWX. Data sets are separated for the three areas and provided as all soundings, gridded at 1-m resolution and gridded at 5-m resolution.

Cad drawing: by Survey Worx Limited numbered 2957-705-01

ANNEX B: DIGITAL SURVEYING SYSTEMS

The WASSP system was operated from the vessel Ten Seventy at a cruising speed of approximately 6 to 7 knots in average. Vessel attitude and heave were measured by a SMC IMU 108 motion sensor. Vessel position was measured by a Trimble R6 model 3 GPS receiver, computing a RTK solution from radio corrections. Sound- celerity profiles were acquired using an Applied Microsystems Ltd SVPlus.

The data ws acquired with Hypack/ Hysweep 2010 survey software and recorded in both the Simrad .all format and the Hypack .hsx format. Tides corrections were provided by tide models supplied by Electronic Navigation Limited.

ANNEX C: ACCURACY OF SOUNDINGS & HORIZONTAL POSITIONS OF SOUNDINGS

An estimate of the sounding error budget for the survey is listed below. The estimates provided are for soundings gathered at minimum, intermediate, and maximum depth levels and are developed on system accuracies for 60° angle (outer beams). LINZ accuracy standards are indicated for information, but contract did not specify any standard to meet.

	Source of error	Depth in meters		
		30 m	35 m	40 m
a	Draught Setting	0.05	0.05	0.05
b	Variation of Draught	0.05	0.05	0.05
c	Sound Velocity	0.12	0.13	0.15
d	Spatial Variation in SV	0.1	0.1	0.1
e	Temporal Variation in SV	0.05	0.05	0.05
f	Application of Measured SV	0.05	0.05	0.05
g	Depth Measurement (Instrument)	0.3	0.32	0.35
h	Depth Measurement (Resolution)	0.01	0.01	0.01
l	Heave	0.2	0.2	0.2
j	Settlement and Squat	0.2	0.2	0.2
k	Roll, Pitch and Seabed Slope	NA	NA	NA
l	Tidal Readings	0.5	0.5	0.5
m	Co-Tidal Correction	NA	NA	NA
n	Tide Corrections	0.05	0.05	0.05
o	Trace Reading	NA	NA	NA
	Total Standard Error $\sqrt{a^2 + b^2 + \dots}$	0.82	0.83	0.84
	LINZ accuracy standards			
	MB Special	0.34	0.36	0.39
	MB-1	0.5	0.54	0.59
	MB-2	0.67	0.72	0.78
	MB-3	0.84	0.9	0.98

Table 2: Sounding Error Budget

Notes:

- a: No bar check was carried out. Worst-case value estimated from total station measurements standard error, and static waterline visual estimation.
- b: Estimation from change in tank contents.
- c: Based on SV-plus accuracy.
- d, e: Worst-case estimation considering size of survey area and frequency of SV casts.

- f: SV applied in WASSP WMB3250 and in post-processing with Hypack.
- g, h.:Estimations from WASSP WMB3250 sounding accuracy from WASSP document, using outer beams.
- I: Significant errors in heave measurements due to sea conditions at time of acquisition (see report).
- J: Maximum error in dynamic draught estimation procedure.
- K: Not applicable. Single-beam only.
- l: Significant potential error as tide models were used instead of measurements. Maximum error estimated from comparison between lines and cross-lines.
- M: Not applicable. Tide models were used.
- N: tide data sampled at 6 minutes. Interpolation is done by Hypack software.
- O: Not applicable. Soundings were derived digitally.

22. ANNEX D: SURVEY PLAN LONG SECTIONS

**23. ANNEX E: ECHOSOUNDER AND MOTION SENSOR
DATA SHEETS**

SEE IT ALL

WMB-3230 / WMB-5230 / WMB-3250 Specifications

	WMB-3230	WMB-5230	WMB-3250
General			
Frequency	160 kHz	80 kHz	160 kHz
Specified Depth Capability	2m - 200m +	10m - 500m +	2m - 200m +
Maximum Range Scale	400m	800m	300m
Output Power	40 W to 1 kW	150 W to 1.2 kW	40 W to 1 kW
Effective Beam Width (arcthwships x fore-aft)	120° x 4°		
Beam Spacing	Equi-Angular 120° @ 1.07° beams		
Electronic Beam Width	112 beams x 1.07° over 120°		224 beams x 0.54° over 120°
Max Ping Rate (Pings Per Second)	16 (@ 10m range)	16 (@ 10m range)	48 (@ 10m range)
Maximum Resolution (height of smallest target detectable at nadir)	7.5cm	15cm	7.5cm
CW Pulse Duration (ms)	0.1, 0.2, 0.5, 1.0, 2.0	0.2, 0.5, 1.0, 2.0, 3.0, 4.0, 6.0, 8.0, 10.0	0.1, 0.2, 0.5, 1.0, 2.0
Advance speed	Slow – fast (5 speeds).		
Beamforming	Digital		
Roll Correction (Accuracy based on sensor used)	Yes		
Pitch Correction	Partial - depth correction only		Yes
Heave Correction	Partial - depth correction only		Yes
Ships Reference Corrections	Partial - depth correction only		Yes
Sound Speed Correction	Surface only		
Bottom Detections	Amplitude & Phase		
GPS Interface	NMEA0183		
Tide Correction	Prediction based on tide stations		
Hydrographic Compliance*	N/A	N/A	IHO Order 1a
* Requires appropriate sensors			
Display Modes			
Acoustic	Sonar view		
Acoustic	Single / Triple beam view		
Acoustic	Sidescan view		
Mapping	2D and 3D mapping (Colour/mono)		
Advanced Mapping	Fish, Chart, Backscatter & Contour Overlay options		Watercolumn, Chart, & Contour Overlay options
Display Windows	2 Display windows (Acoustic & Charting), with User-configured 1/2/3-way split-panels per window (maximum of 6 panels)		Acoustic Display (1): 1/2/3/4-way split-panels; Navigator Display (2): 1/2 way split-panels (User-configured)
Tools			
General	Zoom, Pan, Vertical Scale, Goto, Add Measure, Profile Window		
Marks	At Vessel/Cursor/Ship. Colour, Type, Name Options		
Ship	Centre on ship, North Up, Head Up, Show/Hide Track		
Database Management	Record, Edit & Export capability		
Hardware			
Transducer	Suits In-hull tank mount / Pole Mounting, with 5/10/20m cable* (* gland optional; excludes pole assembly or tank assembly)		
Transceiver (BTxR)	Black box transceiver with ethernet output (suits bulkhead/floor mounting)		
Processor	High Performance Marine Processor with keyboard and trackball	High Performance Advanced Ruggedized Fanless Marine Processor with keyboard and trackball	
Display Monitors			
Display Monitors	Single Display installation: FHD (1920x1080 recommended); or Dual displays installation (Dual monitor installation is recommended): XGA (1024x768) up to full FHD*		Dual Monitor configuration recommended. Minimum resolution: 1024x768
*Not included (local supply)			
Power Supply			
Transceiver	24 VDC, 70 W	24 VDC, 150 W	24 VDC, 70 W
Processor	9-30 VDC, ~ 1.5 Amp @ 24 VDC		9-32 VDC (Optional external AC-DC adaptor available)
Dimensions & Weight			
Transducer Dimensions (LxWxH, mm)	330 x 168 x 98	533 x 340 x 133	330 x 168 x 98
Transducer Weight	15 kg with standard 10m cable	39 kg with standard 20m cable	15 kg with standard 10m cable
Transceiver (BTxR) Dimensions (LxWxH, mm)	535 x 221.5 x 180		
Transceiver (BTxR) Weight	5kg		
Processor Dimensions (WxDxH, mm)	279 x 337 x 102		230 x 205 x 75
Processor Weight	5.7kg		3.8kg
Environmental			
Temperature	0 to 40° C.		
Relative Humidity	5 to 95% non condensing.		
Data Interface			
Input*	NMEA0183 & RS232		
*WASSP requires (3rd party) position, heading, roll, pitch and heave data for electronic beam compensation/stabilization (not included - local supply). See your local WASSP expert for more information/clarification.			
	WMB-3230	WMB-5230	WMB-3250
3rd Party Software Compatibility			
Software Interfaces*	Olex Sodena MaxSea TZ	HYPACK/HYSWEEP® QINSy® GSF logging MaxSea TZ	
* Requires WASSP Interface Module & Excludes 3rd Party Software (contact your local supplier for software component pricing)			

Specifications subject to possible change without notice.



WASSP Ltd.

65 Gaunt Street
Westhaven
PO Box 5849
Auckland
New Zealand

Phone: +64-9-373 5595
Fax: +64-9-379 5655
Email: sales@wassp.com
Website: www.wassp.com



SMC IMU-10 Range

Motion Sensors



SMC has developed its IMU-10 range of Motion Sensors to meet the requirements of the hydrographic and marine sectors. The IMU range provides high accuracy motion measurement data in dynamic environment in all areas from small hydrographic vessels to large oil rigs in all weather conditions.

Key Specifications

- Roll & Pitch 0.03° (RMS) Dynamic Accuracy
- Heave 5 cm or 5 %
- Accelerations / Velocities
- Inputs, Velocity and Heading
- Various Industry Protocols NMEA
- 2 years warranty

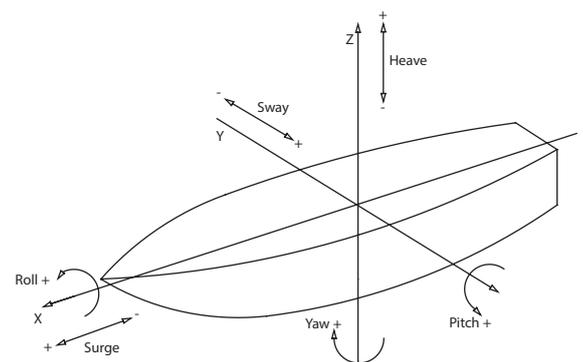
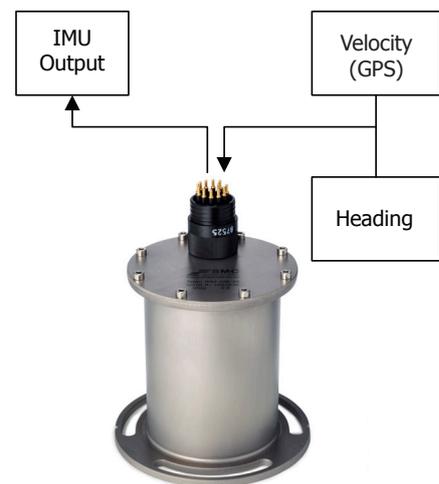


The SMC IMU uses solid state gyros and accelerometers to provide real time motion measurements with high dynamic accuracy even during accelerations. RS232 or RS422 outputs with RS232 velocity and heading inputs for aiding during vessel turns. High quality titanium design, construction and assembly produce an IMU with an extremely high reliability in the most demanding marine environment.

Every SMC IMU is individually calibrated and tested, inside a calibration machine with a controlled temperature environment between 0 and +55 degrees Celsius.

The SMC IMU is supplied with a data distribution unit, cables and windows based software for ease of set up and configuration. The configuration software enables the user to configure the IMU parameters for the installation.

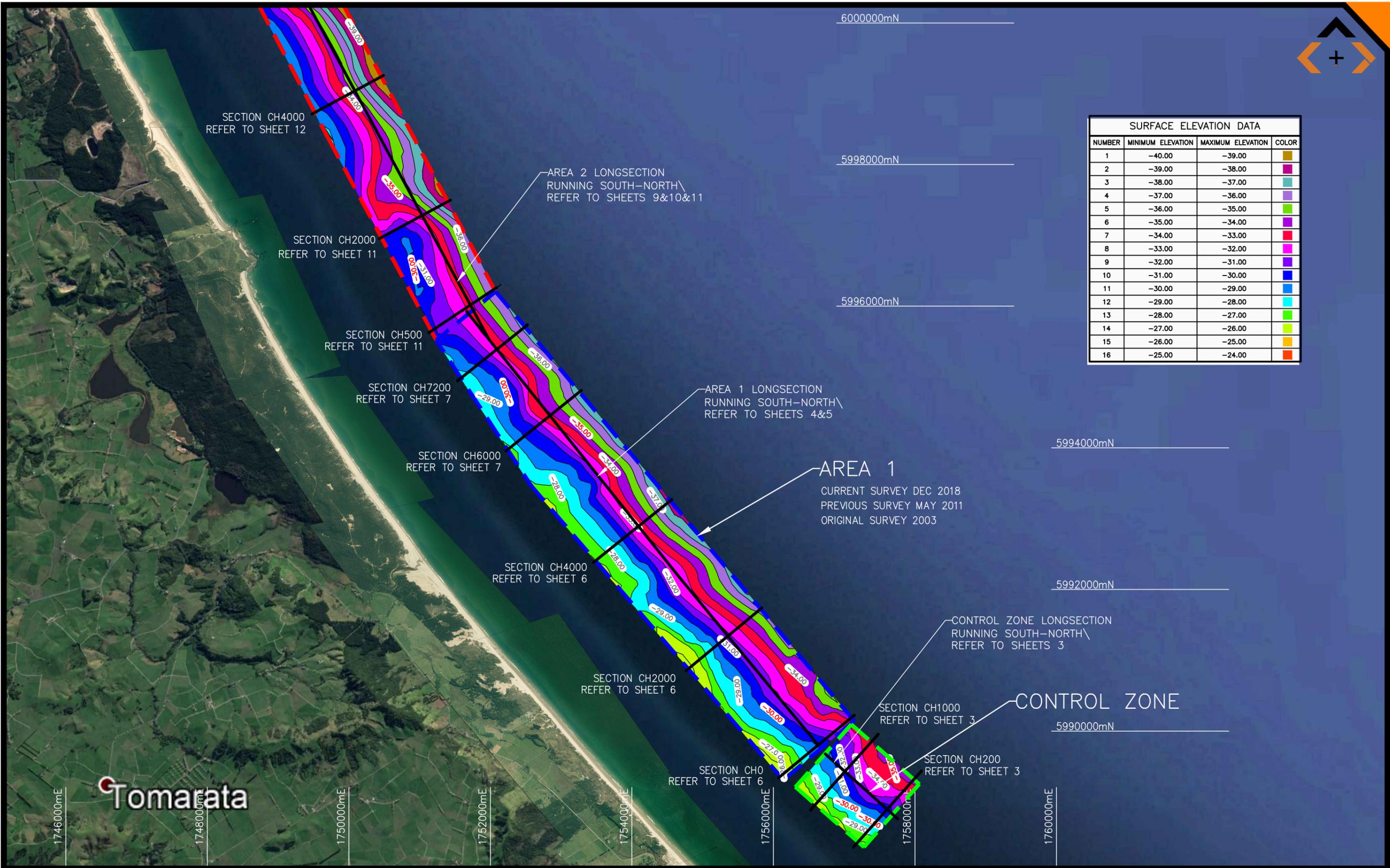
The SMC IMU is available in a variety of design and depth options.





Technical Specifications	IMU-106	IMU-107	IMU-108
Roll / Pitch	N/A	Yes	Yes
Accelerations X, Y, Z	N/A	Yes	Yes
Heave	Yes	N/A	Yes
Performance			
Angle Accuracy static	N/A	0.02° RMS	0.02° RMS
Angle Accuracy Dynamic @ ±5° simultaneous roll and pitch	N/A	0.03° RMS	0.03° RMS
Resolution Angle	N/A	0.001°	0.001°
Resolution Heave	0.01m	N/A	0.01m
Angle range Roll/Pitch	± 30°	± 30°	± 30°
Heave range	±10m	N/A	±10m
Heave Accuracy	5cm or 5%	N/A	5cm or 5%
Acceleration accuracy	N/A	0.01 m/s ² RMS	0.01 m/s ² RMS
Communications			
IMU Configuration Software	The IMU is shipped with SMC configuration windows software allowing on site setup		
Output Signal Protocol	Multiple, user selectable Output Protocols ASCII NMEA and binary		
Communications Interface	Output RS422 and RS232. Analog with remote converter (optional) 2 x RS232 External inputs, (not available on all models) Velocity input formats RMC, RMA, VTG, VBV, VHW; Heading input formats HDT, HDG		
Physical			
Dimensions for IMU-10x (W x H)	tube Ø89, mounting plate Ø134, flange Ø110) x 127		
Weight	~2 kg		
Housing Material	Titanium		
Environmental			
Temperature (absolute max)	0° to +55° Celsius (-10° to +65°); Storage Temperature -40° to +65° Celsius		
Mounting Orientation	Vertical or Horizontal mounting (factory set)		
Power requirements	12 - 30 VDC; 2 W		
MTBF (computed)	50 000 hours		
Depth rating	IP66 (standard); IP68 30 meter depth rated (optional)		
Standard	Complies with the IEC 60945		
Warranty & Support			
Warranty	2-year Limited Hardware & Software Warranty		
Support	Free Technical & Hardware support		
Bundled Delivery			
Junction Box	Multiple Input & Output Connection Case, including 10 m cable		





SURFACE ELEVATION DATA			
NUMBER	MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOR
1	-40.00	-39.00	Yellow
2	-39.00	-38.00	Pink
3	-38.00	-37.00	Light Blue
4	-37.00	-36.00	Purple
5	-36.00	-35.00	Light Green
6	-35.00	-34.00	Dark Purple
7	-34.00	-33.00	Red
8	-33.00	-32.00	Magenta
9	-32.00	-31.00	Blue
10	-31.00	-30.00	Dark Blue
11	-30.00	-29.00	Cyan
12	-29.00	-28.00	Light Cyan
13	-28.00	-27.00	Light Green
14	-27.00	-26.00	Yellow-Green
15	-26.00	-25.00	Yellow
16	-25.00	-24.00	Orange

Tomarata

SURVEYED	CH	10.12.2018	APPROVED	DATE
DESIGNED				
DRAWN	LK	18.12.2018		
TRACED				
REVISION		CHANGES	CHECKED	DATE
3		SWAP CUT/FILL VALUES	CH	23.05.19
2		2003 & 2006 SURVEY ADDED	CH	03.04.19
1		RE ISSUE	CH	28.03.19
0		ORIGINAL ISSUE	CH	18.12.18

NOTES:
 - BEARING AND COORDINATE DATUM IS NEW ZEALAND TRANSVERSE MERCATOR PROJECTION
 - LEVELS ARE IN TERMS OF LANDS AND SURVEY DATUM (MSL) AUCKLAND 1946

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SURVEY WORX+
 CONSTRUCTION & LAND SURVEYORS

mobile +64 021 824 084
 office +64 09 948 6491
www.surveymorx.co.nz

Unit 4, 517 Mt Wellington Highway, Auckland, NZ



CLIENT
 COASTAL RESOURCES

PROJECT
 PAKIRI

TITLE
 SEA FLOOR ASBULT SURVEY
 AREA 1 AND CONTROL ZONE

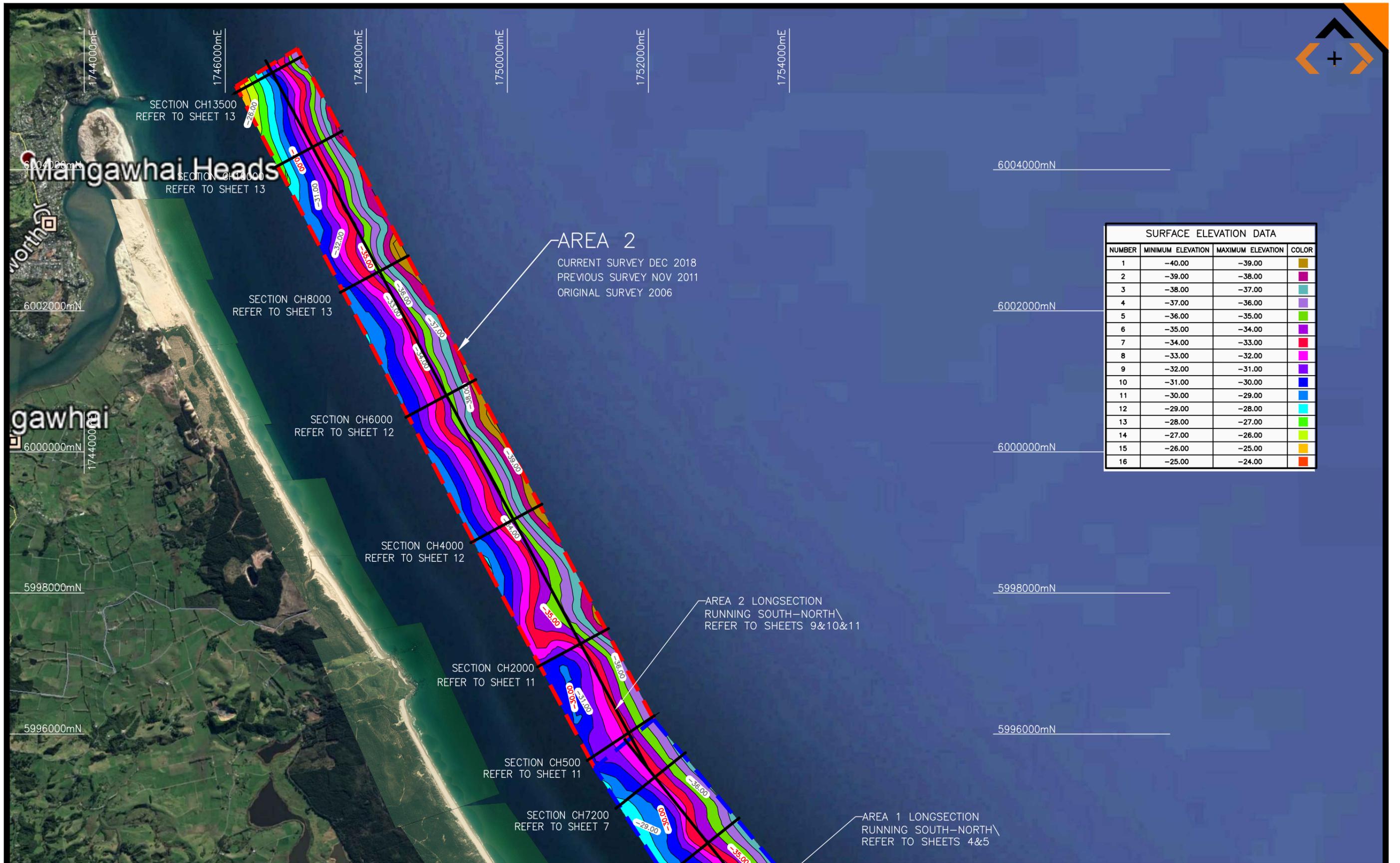
SCALE
 1:25000 (A1)
 1:50000 (A3)

SHEET
 1 of 15

REVISION
 3

DRAWING No
 2957-705-01

PLOT DATE: 3/20/2020 3:06 PM



PLOT DATE: 3/20/2020 3:07 PM

SURVEYED	CH	10.12.2018	APPROVED	DATE
DESIGNED	LK	18.12.2018		
DRAWN				
TRACED				
REVISION		CHANGES	CHECKED	DATE
3	SWAP CUT/FILL VALUES		CH	23.05.19
2	2003 & 2006 SURVEY ADDED		CH	03.04.19
1	RE ISSUE		CH	28.03.19
0	ORIGINAL ISSUE		CH	18.12.18

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SURVEY WORX+
CONSTRUCTION & LAND SURVEYORS

mobile +64 021 824 084
office +64 09 948 6491
www.surveyyorx.co.nz

Unit 4, 517 Mt Wellington Highway, Auckland, NZ



CLIENT
COASTAL RESOURCES

PROJECT
PAKIRI

TITLE
SEA FLOOR ASBULT SURVEY AREA 2

SCALE
1:25000 (A1)
1:50000 (A3)

SHEET
2 of 15

REVISION
3

DRAWING No
2957-705-01

FOR AREA 1_X CH 0
SCALE: 2000 / 100
DATUM: -35.00

DIFFERENCE 2011 v 2018				0.10	0.09	0.08	0.08	0.08	0.08	0.04	0.04	-0.13	-0.25	-0.16	-0.07	0.00	0.09	0.10	0.10	0.05	0.03	0.02	0.03	-0.02	-0.06				
DIFFERENCE 2003 v 2011				0.10	0.05	0.05	0.04	0.02	0.02	0.01	0.00	0.00	0.01	-0.01	-0.05	-0.06	-0.07	0.04	0.04	0.13	0.09	0.11	0.05	-0.02	0.04				
DEC 2018 SURVEY				-26.04	-26.37	-26.67	-26.97	-27.32	-27.66	-28.02	-28.35	-28.68	-29.32	-29.63	-29.95	-30.28	-30.57	-30.86	-31.23	-31.57	-31.86	-32.14	-32.49	-32.85	-33.30	-34.22			
MAY 2011 SURVEY				-26.13	-26.46	-26.75	-27.06	-27.40	-27.74	-28.06	-28.31	-28.56	-29.07	-29.47	-29.88	-30.28	-30.57	-30.97	-31.33	-31.63	-31.90	-32.15	-32.52	-32.88	-33.27	-34.16			
2003 SURVEY	0	-26.00	-26.23	-26.51	-26.80	-27.10	-27.42	-27.76	-28.06	-28.31	-28.56	-28.81	-29.08	-29.45	-29.84	-30.22	-30.60	-30.97	-31.37	-31.75	-31.99	-32.26	-32.57	-32.86	-33.71	-34.21	-34.85		
CHAINAGE	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1388

FOR AREA 1_X CH 2000
SCALE: 2000 / 100
DATUM: -37.00

DIFFERENCE 2011 v 2018	0.00	0.00	0.06	0.18	0.06	0.11	-0.03	-0.03	-0.03	-0.06	-0.05	-0.03	-0.13	-0.05	-0.03	-0.02	-0.02	0.00	0.01	0.01	0.00	0.00	0.02	0.04	0.06	-0.02	-0.06		
DIFFERENCE 2003 v 2011	0.00	0.00	-0.08	-0.21	-0.25	-0.12	0.05	0.06	0.01	-0.04	-0.04	-0.04	-0.08	-0.10	-0.05	-0.03	0.00	0.01	0.02	0.01	0.01	0.00	0.08	0.08	0.02	0.05	0.07		
DEC 2018 SURVEY		-26.00	-26.00	-26.34	-26.69	-27.22	-27.99	-28.34	-28.67	-29.08	-29.64	-30.26	-30.87	-31.24	-31.97	-31.61	-32.33	-32.67	-33.02	-33.45	-33.88	-34.30	-34.70	-35.11	-35.51	-35.93	-36.43		
MAY 2011 SURVEY		-26.00	-26.00	-26.39	-26.87	-27.28	-27.96	-28.31	-28.67	-29.02	-29.60	-30.23	-30.74	-31.19	-31.95	-31.58	-32.31	-32.67	-33.03	-33.45	-33.88	-34.30	-34.72	-35.15	-35.57	-35.91	-36.37		
2003 SURVEY	0	-26.00	-26.00	-26.31	-26.66	-27.03	-27.66	-28.01	-28.37	-28.68	-29.56	-30.19	-30.66	-31.09	-31.53	-31.94	-32.31	-32.68	-33.04	-33.46	-33.88	-34.34	-34.80	-35.23	-35.59	-35.96	-36.44	-36.80	
CHAINAGE	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1388

AREA 1

SURVEYED	CH	10.12.2018	APPROVED	DATE
DESIGNED				
DRAWN	LK	18.12.2018		
TRACED				
REVISION	CHANGES	CHECKED	DATE	
3	SWAP CUT/FILL VALUES	CH	23.05.19	
2	2003 & 2006 SURVEY ADDED	CH	03.04.19	
1	RE ISSUE	CH	28.03.19	
0	ORIGINAL ISSUE	CH	18.12.18	

NOTES:
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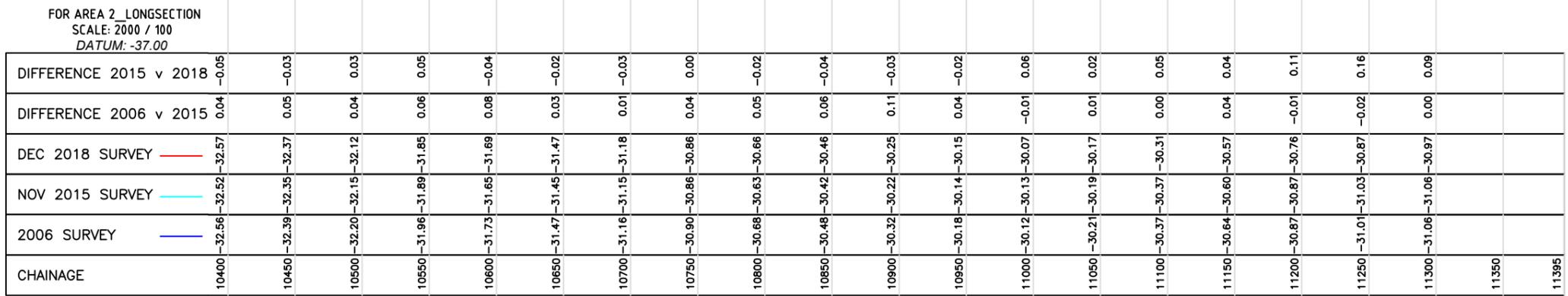
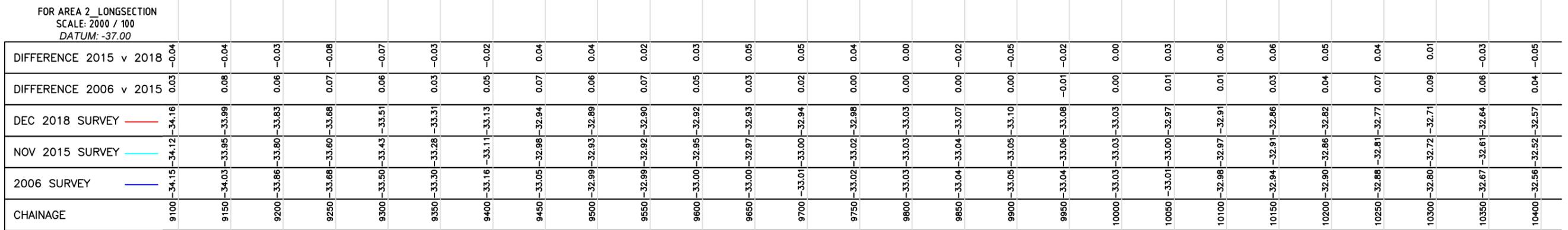
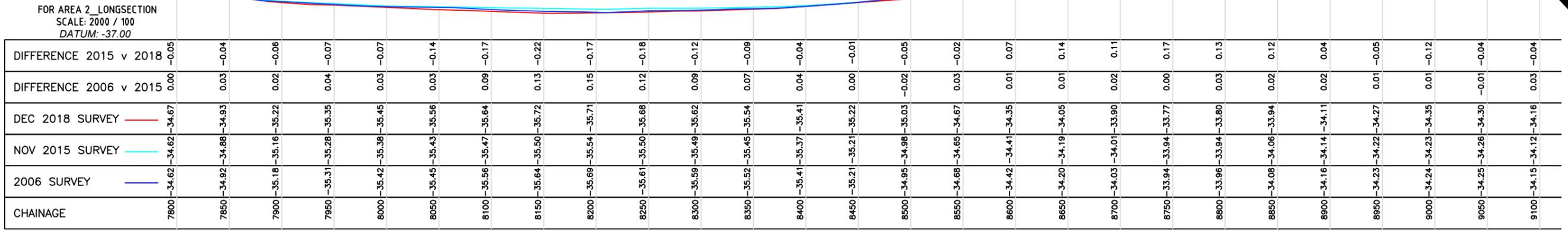
CLIENT
COASTAL RESOURCES

PROJECT
PAKIRI

TITLE
SEA FLOOR ASBUILT SURVEY CROSS SECTION AREA 1

SCALE 1:2000 (A1)
1:4000 (A3)
SHEET 6 of 15
REVISION 3
DRAWING No 2957-705-01

PLOT DATE: 3/20/2020 3:09 PM



AREA 2

SURVEYED	CH	10.12.2018	APPROVED	DATE
DESIGNED	LK	18.12.2018		
DRAWN				
TRACED				
REVISION			CHECKED	DATE
3	SWAP CUT/FILL VALUES	CH	23.05.19	
2	2003 & 2006 SURVEY ADDED	CH	03.04.19	
1	RE ISSUE	CH	28.03.19	
0	ORIGINAL ISSUE	CH	18.12.18	

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PROJECT
PAKIRI

TITLE
SEA FLOOR ASBUILT SURVEY LONG SECTION AREA 2

SCALE 1:2000 (A1)
1:4000 (A3)
SHEET 11 of 15
REVISION 3
DRAWING No 2957-705-01

FOR AREA 2_X CH 500
SCALE: 2000 / 100
DATUM: -38.00

DIFFERENCE 2015 v 2018			0.05	0.07	0.04	0.00	-0.02	-0.05	-0.07	-0.11	-0.17	-0.19	-0.21	-0.29	-0.19	0.07	-0.12	-0.31	-0.38	-0.12	0.05	0.13	0.24		
DIFFERENCE 2006 v 2015		-0.33	-0.17	-0.12	-0.08	-0.04	0.00	0.04	0.07	0.09	0.18	0.21	0.25	0.38	0.26	-0.02	0.01	0.03	0.06	-0.20	-0.35	-0.38	-0.41		
DEC 2018 SURVEY	—	-31.00	-31.11	-31.26	-31.42	-31.56	-31.74	-31.88	-32.06	-32.31	-32.58	-32.84	-33.17	-33.60	-34.01	-34.51	-35.01	-35.40	-35.80	-36.17	-36.49	-36.78	-37.03		
NOV 2015 SURVEY	—	-31.05	-31.17	-31.30	-31.43	-31.56	-31.74	-31.88	-32.06	-32.31	-32.58	-32.84	-33.17	-33.60	-34.01	-34.51	-35.01	-35.40	-35.80	-36.17	-36.49	-36.78	-37.03		
2006 SURVEY	—	-30.31	-30.72	-31.01	-31.17	-31.30	-31.43	-31.56	-31.74	-31.88	-32.06	-32.31	-32.58	-32.84	-33.17	-33.60	-34.01	-34.51	-35.01	-35.40	-35.80	-36.17	-36.49		
CHAINAGE		0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1146

FOR AREA 2_X CH 2000
SCALE: 2000 / 100
DATUM: -40.00

DIFFERENCE 2015 v 2018		-0.01	-0.04	-0.06	-0.09	-0.08	0.00	-0.06	-0.09	-0.19	-0.08	-0.09	-0.19	-0.23	-0.12	-0.16	-0.20	-0.12	-0.10	-0.10	-0.07	-0.01	0.01		
DIFFERENCE 2006 v 2015			-0.01	-0.06	-0.01	-0.01	-0.01	0.01	0.12	0.05	0.09	0.10	0.14	0.11	0.05	-0.05	-0.17	-0.14	-0.05	-0.06	-0.07	-0.05	-0.05		
DEC 2018 SURVEY	—	-30.98	-30.98	-30.97	-30.94	-30.97	-31.00	-31.06	-31.23	-31.70	-31.92	-32.26	-32.75	-33.29	-33.81	-34.55	-35.28	-36.53	-37.20	-37.91	-38.42	-38.92	-39.31		
NOV 2015 SURVEY	—	-30.97	-30.94	-30.91	-30.84	-30.89	-31.00	-31.06	-31.23	-31.70	-31.92	-32.26	-32.75	-33.29	-33.81	-34.55	-35.28	-36.53	-37.20	-37.91	-38.42	-38.92	-39.31		
2006 SURVEY	—	-30.93	-30.85	-30.83	-30.88	-30.99	-31.02	-31.14	-31.26	-31.57	-31.83	-32.17	-32.57	-33.06	-33.69	-34.39	-35.08	-35.86	-36.42	-37.11	-37.84	-38.36	-38.89		
CHAINAGE		0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1145

AREA 2

PLOT DATE: 30/01/2020 3:13 PM

SURVEYED	CH	10.12.2018	APPROVED	DATE
DESIGNED	LK	18.12.2018		
DRAWN				
TRACED				
REVISION	CHANGES	CHECKED	DATE	
3	SWAP CUT/FILL VALUES	CH	23.05.19	
2	2003 & 2006 SURVEY ADDED	CH	03.04.19	
1	RE ISSUE	CH	28.03.19	
0	ORIGINAL ISSUE	CH	18.12.18	

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CLIENT
COASTAL RESOURCES

PROJECT
PAKIRI

TITLE
SEA FLOOR ASBUILT SURVEY CROSS SECTION AREA 2

SCALE 1:2000 (A1)
1:4000 (A3)
SHEET 12 of 15
REVISION 3
DRAWING No 2957-705-01

FOR AREA 2_X CH 4000
SCALE: 2000 / 100
DATUM: -41.00

DIFFERENCE 2015 v 2018		-0.38	-0.30	-0.23	-0.17	0.01	0.04	-0.05	-0.21	-0.24	-0.14	-0.12	-0.24	-0.26	-0.27	-0.42	-0.68	-0.21	0.00	0.01	-0.03	-0.01	0.03	
DIFFERENCE 2006 v 2015			-0.46	-0.29	-0.22	-0.28	-0.24	-0.09	0.05	-0.01	0.00	0.10	0.22	0.05	0.05	0.13	0.29	-0.09	-0.16	-0.12	-0.12	-0.11	-0.12	
DEC 2018 SURVEY	—	-29.10	-29.46	-29.76	-30.05	-30.29	-30.44	-30.79	-31.20	-31.67	-32.23	-32.87	-33.31	-33.70	-34.21	-34.76	-35.02	-35.53	-36.05	-36.71	-37.29	-37.84	-38.44	-39.06
NOV 2015 SURVEY	—	-29.10	-29.46	-29.81	-30.05	-30.29	-30.44	-30.80	-31.24	-31.62	-32.02	-32.63	-33.17	-33.58	-34.21	-34.76	-35.26	-35.53	-36.05	-36.71	-37.29	-37.84	-38.44	-39.06
2006 SURVEY	—	-29.10	-29.00	-29.52	-30.04	-30.52	-31.00	-31.53	-32.06	-32.62	-33.17	-33.67	-34.19	-34.81	-35.31	-35.76	-36.31	-36.84	-37.38	-37.84	-38.32	-38.89	-39.42	-39.97
CHAINAGE	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1147

FOR AREA 2_X CH 6000
SCALE: 2000 / 100
DATUM: -40.00

DIFFERENCE 2015 v 2018		-0.03	-0.01	-0.01	0.04	0.09	0.02	-0.09	-0.07	-0.08	-0.11	-0.12	-0.03	-0.06	-0.14	-0.07	0.02	0.00	-0.08	-0.16	-0.01	0.11		
DIFFERENCE 2006 v 2015		-0.06	-0.07	-0.11	-0.11	-0.10	-0.06	-0.04	-0.02	0.01	0.02	0.03	0.00	0.02	0.05	0.01	-0.07	0.00	0.00	0.07	-0.06	-0.14	-0.14	
DEC 2018 SURVEY	—	-30.25	-30.46	-30.73	-30.96	-31.23	-31.59	-31.99	-32.36	-32.77	-33.21	-33.73	-34.27	-34.85	-35.41	-35.98	-36.50	-37.04	-37.61	-38.16	-38.69	-39.15	-39.61	-39.84
NOV 2015 SURVEY	—	-30.21	-30.44	-30.72	-31.00	-31.32	-31.60	-31.90	-32.27	-32.69	-33.13	-33.62	-34.15	-34.82	-35.35	-35.84	-36.43	-37.05	-37.53	-38.00	-38.62	-39.12	-39.61	-39.84
2006 SURVEY	—	-29.97	-30.15	-30.37	-30.90	-31.22	-31.54	-31.86	-32.25	-32.70	-33.15	-33.63	-34.17	-34.82	-35.37	-35.89	-36.44	-36.99	-37.52	-38.07	-38.62	-39.12	-39.61	-39.84
CHAINAGE	0	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1124

AREA 2

PLOT DATE: 30/01/2020 3:13 PM

SURVEYED	CH	10.12.2018	APPROVED	DATE
DESIGNED	LK	18.12.2018		
DRAWN				
TRACED				
REVISION	CHANGES	CHECKED	DATE	
3	SWAP CUT/FILL VALUES	CH	23.05.19	
2	2003 & 2006 SURVEY ADDED	CH	03.04.19	
1	RE ISSUE	CH	28.03.19	
0	ORIGINAL ISSUE	CH	18.12.18	

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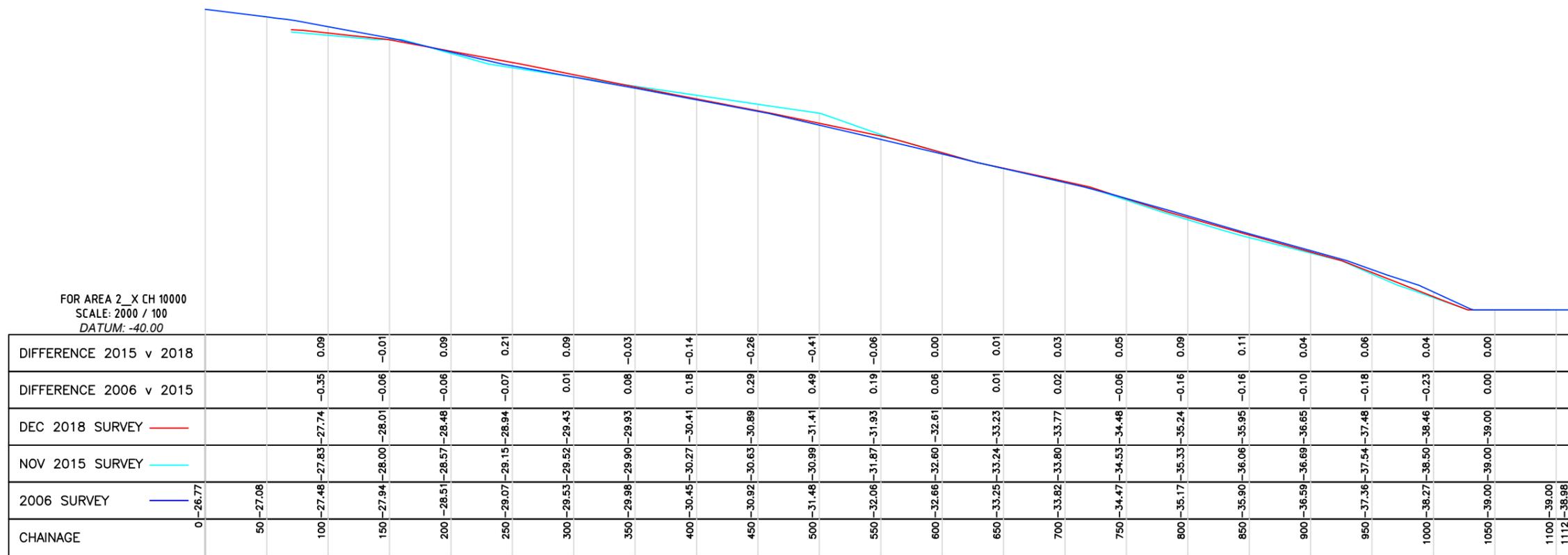
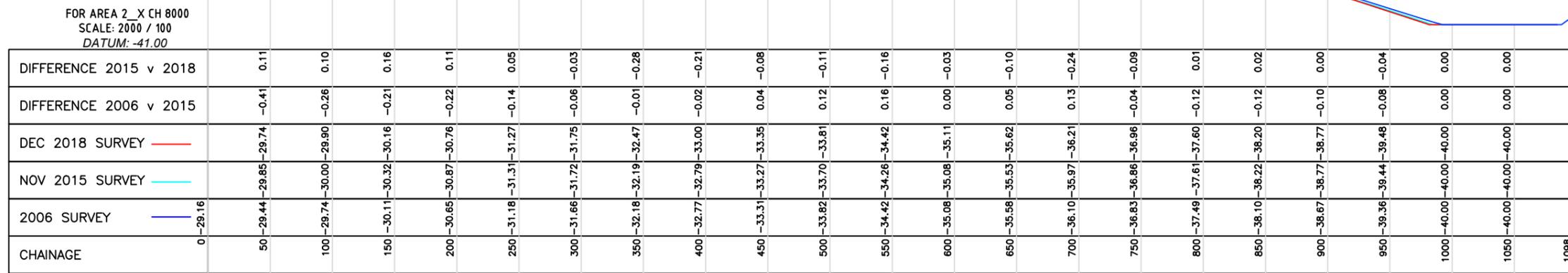
PROJECT
PAKIRI

TITLE
SEA FLOOR ASBUILT SURVEY CROSS SECTION AREA 2

SCALE 1:2000 (A1)
1:4000 (A3)

SHEET 13 of 15
REVISION 3

DRAWING No 2957-705-01



AREA 2

SURVEYED	CH	10.12.2018	APPROVED	DATE
DESIGNED				
DRAWN	LK	18.12.2018		
TRACED				
REVISION			CHECKED	DATE
3	SWAP CUT/FILL VALUES	CH	23.05.19	
2	2003 & 2006 SURVEY ADDED	CH	03.04.19	
1	RE ISSUE	CH	28.03.19	
0	ORIGINAL ISSUE	CH	18.12.18	

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PROJECT
PAKIRI

TITLE
SEA FLOOR ASBUILT SURVEY CROSS SECTION AREA 2

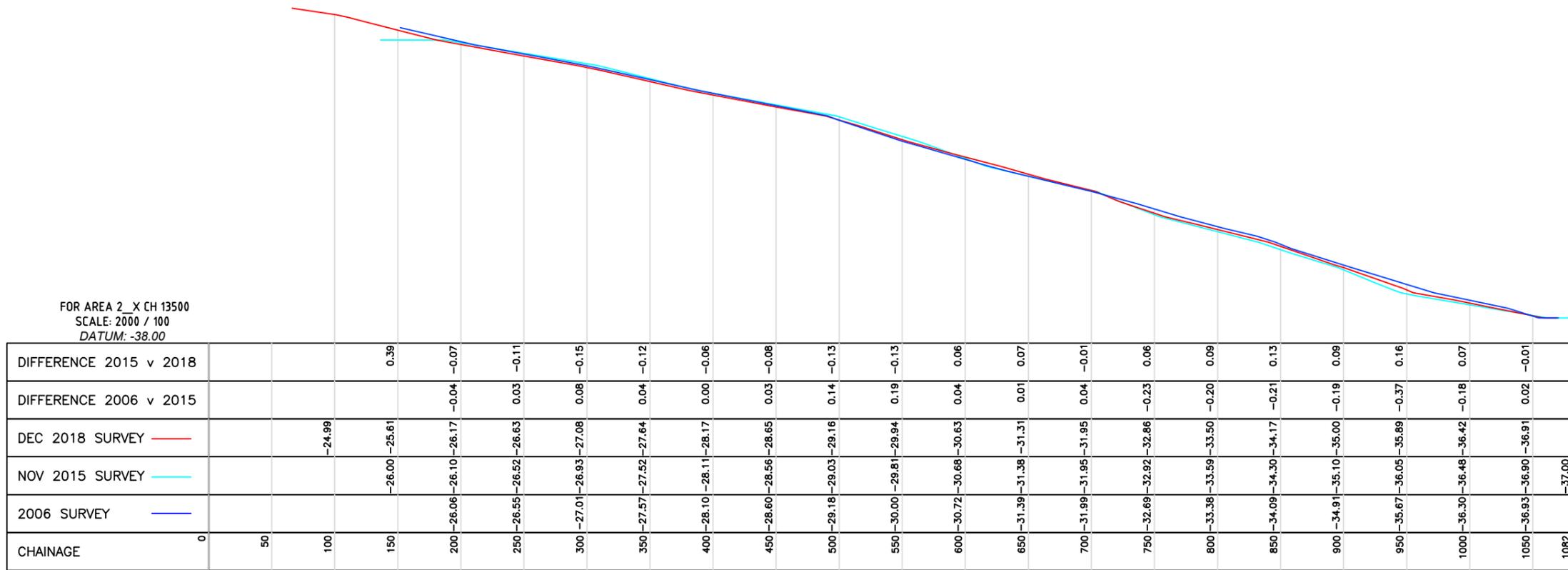
SCALE 1:2000 (A1)
1:4000 (A3)

SHEET 14 of 15

REVISION 3

DRAWING No 2957-705-01

FOR AREA 2_X CH 13500
SCALE: 2000 / 100
DATUM: -38.00



AREA 2

PLOT DATE: 30/01/2020 3:15 PM

SURVEYED	CH	DATE	APPROVED	DATE
DESIGNED	CH	10.12.2018		
DRAWN	LK	18.12.2018		
TRACED				
REVISION	CHANGES	CHECKED	DATE	
3	SWAP CUT/FILL VALUES	CH	23.05.19	
2	2003 & 2006 SURVEY ADDED	CH	03.04.19	
1	RE ISSUE	CH	28.03.19	
0	ORIGINAL ISSUE	CH	18.12.18	

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PROJECT
PAKIRI

TITLE
SEA FLOOR ASBUILT SURVEY CROSS SECTION AREA 2

SCALE 1:2000 (A1)
1:4000 (A3)
SHEET 15 of 15
REVISION 3
DRAWING No 2957-705-01



5996000mN

5994000mN

5992000mN

5990000mN

5988000mN

1748000mE

1750000mE

1752000mE

1754000mE

1756000mE

1758000mE

1760000mE

COMPARISON 2018 TO 2015

SURFACE ELEVATION DATA			
NUMBER	MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOR
1	-1.00	-0.50	Light Blue
2	-0.50	0.00	Green
3	0.00	0.50	Red
4	0.50	1.00	Yellow

↑ CUT
↓ FILL

CH7200

CH6000

CH4000

CH2000

CH1000

CH200

CH0

AREA 1

CURRENT SURVEY DEC 2018
PREVIOUS SURVEY MAY 2011
ORIGINAL SURVEY MAY 2003

CONTROL ZONE

CURRENT SURVEY DEC 2018
PREVIOUS SURVEY MAY 2011

SURVEYED	CH	26.02.2019	APPROVED	DATE
DESIGNED	LK	26.02.2019		
DRAWN				
TRACED				
REVISION			CHECKED	DATE
3	UPDATED PLAN	CH	23.05.19	
2	2003 & 2006 SURVEY ADDED	CH	03.04.19	
1	RE ISSUE	CH	29.03.19	
0	ORIGINAL ISSUE	CH	26.02.19	

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PROJECT
PAKIRI

TITLE
CUT AND FILL FROM 2011 TO 2018 AREA 1 AND CONTROL ZONE

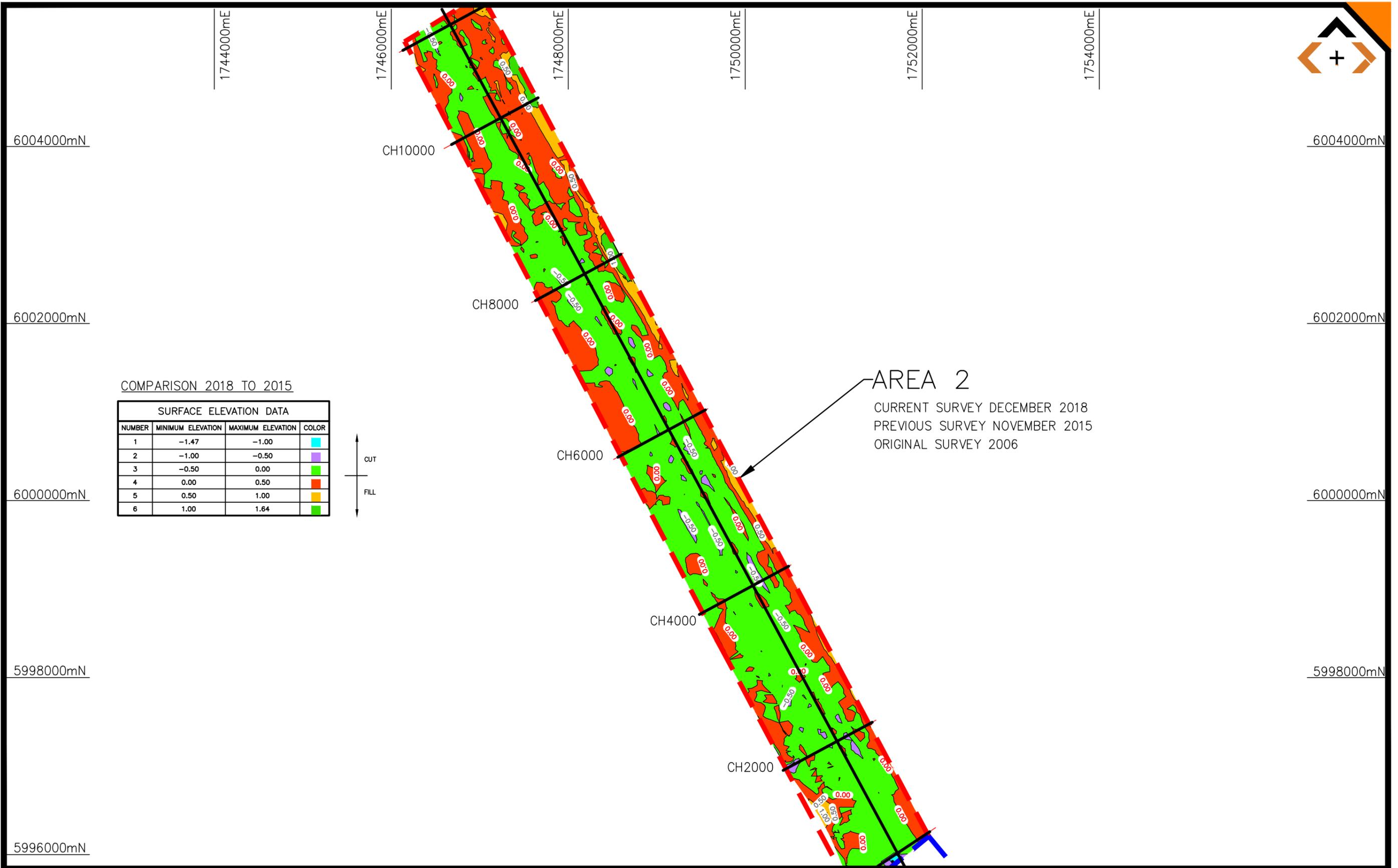
SCALE
1:20000 (A1)
1:40000 (A3)

SHEET
1... of ...1...

REVISION
3

DRAWING No
2957-705-02

PLOT DATE: 3/24/2020 3:40 PM



COMPARISON 2018 TO 2015

SURFACE ELEVATION DATA			
NUMBER	MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOR
1	-1.47	-1.00	
2	-1.00	-0.50	
3	-0.50	0.00	
4	0.00	0.50	
5	0.50	1.00	
6	1.00	1.64	

SURVEYED	CH	28.02.2019	APPROVED	DATE
DESIGNED	CH	28.02.2019		
DRAWN	LK	28.02.2019		
TRACED				
REVISION		CHANGES	CHECKED	DATE
3	UPDATED PLAN		CH	23.05.19
2	2003 & 2006 SURVEY ADDED		CH	03.04.19
1	RE ISSUE		CH	28.03.19
0	ORIGINAL ISSUE		CH	28.02.19

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PROJECT
PAKIRI

TITLE
CUT AND FILL FROM 2015 TO 2018 AREA 2

SCALE
 1:20000 (A1)
 1:40000 (A3)

SHEET
 1 of 1

REVISION
 3

DRAWING No
 2957-705-03

PLOT DATE: 3/24/2020 3:44 PM