Baseline Survey carried out 2018 prior to extraction

N
W E
S

North East Headings

Survey
carried out
4/09/2023

Miniwall S5

Miniwall S4

Miniwall S3

Miniwall S2

Miniwall S1

Pelican Rock
Outcrop

Elevations Table		
Minimum Elevation	Maximum Elevation	Color
	-1.200	
-1.200	-1.000	
-1.000	-0.900	
-0.900	-0.850	
-0.850	-0.800	
-0.800	-0.750	
-0.750	-0.700	
-0.700	-0.650	
-0.650	-0.600	
-0.600	-0.550	
-0.550	-0.500	
-0.500	-0.450	
-0.450	-0.400	
-0.400	-0.350	
-0.350	-0.300	
-0.300	-0.250	
-0.250	-0.200	
-0.200	-0.150	
-0.150	-0.100	
-0.100	-0.050	
-0.050	0.000	
0.000	0.050	
0.050	0.100	
0.100	0.200	
0.200	1.000	

0 100 200 300
METRES

DELTA COAL
CHAIN VALLEY COLLIERY

FASSIFERN SEAM - Miniwalls S2 - S5
BATHY SURVEY RESULTS (Sep 2023)

SCALE:	AS SHOWN	DATE:	20 September 2023
DRAWN:	R Tubridy	DRG NO:	C1S0295.dwg
CHECKED:	-	REV NO:	
SIGNED:	-	SIZE:	A3

Delta coal

ASTUTE SURVEYING

HYDROGRAPHIC AND GPS SURVEYING

HYDROGRAPHIC SURVEY REPORT

Lake Macquarie

NSW

For

Delta Coal

Surveyed on 4-6 September 2023

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General Information

Survey Class	IHO S44 – Special Order
Hydrographic Surveyors	Ben Gray CPHS1 Paul Davies
Survey Date	4-6 September 2023
Purpose of Survey	Hydrographic Survey
Port	Lake Macquarie
Regional Harbour Master	None
Survey Areas	Delta Coal

Reference documents

Rev No	Issue Date	Revision Details	Prepared By	Reviewed By	Approved By
0	17/09/2023	For review	Ben Gray	Paul Davies	Ben Gray

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

The following abbreviations may be used in this document

AAPMA	Association of Australian Port and Marine Authorities
AGD	Australian Geodetic Datum
AHD	Australian Height Datum
AHSCP	Australasian Hydrographic Surveyors Certification Panel
AMG	Australian Map Grid
BM	Bench Mark
CD	Chart Datum
CoG	Vessel Centre of Gravity
CoR	Vessel Centre of Rotation
CPHS1	Certified Practicing Hydrographic Surveyor Level 1
DGPS	Differential Global Positioning System
DTM	Digital Terrain Model
GAMS	GPS Azimuth Measurement Subsystem
GDA94	Geodetic Datum Australia 1994
GDA2020	Geodetic Datum Australia 2020
GNSS	Global Navigation Satellite System
HAT	Highest Astronomical Tide
ICSM	Intergovernmental Committee on Surveying and Mapping
IHO	International Hydrographic Organization
IMU	Inertial Motion Unit
kHz	Kilohertz
LAT	Lowest Astronomical Tide
MBES	Multi Beam Echo Sounder
MGA94	Mapping Grid of Australia 1994
MSL	Mean Sea Level
MRU	Motion Reference Unit
PDOP	Position Dilution of Precision
POSMV	Position Orientation System for Marine Vessel
PSM	Permanent Survey Mark
PTA	Performance Test Area
RL	Reduced Level
RMSE	Root Mean Square Error
RMS	Refer Manufacturer Specifications
RTK GPS	Real Time Kinematic Global Positioning System
SSSI	Surveying and Spatial Sciences Institute
SBES	Single Beam Echo Sounder
SSM	State Survey Mark (PSM)
SVP	Sound Velocity Profile
SVS	Sound Velocity Sensor
TBM	Tidal Bench Mark / Temporary Benchmark
UPS	Uninterruptible Power Supply
UTM	Universal Transverse Mercator
VDOP	Vertical Dilution of Precision
VRF	Vessel Reference Frame
WGS84	World Geodetic System 1984

1 INTRODUCTION

Astute Surveying Pty Ltd has been contracted by Delta Coal to undertake hydrographic monitoring surveys on Lake Macquarie, NSW. This report covers the GNSS control used, vessel, equipment, survey method and checks conducted while undertaking the surveys.

This survey was undertaken in accordance with and exceeds the IHO S-44 Standards for Hydrographic Surveys and the AAPMA - Standards for Hydrographic Surveys within Australian Waters.

2 STANDARDS

This survey complies with the latest versions of relevant codes and standards for:

- IHO S-44 - Standards for Hydrographic Surveys
- AAPMA - Standards for Hydrographic Surveys within Australian Waters
- ICSM - Australian Tides Manual - Special Publication No.9

3 PROJECT PARTICULARS

3.1 Client

Delta Coal

3.2 Project Details

Delta Coal Mine Site in the navigable waters of Lake Macquarie

The hydrographic surveys were carried out in compliance with the standards above.

4 PERSONEL

Surveys were directly supervised on-site by a CPHS Level 1 Surveyor.

Ben Gray (Supervising)
CPHS Level 1 (SSSI AHCP) MSSSI
Bachelor of Spatial Sciences MSQ
Astute Surveying Pty Ltd
18+ Years of continuous hydrographic survey operations

Paul Davies (Surveyor)
Survey Technician / Coxswain
15 + Years working in the hydrographic and spatial industry

5 PROJECT HORIZONTAL AND VERTICAL DATUM

5.1 Horizontal Datum

The project horizontal datum used is the Geocentric Datum of Australia 94 (GDA94) with coordinates projected onto the Map Grid of Australia 94 (MGA94) Zone 56.

Table 2 below lists the key settings for the datum.

PARAMETER	VALUE
Datum	Geocentric Datum of Australia 94 (GDA94)
Reference Frame	International Terrestrial Reference Frame 1992 (ITRF1992)
Ellipsoid	GRS80
Semi Major Axis	6,378,137.0 meters
Inverse flattening	298.257222101
Projection	Map Grid of Australia 94 (MGA94)
Projection Method	Universal Transverse Mercator (UTM),
Zone	56
Latitude of Origin	0° S
Longitude of Origin	153° E
Scale factor at Origin	0.9996
False Easting	500,000m
False Northing	10,000,000m

Table 1: MGA94 parameters

5.2 Vertical Datum

Depths were determined relative to the GDA94 ellipsoid, Australian Height Datum

Ausgeoid09 was utilised.

6 SURVEY CONTROL

The existing Smartnetaus (MNPK) GPS Base Station located at Mannering Park was used as the Primary RTK GPS Base Station.

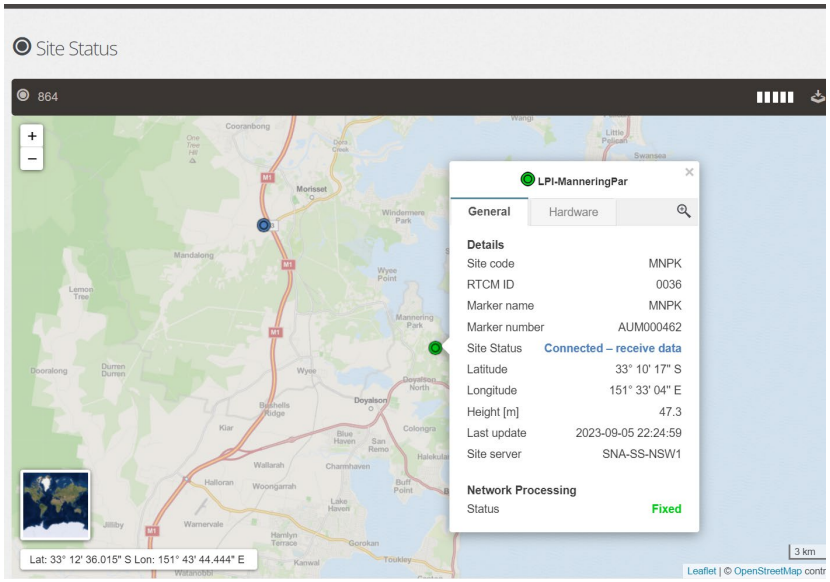


Table 2: GNSS base station details

7 SURVEY EQUIPMENT

Primary Survey Equipment and Software

7.1 Survey Vessel

The hydrographic survey was carried out from Astute Surveying's survey vessel "Coastal Explorer".

Type:	Aluminium Single hull. Enclosed cabin
Survey:	Class 2C – EX40
Length:	6m
Beam:	2.5m
Draft:	0.3m
Propulsion:	200hp Suzuki outboard
Registration:	AHF540C

7.2 Bathymetry Systems

Type:	Norbit i77h
Transducer Frequencies:	200 to 400 kHz (400 kHz used)
Beams:	512 Beams of 1.0˚ x 1.0˚ (at 400 kHz)
Motion Compensation:	POSMV Ocean Master
Pitch/Roll Stabilisation:	Roll stabilised

Ping Rate:	26.6 per sec @ 20 m Range Setting
Beam Mode:	Equi-distant
Installation:	Over the Side
Limiting Sea Conditions:	Primarily aeration of transducers at > 1.5m swell

The MBES sonar head is mounted on an over the side pole located on the port side, close to midship and 1.3m from the centreline. The pole and mounting arrangement is designed to minimize flex and utilises specialised brackets on the side of the hull to ensure the pole locates to an identical position each time it is attached. The mount has been tested (by subsequent bar checks and patch tests) to accurately fit back to its original position each time the vessel is used for survey.

7.2.1 Position and motion sensor

- PosMV Oceanmaster
- RTK GPS primary antenna mounted on the cabin roof with the secondary antenna mounted on the opposite side of the cabin roof, both with unimpeded access to satellites.

7.2.2 RTK Rover

- Trimble SPS 985 RTK Receiver

7.2.3 Radio RTK correction data receiver

- 4G

7.2.4 Sound Velocity Probe

- AML Base X SVP – direct Sound Velocity profile measurement
- AML Micro-X SVP at the MBES Transducer

7.2.5 Acquisition and Processing Software

Hysweep 2023 is a powerful and specialised package by Hypack for multibeam data collection and processing. It allows users to design a survey, for both single and multibeam data, collect and edit the data, and post process it to create contours, cross-sections, volumes, TIN Models etc.

7.2.6 Calibration

Prior to any survey work the following checks were made to ensure the equipment was returning the correct information to the survey software. The data entered in the software was also checked by carrying out these tests.

7.2.7 Base Station

The Base Station used for the survey was the Mannering Park. The RTK correction service was Smartnetaus

The base station operation was checked by measuring with a Trimble SPS985 RTK receiver at known high order bench mark using constrained centring and logging for a minimum 180 epochs. This was to test the

horizontal and vertical position of the Manering Park Base (MNPK). An accurate result proved the integrity the Base Station and GPS rover unit.

Bench Mark	MGA94 East	MGA94 North	AHD71
PM109307	364105.771	6330789.594	8.237
RTK Avg	364105.796	6330789.579	8.265
Difference	**0.025**	**-0.015**	**0.028**
2 Standard Deviations	**0.012**	**0.015**	**0.018**

Table 3: Benchmark position check results

As can be seen from the results above, the Mannering Park Base Station was outputting the correct RTK corrections.

7.2.8 Heading Check

A GPS Azimuth Measurement Subsystem (GAMS) test was carried out on the system before surveys commenced.

7.2.9 Position Check

Position checks were carried out on the reference point of the IMU using the calibrated RTK Rover.

These checks were used to test the positioning, the application of the heading and the measurement of the vessel offsets.

Easting from Hysweep	Northing from Hysweep	Easting from Rover	Northing from Rover	Difference East	Difference North
363532.031	6331772.07	363532.036	6331772.047	0.005	-0.023
363532.038	6331772.15	363532.044	6331772.131	0.006	-0.019
363532.092	6331772.84	363532.078	6331772.835	-0.014	-0.007
			average	**-0.001**	**-0.016**

Table 4: IMU position and heading check.

7.2.10 Patch test

Prior to the survey, patch tests were run in a suitably deep area within survey area.

DATE	LATENCY	ROLL	PITCH	YAW
4/09/2023	0°	0.15°	0.00°	0.00°

Table 5: Patch Test Results

7.2.11 Bar Check

Bar checks were carried out on the beams close to the nadir of the Norbit Wing Head Multibeam using a stainless-steel plate lowered over the side of the vessel directly below the transducer to a measured distance.

A MBES measurement was taken over six different measurements all at 2m depth.

Bar depth below waterline (m)	RTK Tide	Bar RL	Processed data RL	Diff
2	0.817	1.183	1.17	0.013
2	0.833	1.167	1.18	-0.013
2	0.819	1.181	1.2	-0.019
2	0.814	1.186	1.17	0.016
2	0.778	1.222	1.24	-0.018
2	0.776	1.224	1.24	-0.016
			Average Difference	**-0.006**

Table 6:Bar Check Summary of Results

7.2.12 Sound Velocity Profile (SVP)

Manual SVP was compared with the sound velocity sensor (SVS) on the MBES Transducer. Regular consistency between the SVP and SVS was noted. There was satisfactory correlation between the down cast and up cast. In this depth, the system was considered adequate when the difference between SVP and SVS was less than 2m/s.

8 SURVEY METHOD

The survey was carried out to meet the following requirements:

- Horizontal Uncertainty ±0.5m @ 95% confidence
- Vertical Uncertainty ±0.15m @ 95% confidence
- 0.5m object detection (minimum of 3 hits in the along track direction)
- 100% coverage over the survey area in depths below 5m

8.1 Survey Coverage

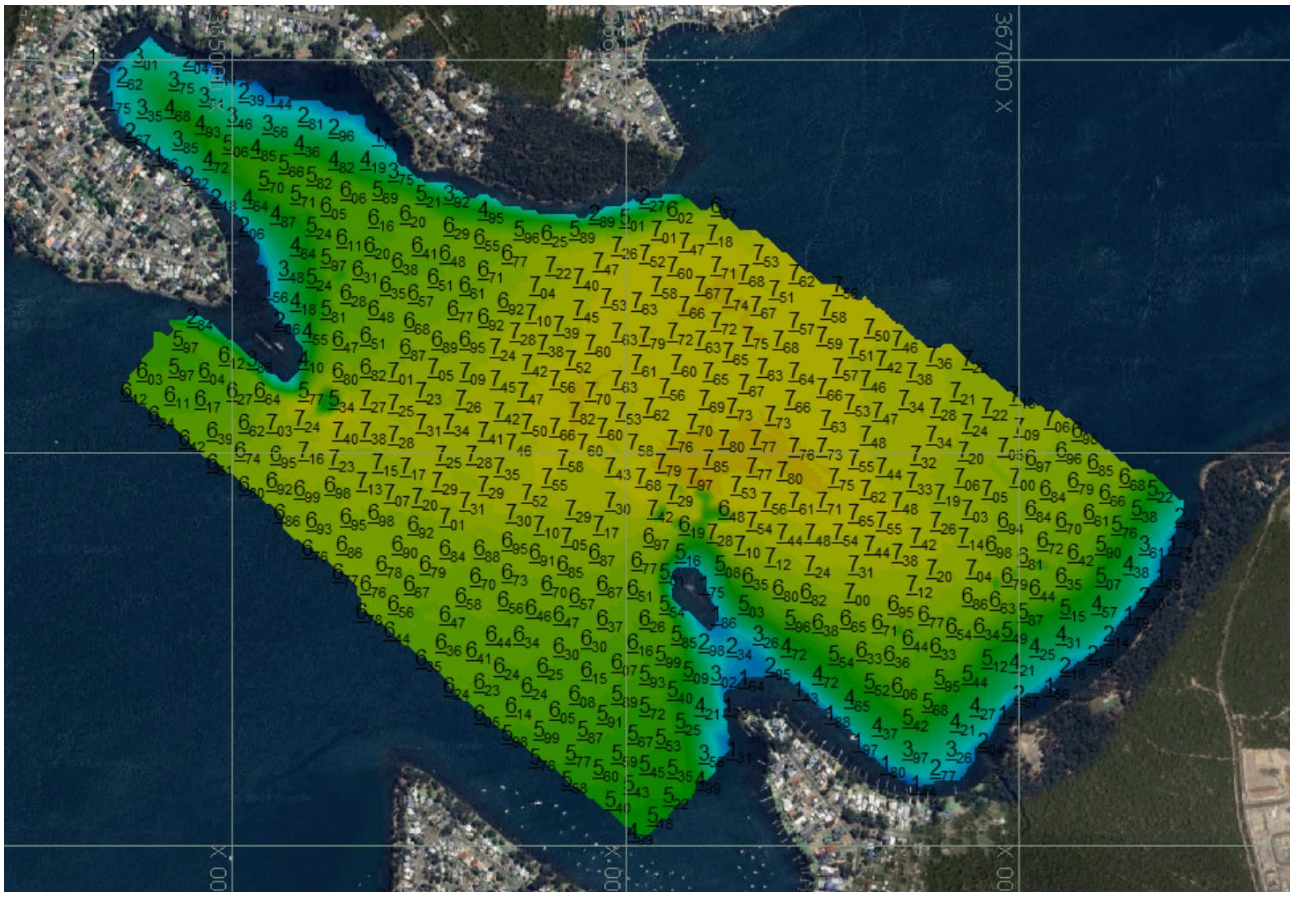


Figure 1: Lake Macquarie Survey Area

8.2 Line Spacing

20m transects were undertaken.

8.3 Sounding Speed

The minimum ping rate during the surveys was 20Hz which can be set in the software. The vessel speed during survey was less than 6 knots (~3m/s). This meant the minimum number of pings from one pass in the along track direction is 3.333 pings per 0.5m.

8.4 Multibeam Settings

The MBES was setup to achieve the most accurate result utilising a 120-degree swath,

This had the effect of:

- Minimising the inaccuracies in the outer beams
- Concentrating the soundings over a shorter distance for better resolution
- Increasing the ping rate

Depth filters were utilised for the survey acquisition. This eliminated all returns that were clearly out of range thus allowing the MBES a more thorough acquisition of the seabed features. No other filters were applied as there is the possibility that some spot features could be eliminated by the software if aggressive filters were used.

8.5 Online Checks

During the survey, the system was checked by monitoring certain aspects.

In the surveyor's geographical display, we can plot the seabed depths (mean, Shallowest or Deepest), the Hit count per cell or the 95% confidence data layer. By monitoring these different layers, we can assess if there are discrepancies in the data.

POSview software allowed RTK accuracy and quality to be monitored independently of the Hypack survey system. This was used to assess the integrity of the results.

Any issues were examined, and additional survey lines were run to verify the data if necessary. All actions noted on the logs.

8.6 Rejection Criteria for Position Data

The following standards were used to ensure correct position reliability was maintained:

Minimum Satellite Elevation:	15˚
Min Satellite Count:	6
Maximum HDOP:	4
Maximum VDOP:	4
Maximum Age of Corrections:	2 seconds

Data storage would have ceased had this criterion been exceeded

8.7 Online Software Alarms

All the equipment linked to the survey system was monitored for communication errors.

- The PPS time synchronisation signal was monitored for integrity.
- The RTK system timeout -2 seconds.
- VDOP limit alarm - 3
- IMU updates to the system
- MBES functions
- MBES head Sound Velocity compared to currently loaded Sound Velocity profile - 2m/s

If any of these systems fell outside the accepted limits then an alarm would have been raised in the system, and investigated by the survey team.

9 DATA REDUCTION

All bathymetry data was logged with Hysweep multibeam data collection and editing module within Hypack.

The same module was used to edit the data and carry out QC and performance testing.

The data was:

- Initially processed to remove any obvious data spikes using a broad filter deleting all points above a specified minimum depth and below a maximum acceptable depth.
- The data was then assessed manually and all spurious data removed.
- Once the dataset was finalised it was checked for hit count, coverage, and statistical acceptance. Any areas requiring more information to comply with the survey requirements were resurveyed.

A statistically derived surface was created with a grid spacing of 1m. This surface was used as the base for the 10m grid output.

10 HEIGHT DIFFERENCE TO PREVIOUS SURVEYS

Some time ago it was discovered that the project that we had been using for the hydrographic surveys on Lake Macquarie had a software error in the programming and altered our height values by approximately 0.15m. This was a developer error for that particular version (2012) of the software and was corrected by a hotfix sent to all users sometime after. Upon discovering this error, we upgraded our other projects. However, as the main focus for the Lake Macquarie Surveys was to monitor relative change over time, we decided to continue using this project to keep consistency between current and past surveys.

Recently we have upgraded our systems and needed to upgrade our project to the latest device drivers for the new multibeam to be compatible. Unfortunately, we did not adjust the height values of these surveys to match the old project as intended and now have a datum shift between the old and new projects. We have adjusted the most recent surveys and generated Cross Sections over the site to validate the data.

As depicted in the cross sections, the data on the outsides of the mine area and close to the shorelines have not changed significantly over time. We do note that the lakebed is made of soft silty mud which can be hard

to define the top layer accurately. Also, some natural movement would be present on site with seasonal weather and storm events.

Please see Chapter 13 for the Cross Sections

11 DATA DELIVERABLES

All processed data is delivered in the following formats:

Digital XYZ

20180530 - Lake Coal 10x10m Grid MGA94_AHD (BASE).xyz
20190123 - Lake Coal 10x10m Grid MGA94_AHD.xyz
20190707 - Lake Coal 10x10m Grid MGA94_AHD.xyz
20200405 - Delta Coal 10x10m Grid MGA94_AHD.xyz
20200803 - Delta Coal 10 x10m Grid MGA94-AHD.xyz
20210320 - Delta Coal 10x10m Grid MAG94_AHD.xyz
20210915 - Delta Coal 10 x10m Grid MAG94_AHD.xyz
20220914 - Delta Coal 10 x10m Grid MGA94_AHD.xyz
20230317 - Delta Coal 10 x 10m Grid MGA94_AHD.xyz
20230619 - Delta Coal 10x10m Grid MGA94_AHD.xyz
20230904 - Delta Coal 10x10m Grid MGA94_AHD.xyz
20230914 - Delta Coal Cross Sections Sheets 1 to 6 - 001.pdf

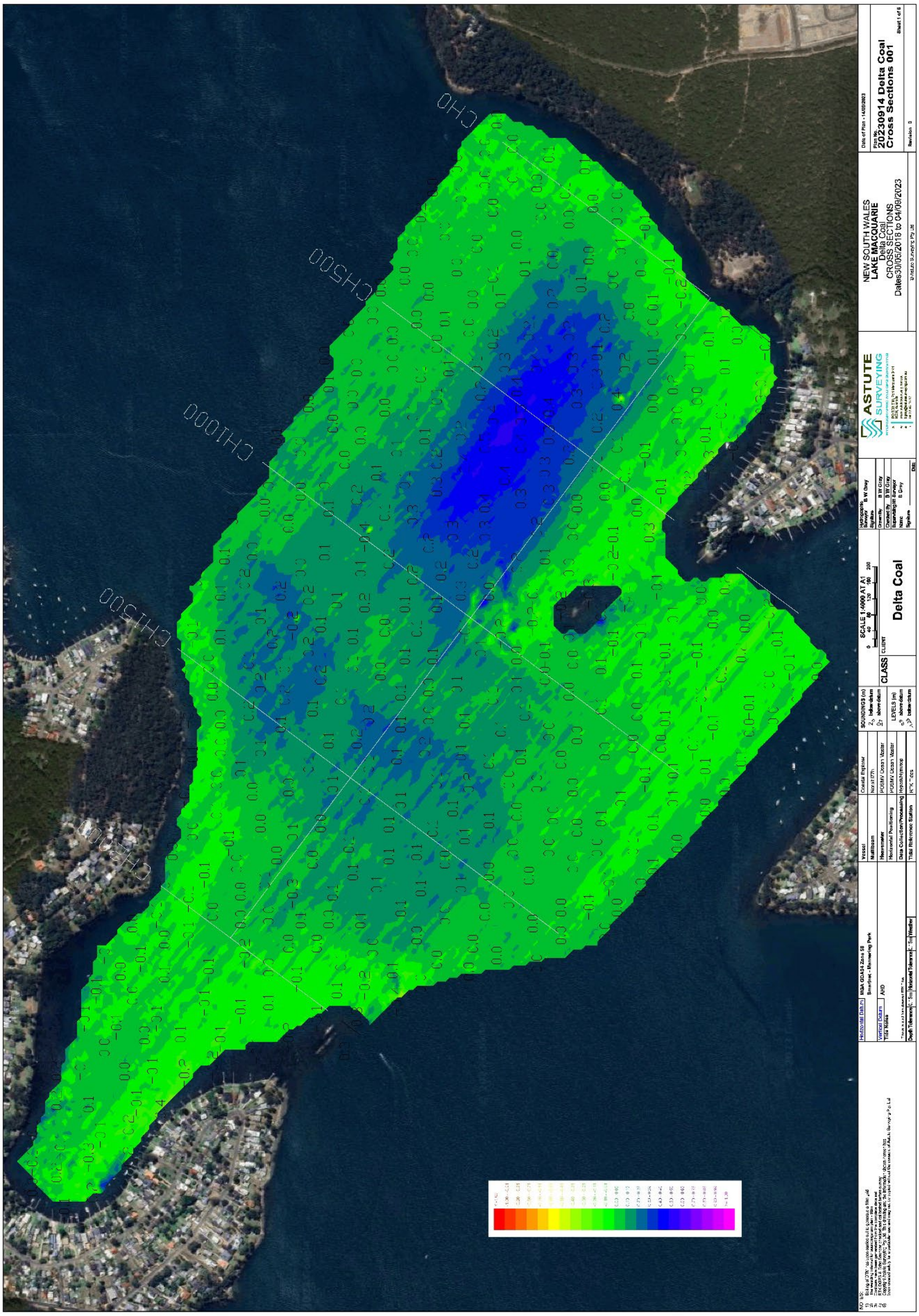
12 HYDROGRAPHIC SURVEYOR APPROVAL

Survey Report and Deliverables Approved By

17 September 2023

Ben Gray
Certified Professional Hydrographic Surveyor Level 1

13 Cross Sections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LAKE MACQUARIE
Delta Coal
CROSS SECTIONS
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SURVEYING
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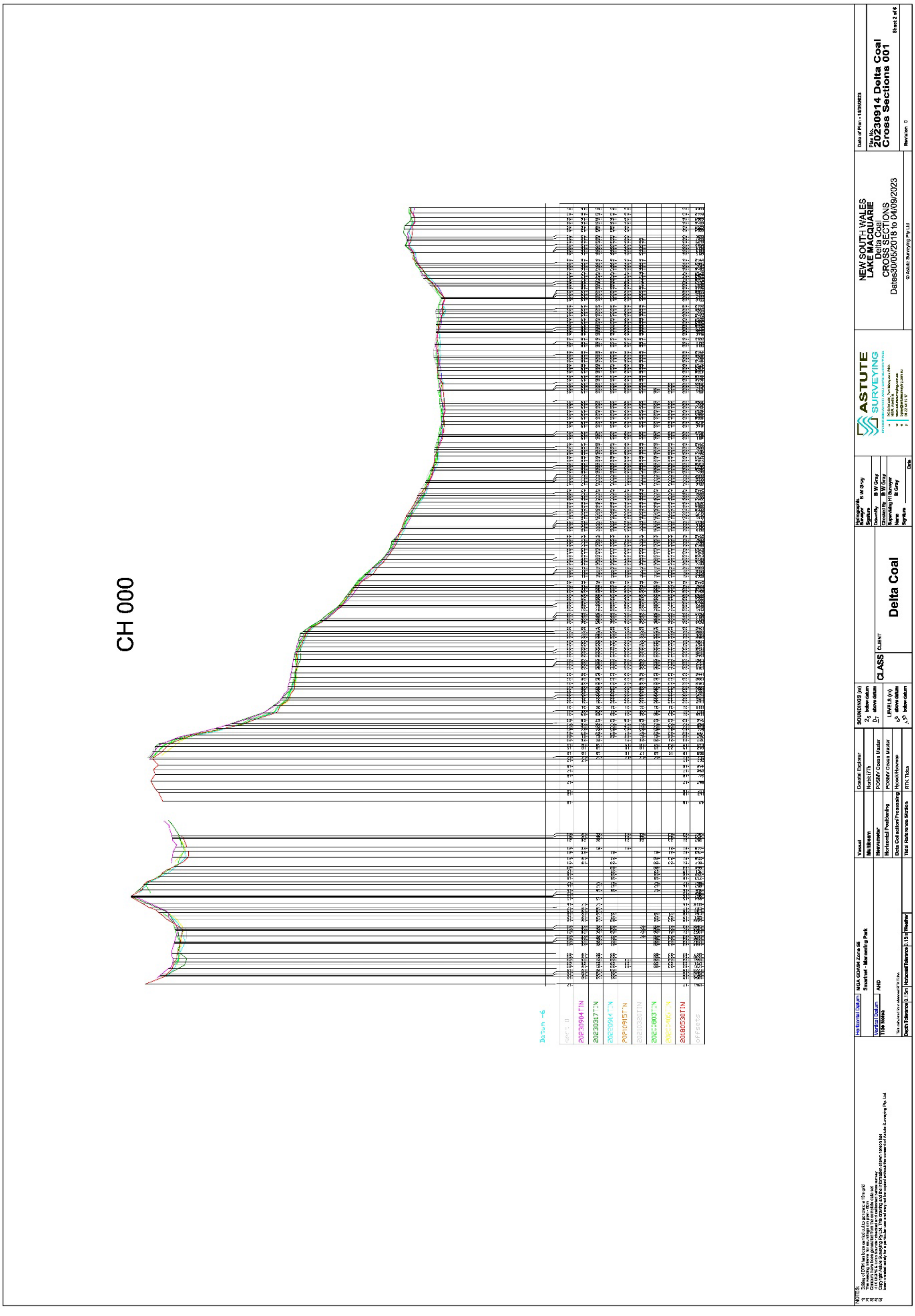
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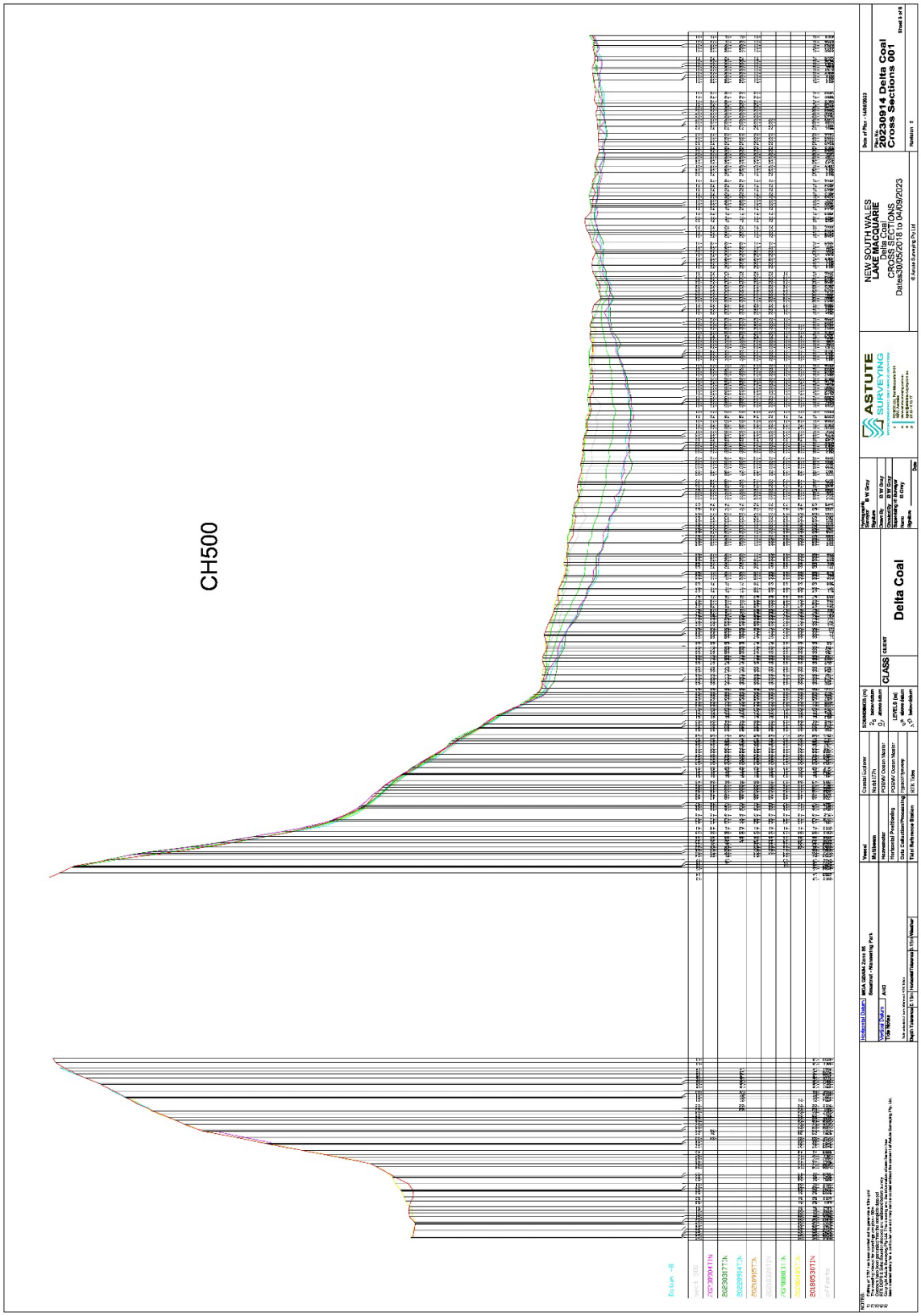
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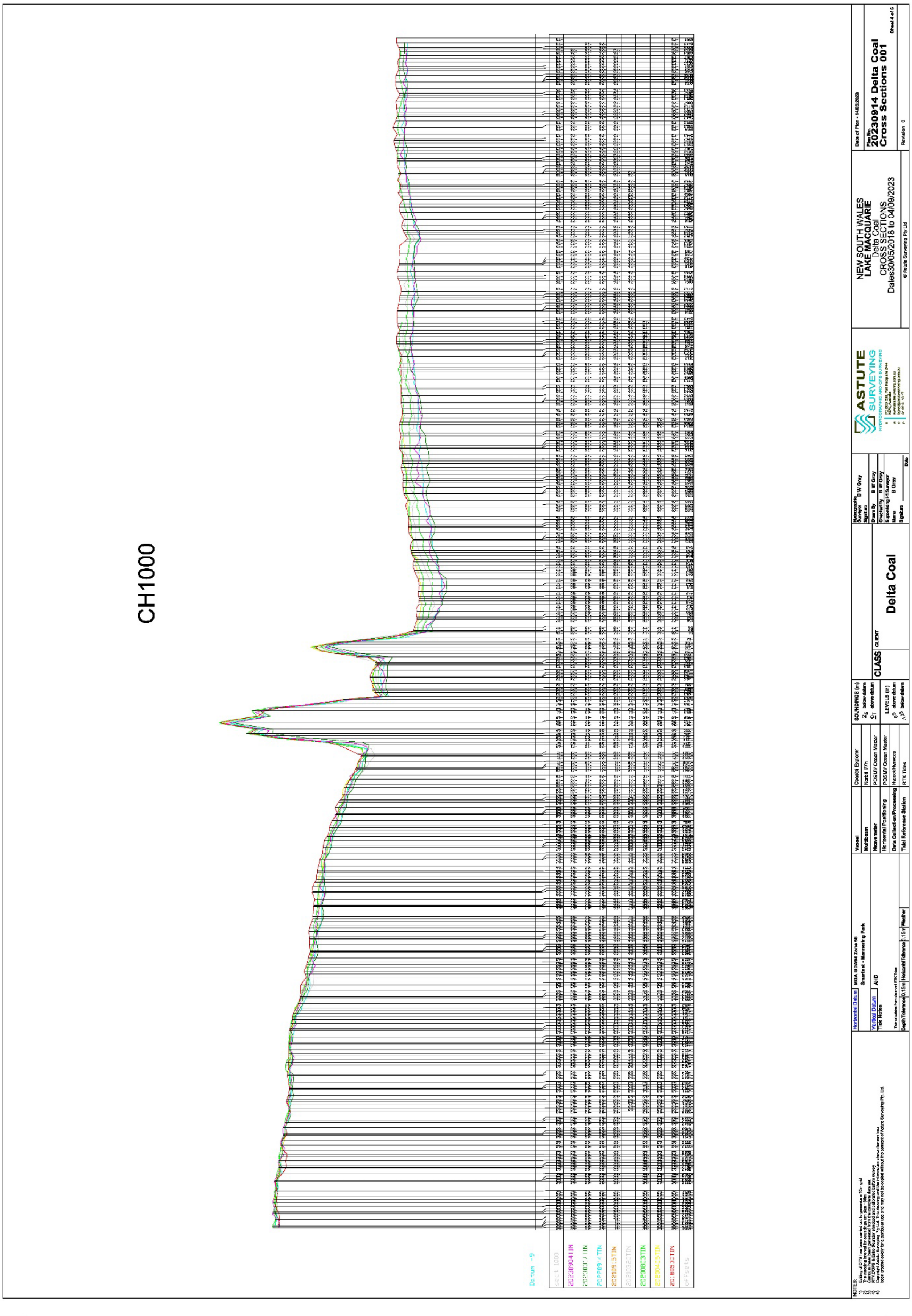
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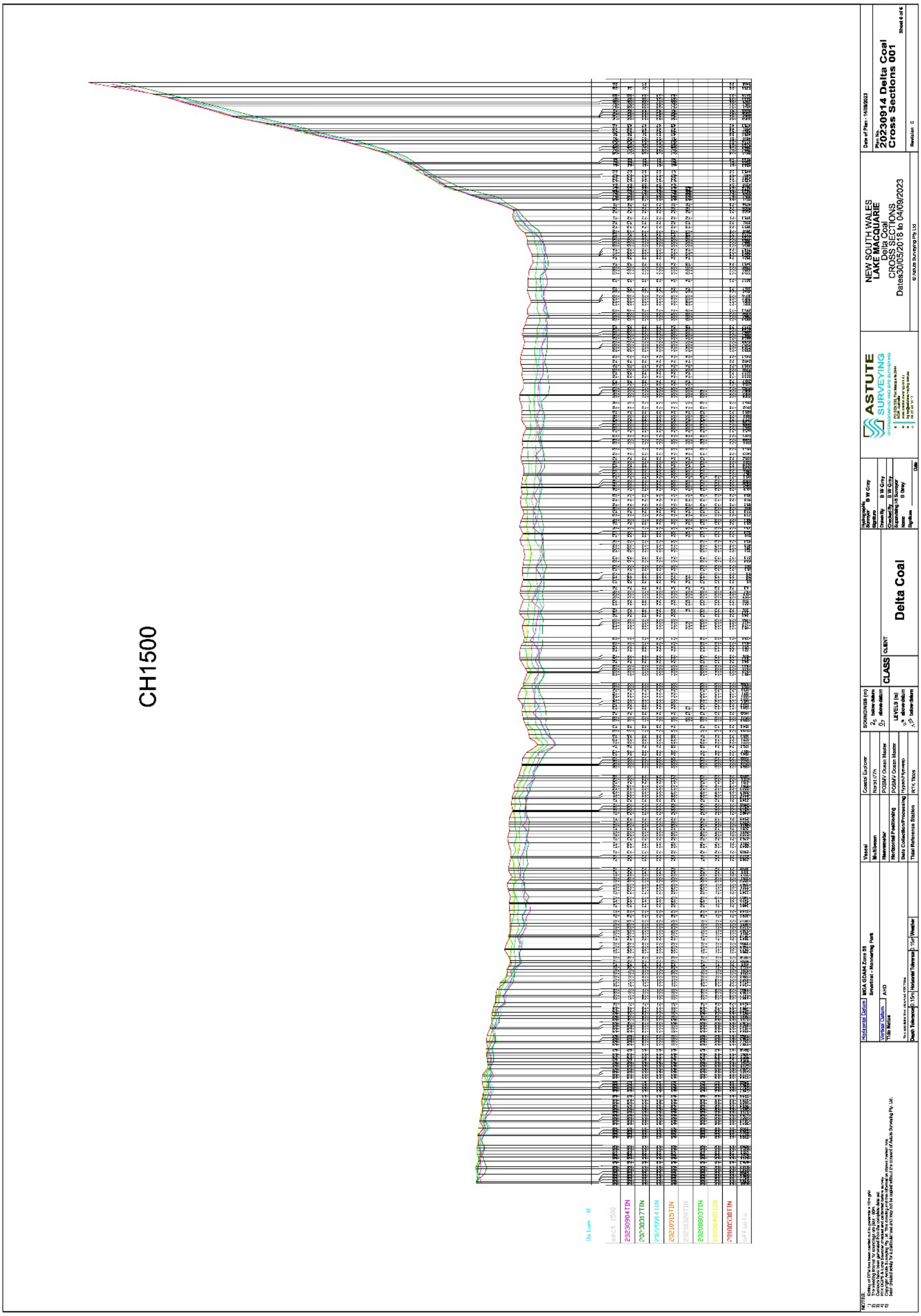
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SURVEYING
Delta Coal
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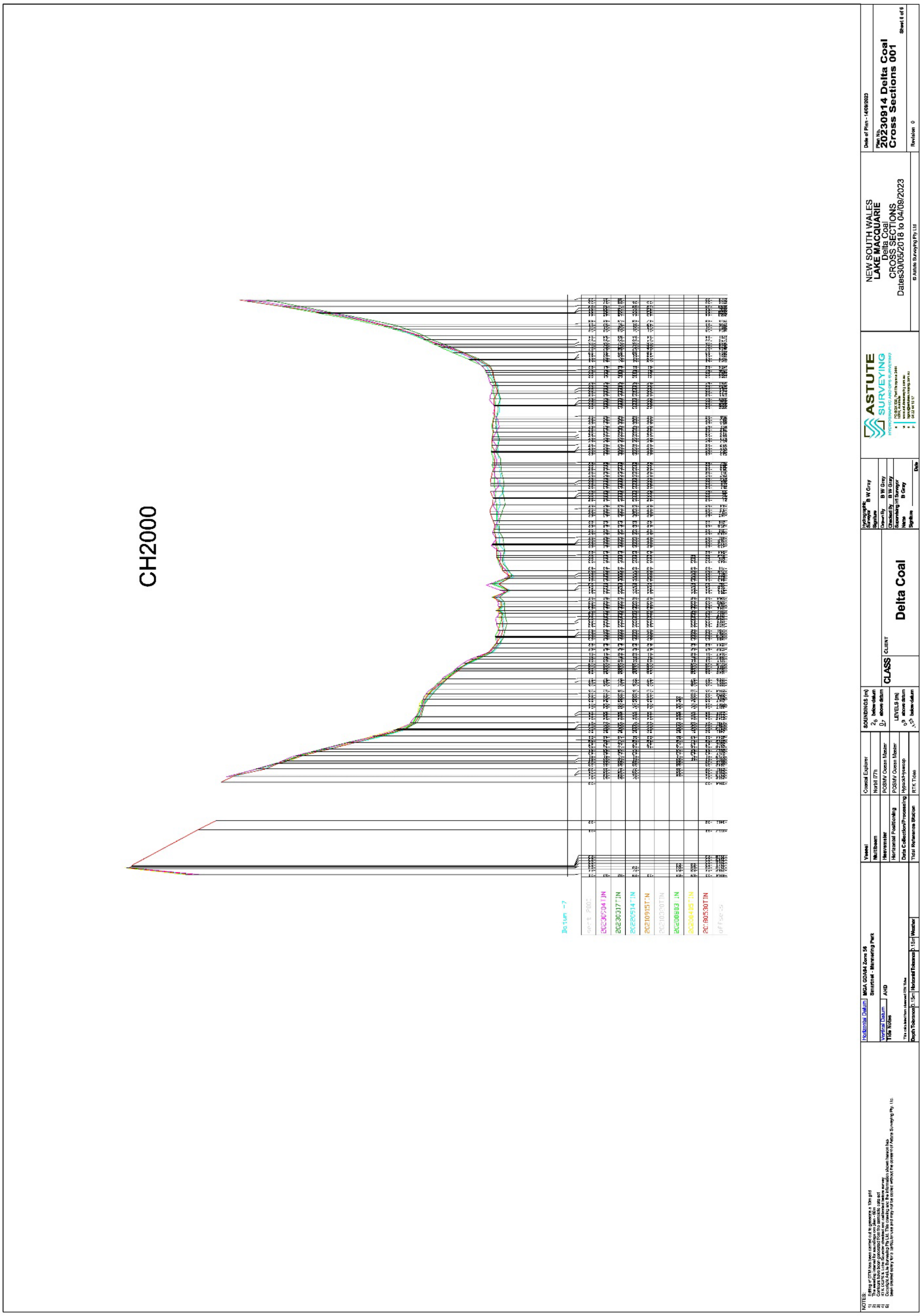
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Delta Coal