Aspect
Land+Hydrographic Surveys
CHARTERED SURVEYORS

TEL: 01294 313 399 • WEB: WWW.ASPECTSURVEYS.COM

UAV LIDAR TOPOGRAPHIC SURVEY & MULTIBEAM BATHYMETRIC SURVEY

ARDERSIER PORT, MORAY FIRTH

MAY 2018

PROJECT REF: A6643

REV: 00

Client:

CWC Group
Moray House
16-18 Bank Street
Inverness
IV1 1QY

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TABLE OF REVISIONS

Revision No.	Date	Issue / Revision	Compiled	Approved
00	18/06/2018	Original	CKS	RM

1. INTRODUCTION

On the instruction of CWC Group, Aspect Land and Hydrographic Surveys Ltd (herein ALHS) undertook a combined topographic, UAV/drone and multibeam bathymetric survey of an area around Ardersier Port, Moray Firth East of Inverness.

FIGURE 1 - SURVEY LOCATION, ARDERSIER PORT (GOOGLE EARTH IMAGE)

2. SCOPE OF WORKS

The survey aimed to replicate an area previously completed in December 2016 with full multibeam coverage and additional areas to the East and West at 50m intervals (striped). An additional area was added (see figure 3). Survey work at Ardersier Port was to aid with monitoring sediment movement around the port.

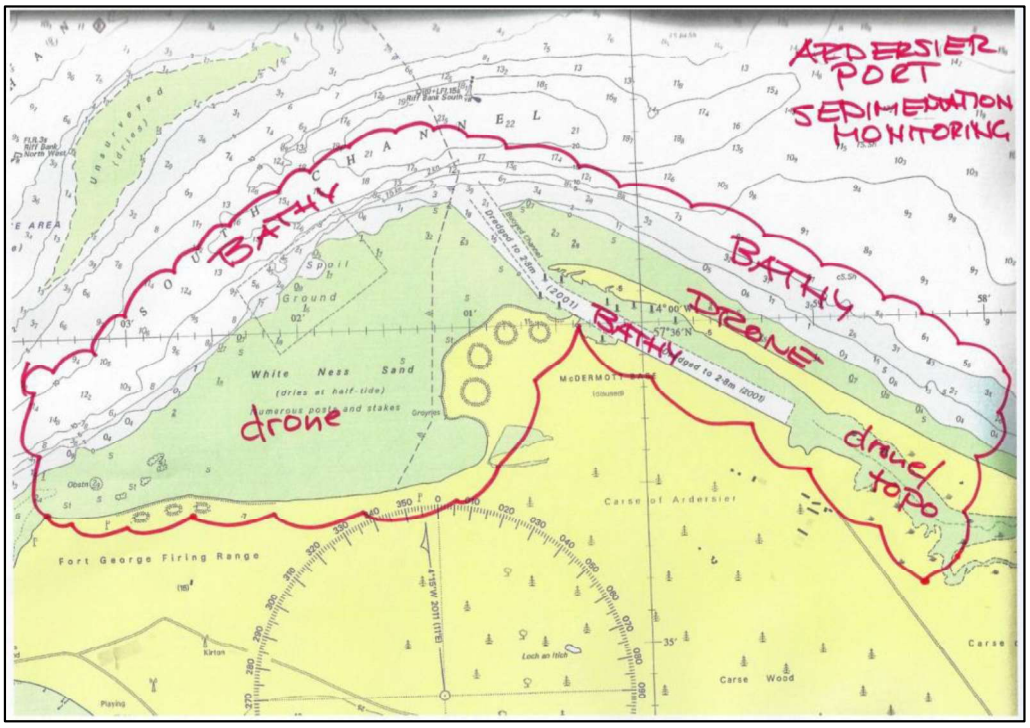


FIGURE 2 - SURVEY EXTENTS (AS PROVIDED BY CLIENT)

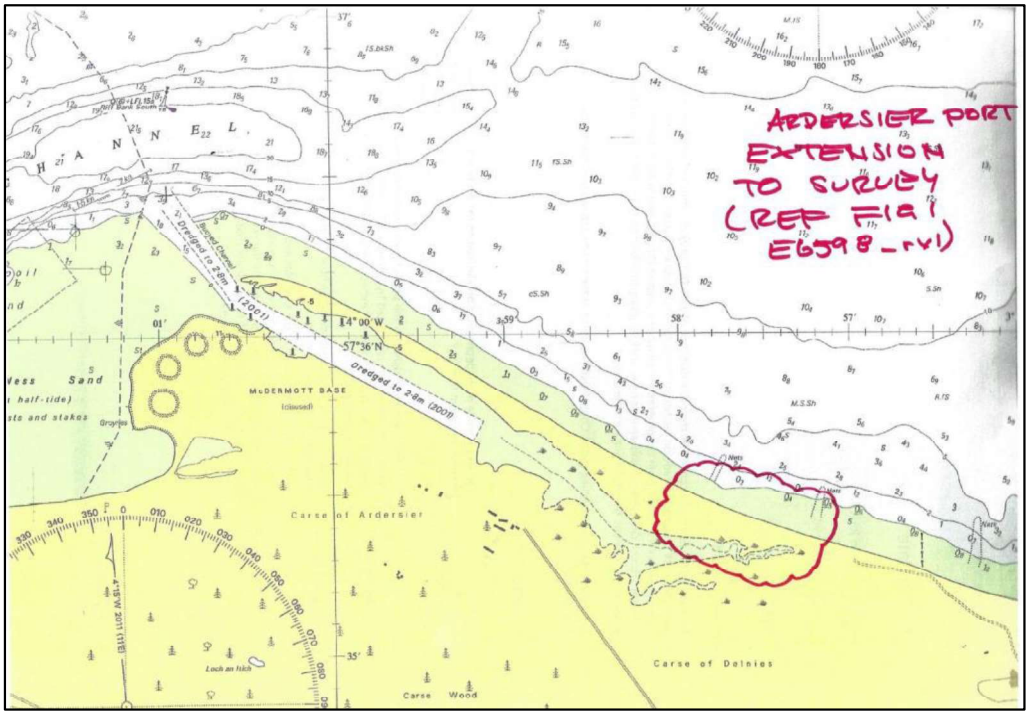


FIGURE 3 - ADDITIONAL AREA (AS PROVIDED BY CLIENT)

3. GEODESY & DATUM

The horizontal datum used throughout the data gathering phase of the survey was OSGB36 (OSTN15). Data has been rendered in OSGB36 Datum, British National Grid.

The vertical datum for all topographic and bathymetric data issued is Ordnance Datum. OSTN15 defines OSGB36 National Grid in conjunction with the National GPS Network.

In this respect OSTN15 can be considered error free (not including any GPS positional errors). The agreement between OSTN15 and the old triangulation network stations (down to 3rd order) is 0.1m rms.

4. TOPOGRAPHIC SURVEY

A summary of the equipment used for completion of the topographic survey can be seen in table below:

Positioning System	R10 RTK GPS (Base and Rover)
Controller	TSC3
Vehicle	Suzuki 500 Kingquad ATV

A Suzuki 500 Kingquad ATV was used to survey the area to the West of Ardersier Port due to this area being a no-fly zone (restricted area) around Fort George.

FIGURE 4 - NO-FLY ZONE AROUND FORT GEORGE (RESRICTED AREA).

FIGURE 5 - SUZUKI 500 KINGQUAD ATV WITH R10 AND TSC3

5. UAV MOBILE MAPPING

A summary of the equipment used for completion of the aerial mapping system used for UAV survey can be seen in the table below:

Survey Platform	DJI Matrice 600 Pro
GPS Correction Source	Post Processed GNSS Corrections (PPK)
LIDAR	Velodyne HDL-32E
Motion Compensator	Trimble Applanix APX-15 INS

The DJI Matrice 600 Pro is a dynamic, lightweight airframe, and multi-functional UAV offering increased inflight efficiency and stability for survey grade data collection.

The UAV's trajectory is determined from Post Processed GNSS observations within Applanix POS-UAV software. Similar to RTK positioning this method of positioning assumes that the GNSS antennas on the UAV are receiving the same satellite errors as the base reference station and therefore cancelling the error.

Dynamic Positioning Precision

	HORIZONTAL ACCURACY	VERTICAL ACCURACY
REAL TIME KINEMATIC GPS	±10mm + 1ppm RMS	±20mm + 1ppm RMS

Again, all UAV mapping has been quality assured against the RTK observations taken across the survey extents. It was found to tie into ±50mm on short grass and 50 - 500mm in densely vegetated areas.

FIGURE 6 - UAV MAPPING SYSTEM (DJI MATRICE 600 PRO)

6. MULTIBEAM BATHYMETRIC SURVEY

A summary of the equipment used for completion of the multibeam bathymetric survey can be seen in the table below:

Survey Vessel	Coastal Sensor (MCA Cat III)
Positioning System	Trimble Applanix POS MV
GPS Correction Source	Trimble VRS NOW Network RTK
Echosounder	R2Sonic 2022 Multibeam System 400kHz
Motion Compensator	Trimble Applanix POS MV

ALHS' R2Sonic 2024 multibeam sonar system was used for the bathymetric survey. This was controlled using Sonic Control software during the course of data gathering.

Very detailed data with full seafloor coverage was gathered throughout the survey area as a result of the R2Sonic 2024's narrow beam width and high ping rate and the selection of 400kHz as an operating frequency.

The system was operated at the maximum ping rate achievable throughout the survey, such that the ping rate was controlled by the depth of water.

Sound Velocity (SV) dips were carried out prior to commencing survey operations and thereafter whenever the surface sound velocity varied by more than $2ms^{-1}$. There was very little variation in surface SV.

The SV dips were carried out using a Valeport Swift SVP dipping probe with Datalog X2 software, and the data was incorporated into the Hysweep Survey software for real-time corrections.

Positioning was achieved using an Applanix POS MV INS RTK GPS system, providing horizontal and vertical positioning as well as heading and motion compensation.

An R2Sonic Sonar Interface Module (SIM) was used to control the sonar throughout the course of data gathering. The multibeam data was transmitted to the survey laptops running Hypack Hysweep over an Ethernet connection. Hypack Hysweep Survey was used for data gathering. Hypack MBMax software was used for post-processing. The stages of multibeam processing are detailed in Annex C.

Data was gathered to give at least 200% insonification over the survey area. This allowed full quality assurance checks to be carried out. Calibration values for the survey vessel were calculated from patch tests conducted on the day of data collection. Details of the conduct of the patch test can be seen in Annex C.

7. SUMMARY

The results of the survey drawing are detailed in the rendered AutoCAD drawing. This information is also rendered as PDF files for ease of viewing on non-AutoCAD systems.

The area around Ardersier Port is sand, mud and pebbles.

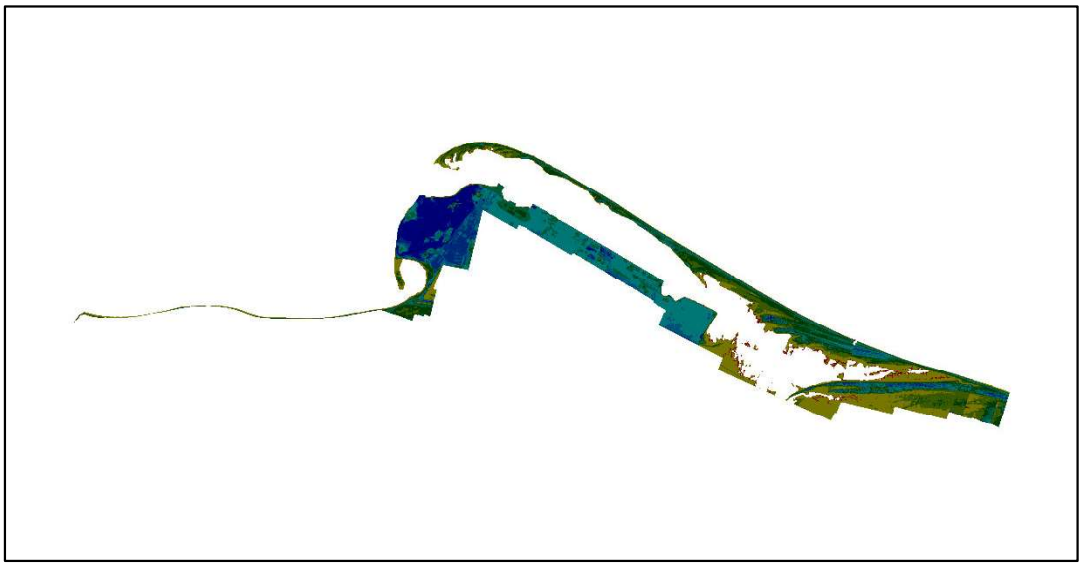


FIGURE 7 - AREA ABOVE MEAN HIGH WATER SPRINGS

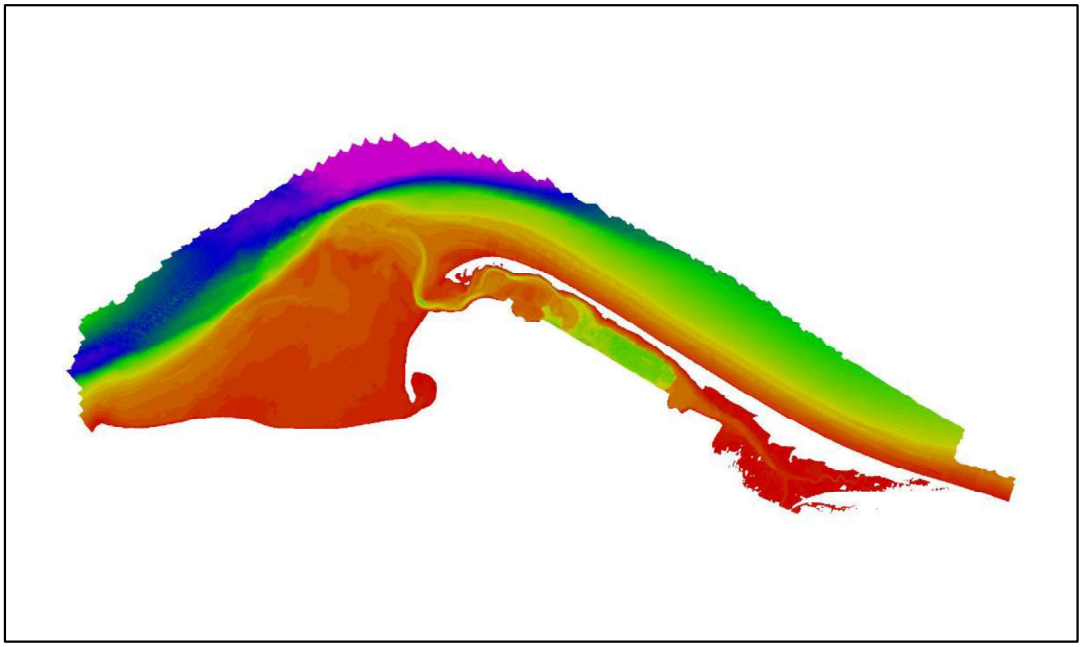


FIGURE 8 - AREA BELOW MEAN HIGH WATER SPRINGS

The area to the West of Ardersier Port is Fort George live firing range and is restricted to times the public are allowed to access the land. During these times (see figure 9) no access was allowed and if red flags were still out during other times no access was permitted. ALHS was in constant contact with all relevant parties to make sure it was safe to access the land. These restrictions made the survey very

challenging, taking into account the restriction to access the land and having to survey areas at low water for land surveys, high water for marine surveys and weather conditions. Time on site had to be planned around these conditions, with early morning and late evening being the only times allowed on site.

FORT GEORGE TRAINING AREA, ARDERSIER, IV27TD

Contact: Range Control: Working hours 0131 310 8690.
Range Ops Room: 0131 310 3426.

Notification of live firing & pyrotechnics (except red flares) being discharged on Fort George ranges.

DATE:	From:	To:
01	1800hrs	2130hrs
02		
03		
04		
05	0900hrs	1600hrs
06		
07		
08	0900hrs	1600hrs
09	0900hrs	1600hrs
10	0900hrs	2359hrs
11	0900hrs	1600hrs
12	0900hrs	2350hrs
13	0001hrs	1300hrs
14	0900hrs	1600hrs
15	0900hrs	2359hrs
16	0900hrs	1600hrs
17	0900hrs	1600hrs
18		
19	0900hrs	1600hrs
20	0900hrs	1230hrs
21	0900hrs	1600hrs
22	0900hrs	2359hrs
23	0900hrs	1600hrs
24	0900hrs	2359hrs
25	0900hrs	1600hrs
26	0900hrs	1600hrs
27	0900hrs	1230hrs
28	0900hrs	1600hrs
29	0900hrs	2359hrs
30	0900hrs	1600hrs
31	0900hrs	2359hrs

FIGURE 9 - FORT GEORGE RESTRICTED ACCESS TIMES

8. SURVEY VESSEL

ALHS' 6.0m Sportis cabin RIB Coastal Sensor was used to carry out all aspects of the survey.

Coastal Sensor is a Cat III vessel capable of working up to 20Nm from a safe haven. The vessel is road transportable and was launched at North Kessock slipway, North of Inverness and moored at Inverness Marina for the duration of the survey.

FIGURE 10 - SURVEY VESSEL COASTAL SENSOR

9. SURVEY PERSONNEL

The following personnel were involved in all aspects of the data capture, post processing and data release elements of the project.

NAME	POSITION
[Redacted]	Technical Manager/Vessel Skipper
[Redacte	Hydrographic Surveyor
[Redact	Senior Surveyor & UAV Pilot
[Redacte	Land Surveyor & UAV Pilot
[Redacte	Land Surveyor
[Redacte	Land Surveyor

10. SURVEY STANDARDS

The hydrographic survey is considered complete to International Hydrographic Organisation Special Order standard, with a Full Sea Floor Search being achieved as per IHO publication S44, Table 1. A representation of the section of interest within that document is shown in Table1:

Order	Examples of Typical Areas	Horizontal Accuracy (95% Confidence Level)	Depth Accuracy for Reduced Depths (95% Confidence Level)	100% Bottom Search	System Detection Capability	Maximum Line Spacing
Special	Harbours, berthing area and associated critical channels with minimum under keel clearances	2m	a = 0.25m b = 0.0075	Compulsory	Cubic features > 1m	Not applicable as 100% search compulsory

The error limits for depth accuracy are calculated by introducing the values listed in Table 1 for a and b into the formula $\pm\sqrt{[a^2+(b*d)^2]}$, where:

a constant depth error, i.e. the sum of all constant errors.

b*d depth dependent error, i.e. the sum of all depth dependent errors.

b factor of depth dependent error.

d depth.

The multibeam system was shown on numerous instances to be capable of detecting objects far smaller than the 1m cubic features specified for a Special Order survey.

11. DRAWING REGISTER

The following drawing files and documents are issued in conjunction with this project:

TITLE	DESCRIPTION
A6643.dwg	2D AutoCAD file
A6643_Ardersier, Highlands.pdf (5 Sheets)	2D PDF file
A6643_Bathy_CD.xyz	XYZ File
A6643_Topo_CD.xyz	XYZ File
Bathy_Image.tif/tfw	Image File
Topo_Image.tif/tfw	Image File
A6643_Ardersier_Report of Survey.docx	Survey Report

Annex A
Horizontal & Vertical Positioning System Precision

A6643

Dynamic Positioning Precision

	HORIZONTAL ACCURACY	VERTICAL ACCURACY
REAL TIME KINEMATIC GPS	±10mm + 1ppm RMS	±20mm + 1ppm RMS

Annex B
Data Processing Procedures

A6643

Sonar Control 2000 software was used to control the MBES system during the data gathering phase.

Data was logged in HYPACK HYSWEEP software.

After data gathering the data was post processed in HYPACK MBMax where the following stages of processing were undertaken:

- Navigation data was processed.
- Motion Sensor data was examined and edited as required.
- Tidal data was examined and edited as required
- Automatic filtering of the data was carried out.
- Individual lines of MBES sounding data were manually edited.
- The data was gridded at appropriate post spacing for the scale of plot requested by the client. This was exported to AutoCAD for presentation.
- The data was contoured at 0.5 m intervals in Hypack and exported to AutoCAD.

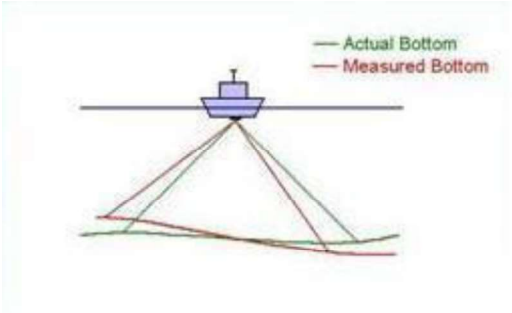
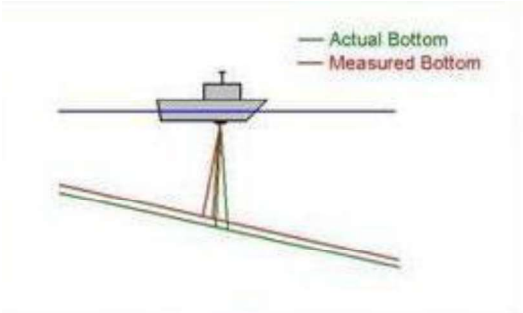
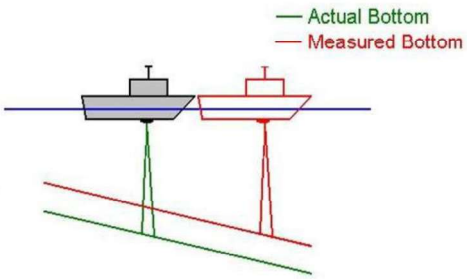
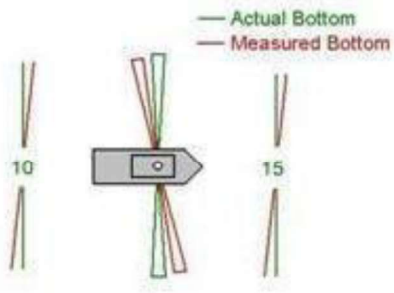
Annex C
Multibeam Echosounder Calibration

A6643

Patch tests are tests which are performed after initial equipment installation, and periodically thereafter as well as if sensors are modified, to quantify any residual biases from the initial system alignment.

During this calibration series, four separate tests must be performed to determine residual alignment biases for:

- Roll offset
- Position Time Delay (Latency)
- Pitch Offset
- Yaw (Heading) Offset

ROLL 	**PITCH** 
▪ *Sonar and Motion Reference Unit (MRU) alignment relative to vertical.* ▪ *Can cause large depth and position errors at outer beams.*	▪ *Sonar and MRU alignment relative to vertical.* ▪ *Can cause depth and position errors across the swath.*
LATENCY 	**YAW (HEADING)** 
▪ *The delay between position and fix transmission.* ▪ *Will cause positional errors.* ▪ *Error is independent of multibeam system.*	▪ *Sonar and MRU alignment relative to vertical* ▪ *Can cause depth and position errors across the swath.*

Annex D
Standard Disclaimer

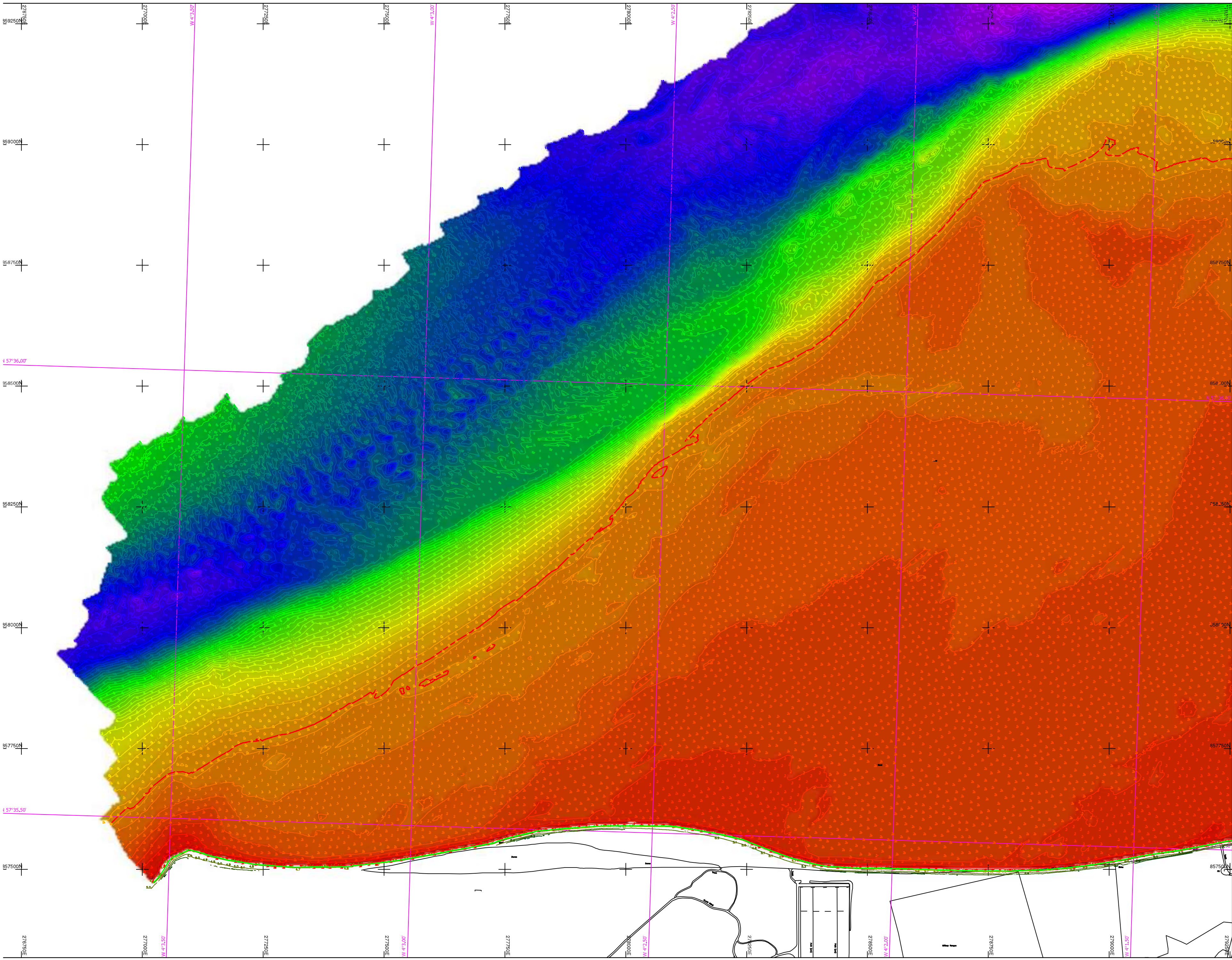
A6643

1. All client-supplied data is taken on trust as being accurate and correct, and the sub-contractor cannot be held responsible for the quality and accuracy of that data set.

2. Geophysical interpretation of bathymetry and sonar is based on an informed opinion of the supplied data, and is subject to inherent errors out with the control of the interpretational hydrographer or geophysicist, which include but are not limited to GPS positioning errors, navigation busts, data quality, assumed speed velocity sediment profiles in the absence of Geotechnical data, sub bottom profile pulse width, and induced scaling errors therein associated with seismic signature. Seabed geomorphology and sub-seabed geology should be further investigated by visual or intrusive methods.

3. The limits of this survey are defined by the data set; out with the survey limits are not covered at any level by the sub-contractor.

4. The data is accurate at the time of data acquisition, the sub-contractor cannot be held responsible for environmental changes, and the client by accepting this report accepts that the environment of the seabed is subject to continuous change, that items of debris, hard contacts etc. may move, appear, be relocated or removed, thickness of surficial sediment change out with the knowledge of the sub-contractor and they will not be held responsible for such actions at any level.



Legend

4.56	Heights relative to CHART DATUM.
12_2	Depths relative to CHART DATUM.
(blue line)	Sea-bed contour relative to CHART DATUM.
(green line)	Mean High Water Springs
(red line)	Mean Low Water Springs

SURVEY IS ROTATED TO GRID NORTH.

Survey Parameters & Equipment	
Survey Vessel:	Coastal Sensor (MCA Cat III)
Positioning System:	Trimble Applanix POS MV
GPS Correction Source:	Trimble VRS NOW Network RTK
Echosounder:	R2Sonic 2022 Multibeam System 400kHz
Motion Compensator:	Trimble Applanix POS MV
Positioning System Spheroid & Datum:	ETRS89
Grid System:	National Grid of Great Britain
Geoid Model:	OSGM15
Transformation Parameters:	OSTN15
Spheroid:	Airy
Semi Major Axis:	6377563.396
Flattening (1/f):	299.324964600
Vertical Datum (Topographic):	Chart Datum
Vertical Datum (Hydrographic):	Chart Datum
Distance Unit:	Metre

Chart Datum is 2.14m below Ordnance Datum.

The datum was established using corrected OS Rinex data and post-processed using Trimble Business Centre Software.

Coloured Depth Bands:

>= 4.00
3.50 - 3.99
3.00 - 3.49
2.50 - 2.99
2.00 - 2.49
1.50 - 1.99
1.00 - 1.49
0.50 - 0.99
0.00 - 0.49
-0.50 - -0.01
-1.00 - -0.51
-1.50 - -1.01
-2.00 - -1.51
-2.50 - -2.01
-3.00 - -2.51
-3.50 - -3.01
-4.00 - -3.51
-4.50 - -4.01
-5.00 - -4.51
-5.50 - -5.01
-6.00 - -5.51
-6.50 - -6.01
-7.00 - -6.51
-7.50 - -7.01
-8.00 - -7.51
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-9.00 - -8.51
-9.50 - -9.01
-10.00 - -9.51
-10.50 - -10.01
-11.00 - -10.51
-11.50 - -11.01
-12.00 - -11.51
-12.50 - -12.01
-13.00 - -12.51
-13.50 - -13.01
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-14.50 - -14.01
-15.00 - -14.51
-15.50 - -15.01
-16.00 - -15.51
-16.50 - -16.01
-17.00 - -16.51
-17.50 - -17.01
-18.00 - -17.51
-18.50 - -18.01
-19.00 - -18.51
-19.50 - -19.01
-20.00 - -19.51
< -20.00

Coloured Height Bands (Topo):

>= 8.80
8.30 - 8.79
7.80 - 8.29
7.30 - 7.79
6.80 - 7.29
6.30 - 6.79
5.80 - 6.29
5.30 - 5.79
4.80 - 5.29
4.30 - 4.79
< 4.30

Notes:

The Bathymetric survey limits are MHWS, data is relative to Chart Datum.

Topographic survey data is relative to Chart Datum.

Horizontal and vertical datums were referenced to control stations on site.

Heights in metres above Chart Datum (VORF)			
MHWS	MHWN	MLWN	MLWS
4.3	-	-	0.8

CONTROL STATION COORDINATES (OD)			
STN	EASTING	NORTHING	LEVEL
BASE1	279863.392	858404.091	13.554

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Web: www.aspectsurveys.com

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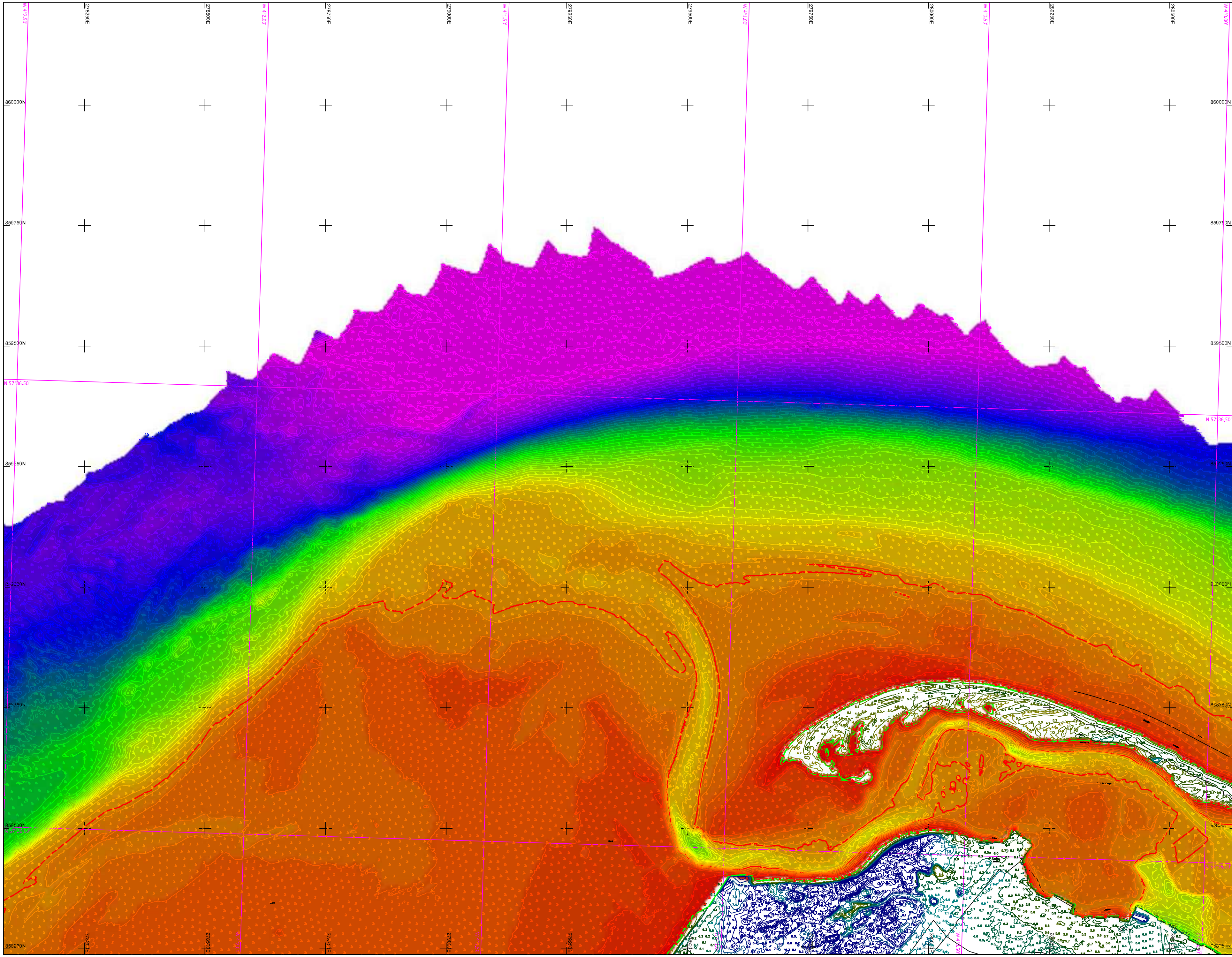
EH3 7AL

Project Title :

COMBINED UAV AERIAL TOPOGRAPHIC & MULTIBEAM BATHYMETRIC SURVEY
ARDERSIER
MORAY FIRTH
INVERNESS

Project No: A6643	Scale : 1:2500
Surveyed date : 14th May 2018	Issued date : 18th June 2018
Surveyed by : SJS/ES	Checked by : CKS
Sheet No. : 1 of 5	Plot Scale: 1:1 @ A0



Legend

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Grid System:	National Grid of Great Britain
Geoid Model:	OSGM15
Transformation Paramaters:	OSTN15
Spheroid:	Airy
Semi Major Axis:	6377563.396
Flattening (1/f):	299.324964600
Vertical Datum (Topographic):	Chart Datum
Vertical Datum (Hydrographic):	Chart Datum
Distance Unit:	Metre

Chart Datum is 2.14m below Ordnance Datum.

The datum was established using corrected OS Rinex data and post-processed using Trimble Business Centre Software.

Coloured Depth Bands

>= 4.00
3.50 - 3.99
3.00 - 3.49
2.50 - 2.99
2.00 - 2.49
1.50 - 1.99
1.00 - 1.49
0.50 - 0.99
0.00 - 0.49
-0.50 - -0.01
...
-15.00 - -14.51
-15.50 - -15.01
-16.00 - -15.51
-16.50 - -16.01
-17.00 - -16.51
-17.50 - -17.01
-18.00 - -17.51
-18.50 - -18.01
-19.00 - -18.51
-19.50 - -19.01
-20.00 - -19.51
< -20.00

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>= 8.80
8.30 - 8.79
7.80 - 8.29
7.30 - 7.79
6.80 - 7.29
6.30 - 6.79
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5.30 - 5.79
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4.30 - 4.79
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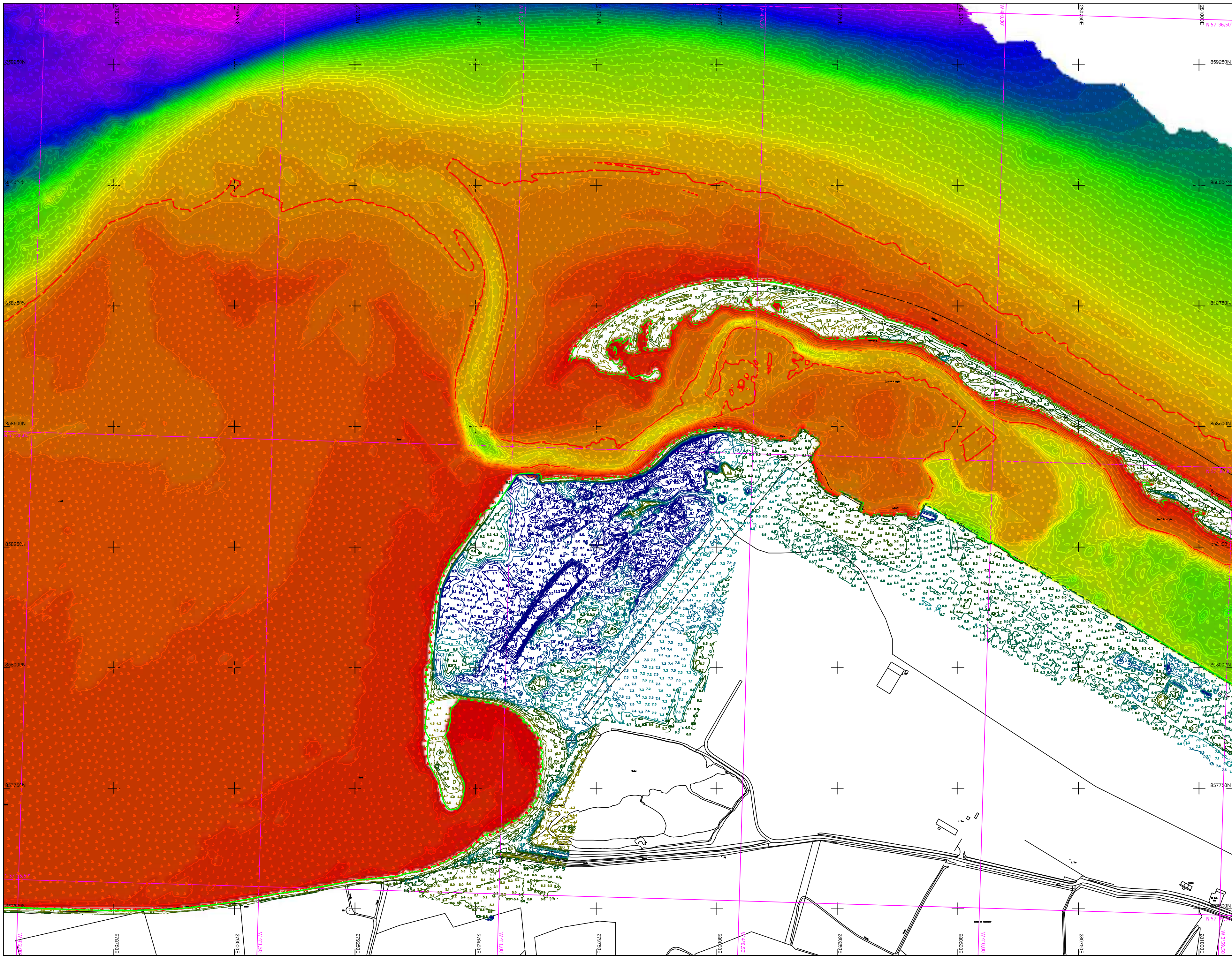

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1.00 - 1.49
0.50 - 0.99
0.00 - 0.49
-0.50 - -0.01
-1.00 - -0.51
-1.50 - -1.01
-2.00 - -1.51
-2.50 - -2.01
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-10.50 - -10.01
-11.00 - -10.51
-11.50 - -11.01
-12.00 - -11.51
-12.50 - -12.01
-13.00 - -12.51
-13.50 - -13.01
-14.00 - -13.51
-14.50 - -14.01
-15.00 - -14.51
-15.50 - -15.01
-16.00 - -15.51
-16.50 - -16.01
-17.00 - -16.51
-17.50 - -17.01
-18.00 - -17.51
-18.50 - -18.01
-19.00 - -18.51
-19.50 - -19.01
-20.00 - -19.51
< -20.00

Coloured Height Bands (Topo):

>= 8.80
8.30 - 8.79
7.80 - 8.29
7.30 - 7.79
6.80 - 7.29
6.30 - 6.79
5.80 - 6.29
5.30 - 5.79
4.80 - 5.29
4.30 - 4.79
< 4.30

Notes:

The Bathymetric survey limits are MHWS, data is relative to Chart Datum.

Topographic survey data is relative to Chart Datum.

Horizontal and vertical datums were referenced to control stations on site.

Heights in metres above Chart Datum (VORF)			
MHWS	MHWN	MLWN	MLWS
4.3	-	-	0.8

CONTROL STATION COORDINATES (OD)			
STN	EASTING	NORTHING	LEVEL
BASE1	279863.392	858404.091	13.554

Aspect
Land + Hydrographic Surveys
CHARTERED SURVEYORS
Thornhouse Business Centre
Ballot Road
Irvine
KA12 0HW
Tel : 01294 313399 Fax : 01294 313389
E-mail: mail@aspectsurveys.com
Web: www.aspectsurveys.com

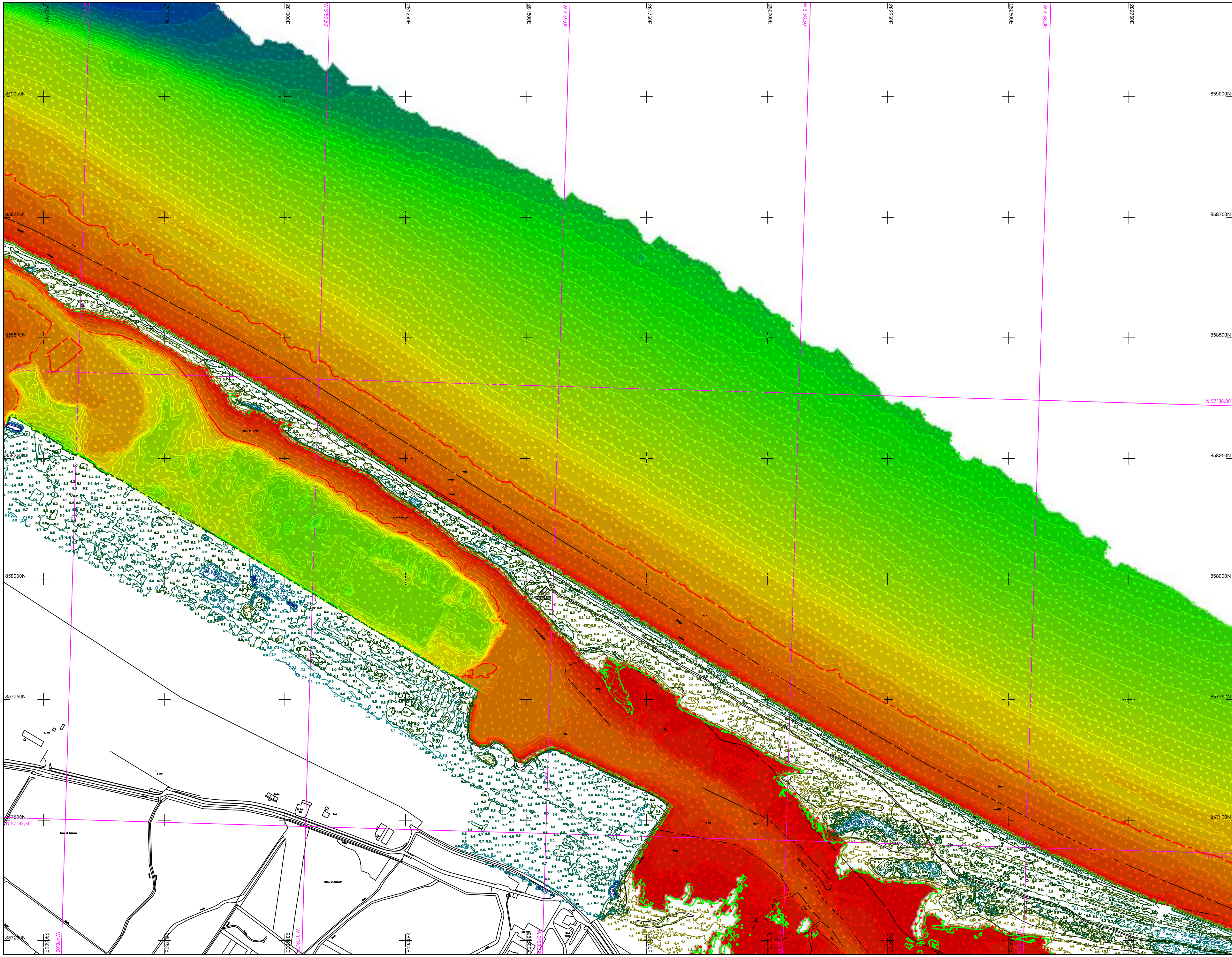
Client :

ARDERSIER PORT LTD
c/o CWC GROUP LTD
9 COATES CRESCENT
EDINBURGH
EH3 7AL

Project Title :

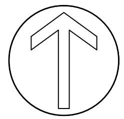
COMBINED UAV AERIAL TOPOGRAPHIC
& MULTIBEAM BATHYMETRIC SURVEY
ARDERSIER
MORAY FIRTH
INVERNESS

Project No: A6643	Scale : 1:2500
Surveyed date : 14th May 2018	Issued date : 18th June 2018
Surveyed by : SJS/ES	Checked by : CKS
Sheet No. : 3 of 5	Plot Scale: 1:1 @ A0



Legend

4.56	Heights relative to CHART DATUM.
12₂	Depths relative to CHART DATUM.
(blue line)	Sea-bed contour relative to CHART DATUM.
(green line)	Mean High Water Springs
(red line)	Mean Low Water Springs



SURVEY IS ROTATED TO GRID NORTH.

Survey Parameters & Equipment	
Survey Vessel:	Coastal Sensor (MCA Cat III)
Positioning System:	Trimble Applanix POS MV
GPS Correction Source:	Trimble VRS NOW Network RTK
Echosounder:	R2Sonic 2022 Multibeam System 400kHz
Motion Compensator:	Trimble Applanix POS MV
Positioning System Spheroid & Datum:	ETRS89
Grid System:	National Grid of Great Britain
Geoid Model:	OSGM15
Transformation Paramaters:	OSTN15
Spheroid:	Airy
Semi Major Axis:	6377563.396
Flattening (1/f):	299.324964600
Vertical Datum (Topographic):	Chart Datum
Vertical Datum (Hydrographic):	Chart Datum
Distance Unit:	Metre

Chart Datum is 2.14m below Ordnance Datum.

The datum was established using corrected OS Rinex data and post-processed using Trimble Business Centre Software.

Coloured Depth Bands

>= 4.00
3.50 - 3.99
3.00 - 3.49
2.50 - 2.99
2.00 - 2.49
1.50 - 1.99
1.00 - 1.49
0.50 - 0.99
0.00 - 0.49
-0.50 - -0.01
-1.00 - -0.51
-1.50 - -1.01
-2.00 - -1.51
-2.50 - -2.01
-3.00 - -2.51
-3.50 - -3.01
-4.00 - -3.51
-4.50 - -4.01
-5.00 - -4.51
-5.50 - -5.01
-6.00 - -5.51
-6.50 - -6.01
-7.00 - -6.51
-7.50 - -7.01
-8.00 - -7.51
-8.50 - -8.01
-9.00 - -8.51
-9.50 - -9.01
-10.00 - -9.51
-10.50 - -10.01
-11.00 - -10.51
-11.50 - -11.01
-12.00 - -11.51
-12.50 - -12.01
-13.00 - -12.51
-13.50 - -13.01
-14.00 - -13.51
-14.50 - -14.01
-15.00 - -14.51
-15.50 - -15.01
-16.00 - -15.51
-16.50 - -16.01
-17.00 - -16.51
-17.50 - -17.01
-18.00 - -17.51
-18.50 - -18.01
-19.00 - -18.51
-19.50 - -19.01
-20.00 - -19.51
< -20.00

Coloured Height Bands (Topo):

>= 8.80
8.30 - 8.79
7.80 - 8.29
7.30 - 7.79
6.80 - 7.29
6.30 - 6.79
5.80 - 6.29
5.30 - 5.79
4.80 - 5.29
4.30 - 4.79
< 4.30

Notes:

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Topographic survey data is relative to Chart Datum.

Horizontal and vertical datums were referenced to control stations on site.

Heights in metres above Chart Datum (VORF)

MHWS	MHWN	MLWN	MLWS
4.3	-	-	0.8

CONTROL STATION COORDINATES (OD)

STN	EASTING	NORTHING	LEVEL
BASE1	279863.392	858404.091	13.554

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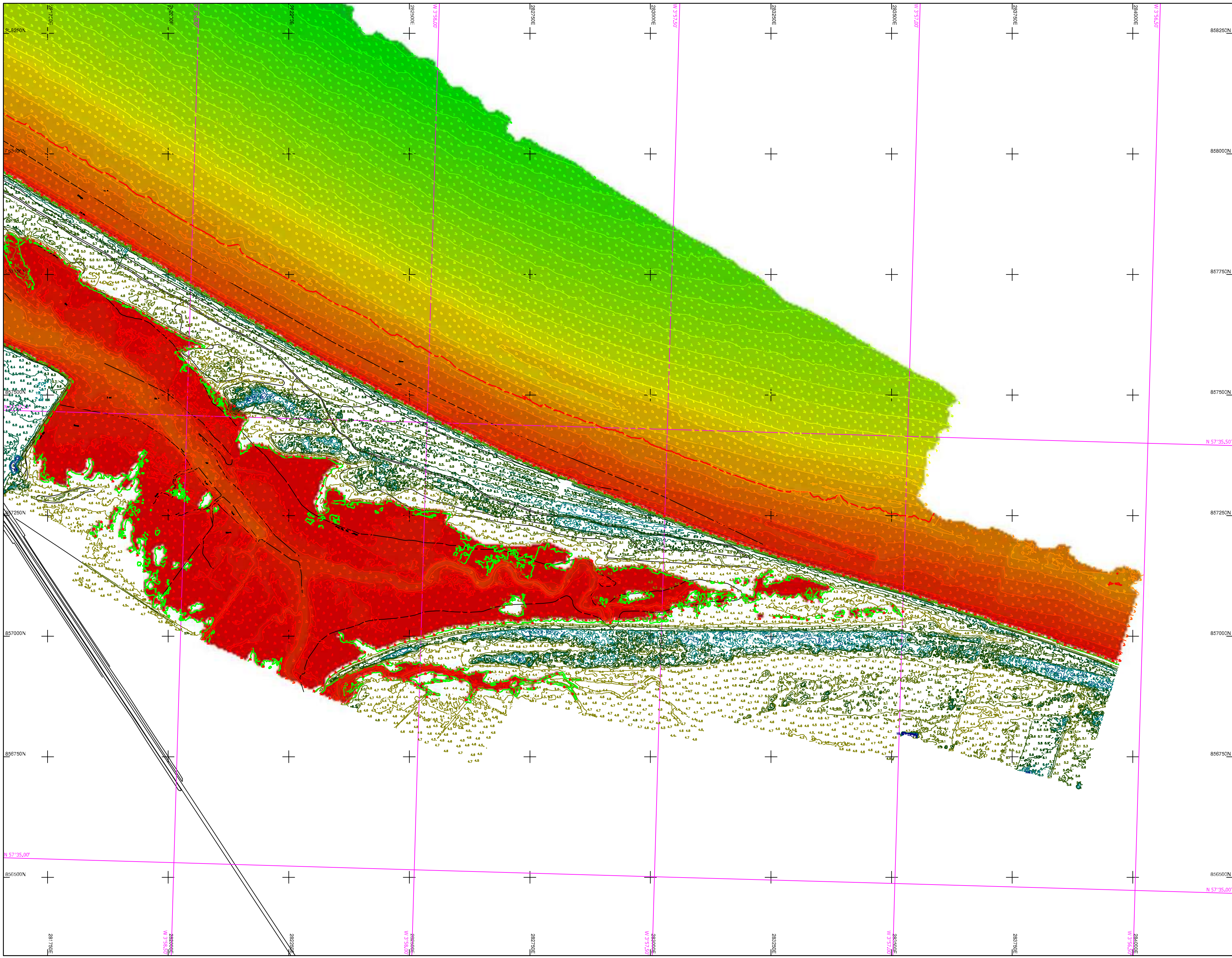

Legend

4.56	Heights relative to CHART DATUM.
12_2	Depths relative to CHART DATUM.
(blue line)	Sea-bed contour relative to CHART DATUM.
(green line)	Mean High Water Springs
(red line)	Mean Low Water Springs

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Motion Compensator:	Trimble Applanix POS MV
Positioning System Spheroid & Datum:	ETRS89
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Geoid Model:	OSGM15
Transformation Parameters:	OSTN15
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1.00 - 1.49
0.50 - 0.99
0.00 - 0.49
-0.50 - -0.01
-1.00 - -0.51
-1.50 - -1.01
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-2.50 - -2.01
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-3.50 - -3.01
-4.00 - -3.51
-4.50 - -4.01
-5.00 - -4.51
-5.50 - -5.01
-6.00 - -5.51
-6.50 - -6.01
-7.00 - -6.51
-7.50 - -7.01
-8.00 - -7.51
-8.50 - -8.01
-9.00 - -8.51
-9.50 - -9.01
-10.00 - -9.51
-10.50 - -10.01
-11.00 - -10.51
-11.50 - -11.01
-12.00 - -11.51
-12.50 - -12.01
-13.00 - -12.51
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-14.00 - -13.51
-14.50 - -14.01
-15.00 - -14.51
-15.50 - -15.01
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DATASHEET

Trimble R10 GNSS System

Key Features

Cutting-edge **Trimble HD-GNSS** processing engine

Precise position capture with **Trimble SurePoint** technology

Trimble CenterPoint RTX provides RTK level precision anywhere without the need for a base station or VRS network

Trimble xFill technology provides RTK coverage during connection outages

Advanced satellite tracking with **Trimble 360** receiver technology

Sleek ergonomic design for easier handling

A NEW LEVEL OF PRODUCTIVITY

Collect more accurate data faster and easier – no matter what the job or the environment, with the Trimble® R10 GNSS System. Built with powerful technologies like Trimble HD-GNSS, Trimble SurePoint™, Trimble CenterPoint™ RTX, and Trimble xFill™, integrated into a sleek design, this unique system provides Surveyors with a powerful way to increase productivity in every job, every day.

Trimble HD-GNSS Processing Engine

The next generation of core positioning technology

The advanced Trimble HD-GNSS processing engine provides markedly reduced convergence times as well as high position and precision reliability while reducing measurement occupation time. Transcending traditional fixed/float techniques, it provides a more accurate assessment of error estimates than traditional GNSS technology.

Trimble SurePoint

Faster measurements, increased accuracy, and greater quality control with electronic bubble

With this system, surveyors don't have to switch focus from the controller screen to the pole bubble to check that the pole is plumb. The Trimble controller displays an electronic bubble.

Full Tilt Compensation

The system constantly monitors pole tilt and compensates while the point is automatically or manually measured. If a point is measured with pole tilt beyond a user-defined setting, Trimble Access™ software will give an alert and prompt the surveyor to accept or discard the point. Trimble SurePoint even uses the pole tilt as a controlling input. After a point is measured, tilting the pole causes the system to automatically prepare to measure the next point.

Data Traceability

As insurance that all of your data is traceable, the Trimble R10 can record the pole tilt information for measured points. These records include tilt and compass data for 100% data traceability.

Trimble 360 Receiver

Future Proof Your Investment

Powerful Trimble 360 receiver technology in the Trimble R10 supports signals from all existing and planned GNSS constellations and augmentation systems. With two integrated Trimble Maxwell™ 6 chips, the Trimble R10 offers an unparalleled 440 GNSS channels. Trimble delivers business confidence with a sound GNSS investment for today and long into the future.

Trimble CenterPoint RTX

RTK Level Precision Anywhere

Trimble CenterPoint RTX delivers RTK level precision anywhere in the world without the use of a local base station or Trimble VRS™ Network. Survey using satellite delivered, CenterPoint RTX corrections in areas where terrestrial based corrections are not available. When surveying over a great distance in a remote area, such as a pipeline or utility right of way, CenterPoint RTX eliminates the need to continuously move base stations or maintain connection to a cellular network.

Trimble xFill

More continuous surveying, less downtime

Leveraging a worldwide network of Trimble GNSS reference stations and satellite datalinks, Trimble xFill seamlessly fills in for gaps in your RTK or VRS connection stream. Extend xFill indefinitely with a subscription to CenterPoint RTX.

Ergonomically Designed

As the smallest and lightest integrated receiver in its class, the Trimble R10 is ergonomically designed to provide the surveyor with effortless handling and operation. Designed for ease of use, the progressive design incorporates a more stable center of mass at the top of the range pole, while its sleeker, taller profile provides the durability and reliability for which Trimble is known.

The Trimble R10 receiver incorporates a quick release adaptor for simple and safe removal of the receiver from the range pole. Additionally the quick release adaptor ensures a solid, stable connection between the range pole and receiver.

An Intelligent Solution

A smart lithium-ion battery inside the Trimble R10 system delivers extended battery life and more reliable power. A built-in LED battery status indicator allows the user to quickly check remaining battery life.

Advanced Communication Capabilities

The Trimble R10 system provides a number of communications options to support any workflow. The latest mobile phone technology is built in to receive VRS corrections and connect to the Internet from the field. Access Trimble Connected Community to send or receive documents while away from the office. Using WiFi, easily connect to the Trimble R10 system using a laptop or smartphone to configure the receiver without a Trimble controller.

The Complete Solution: Trimble hardware and software

Bring the power and speed of the Trimble R10 system together with trusted Trimble software solutions, including Trimble Access and Trimble Business Center™.

Trimble Access field software provides specialized and customized workflows to make surveying tasks quicker and easier while enabling teams to communicate vital information between field and office in real time. Back in the office, users can seamlessly process data with Trimble Business Center software.

The R10 GNSS system, a new era of surveying productivity beyond GNSS for professional surveyors.

Trimble

Trimble R10 GNSS System

PERFORMANCE SPECIFICATIONS

Measurements

- Measuring points sooner and faster with Trimble HD-GNSS technology
- Increased measurement productivity and traceability with Trimble SurePoint electronic tilt compensation
- Worldwide centimeter level positioning using Trimble CenterPoint RTX satellite delivered corrections
- Reduced downtime due to loss of radio signal with Trimble xFill technology
- Advanced Trimble Maxwell 6 Custom Survey GNSS chips with 440 channels
- Future-proof your investment with Trimble 360 GNSS tracking
- Satellite signals tracked simultaneously:
  - GPS: L1C/A, L1C, L2C, L2E, L5
  - GLONASS: L1C/A, L1P, L2C/A, L2P, L3
  - SBAS: L1C/A, L5 (For SBAS satellites that support L5)
  - Galileo: E1, E5a, E5B
  - BeiDou (COMPASS): B1, B2
- CenterPoint RTX, OmniSTAR HP, XP, G2, VBS positioning
- QZSS, WAAS, EGNOS, GAGAN
- Positioning Rates: 1 Hz, 2 Hz, 5 Hz, 10 Hz, and 20 Hz

POSITIONING PERFORMANCE[1]

Code differential GNSS positioning

Horizontal	0.25 m + 1 ppm RMS
Vertical	0.50 m + 1 ppm RMS
SBAS differential positioning accuracy[2]	typically <5 m 3DRMS

Static GNSS surveying

High-Precision Static	
Horizontal	3 mm + 0.1 ppm RMS
Vertical	3.5 mm + 0.4 ppm RMS
Static and Fast Static	
Horizontal	3 mm + 0.5 ppm RMS
Vertical	5 mm + 0.5 ppm RMS

Real Time Kinematic surveying

Single Baseline <30 km	
Horizontal	8 mm + 1 ppm RMS
Vertical	15 mm + 1 ppm RMS
Network RTK[3]	
Horizontal	8 mm + 0.5 ppm RMS
Vertical	15 mm + 0.5 ppm RMS
RTK start-up time for specified precisions[4]	2 to 8 seconds
Trimble CenterPoint RTX	
Horizontal	4 cm
Vertical	9 cm
RTX convergence time for specified precisions[12]	30 minutes or less
RTX QuickStart convergence time for specified precisions[12]	5 minutes or less
Trimble xFill[5]	
Horizontal	RTK[6] + 10 mm/minute RMS
Vertical	RTK[6] + 20 mm/minute RMS

1 Precision and reliability may be subject to anomalies due to multipath, obstructions, satellite geometry, and atmospheric conditions. The specifications stated recommend the use of stable mounts in an open sky view, EMI and multipath clean environment, optimal GNSS constellation configurations, along with the use of survey practices that are generally accepted for performing the highest-order surveys for the applicable application including occupation times appropriate for baseline length. Baselines longer than 30 km require precise ephemeris and occupations up to 24 hours may be required to achieve the high precision static specification.
2 Depends on WAAS/EGNOS system performance.
3 Network RTK PPM values are referenced to the closest physical base station.
4 May be affected by atmospheric conditions, signal multipath, obstructions and satellite geometry. Initialization reliability is continuously monitored to ensure highest quality.
5 Precisions are dependent on GNSS satellite availability. xFill positioning without a RTX subscription ends after 5 minutes of radio downtime. xFill positioning with a RTX subscription will continue beyond 5 minutes providing RTX has converged, with typical precisions not exceeding 6 cm horizontal, 14 cm vertical. xFill is not available in all regions, check with your local sales representative for more information.
6 RTK refers to the last reported precision before the correction source was lost and xFill started.
7 Receiver will operate normally to –40° C, internal batteries are rated to –20° C.
8 Tracking GPS, GLONASS and SBAS satellites.
9 Varies with temperature and wireless data rate. When using a receiver and internal radio in the transmit mode, it is recommended that an external 6 Ah or higher battery is used.
10 Varies with terrain and operating conditions.
11 Bluetooth type approvals are country specific.
12 Receiver convergence time varies based on GNSS constellation health, level of multipath, and proximity to obstructions such as large trees and buildings. Convergences times decrease significantly when using a "RTX Quickstart" on a previously surveyed point or a known survey control point.

HARDWARE

Physical

Dimensions (W×H)	11.9 cm x 13.6 cm (4.6 in x 5.4 in)
Weight	1.12 kg (2.49 lb) with internal battery, internal radio with UHF antenna, 3.57 kg (7.86 lb) items above plus range pole, controller & bracket
Temperature[7]	
Operating	–40° C to +65° C (–40° F to +149° F)
Storage	–40° C to +75° C (–40° F to +167° F)
Humidity	100%, condensing
Ingress Protection	IP67 dustproof, protected from temporary immersion to depth of 1 m (3.28 ft)
Shock and vibration	Tested and meets the following environmental standards:
Shock	Non-operating: Designed to survive a 2 m (6.6 ft) pole drop onto concrete. Operating: to 40 G, 10 msec, sawtooth
Vibration	MIL-STD-810F, FIG.514.5C-1

Electrical

- Power 11 to 24 V DC external power input with over-voltage protection on Port 1 and Port 2 (7-pin Lemo)
- Rechargeable, removable 7.4 V, 3.7 Ah Lithium-ion smart battery with LED status indicators
- Power consumption is 5.1 W in RTK rover mode with internal radio[8]
- Operating times on internal battery[9]:
  - 450 MHz and 900 MHz receive only option. 5.5 hours
  - 450 MHz and 900 MHz receive/transmit option (0.5 W) 4.5 hours
  - 450 MHz receive/transmit option (2.0 W) 3.7 hours
  - Cellular receive option 5.0 hours

COMMUNICATIONS AND DATA STORAGE

- Serial: 3-wire serial (7-pin Lemo)
- USB v2.0: supports data download and high speed communications
- Radio Modem: fully Integrated, sealed 450 MHz wide band receiver/transmitter with frequency range of 403 MHz to 473 MHz, support of Trimble, Pacific Crest, and SATEL radio protocols:
  - Transmit power: 2 W
  - Range: 3–5 km typical / 10 km optimal[10]
- Cellular: integrated, 3.5 G modem, HSDPA 7.2 Mbps (download), GPRS multi-slot class 12, EDGE multi-slot class 12, UMTS/HSDPA (WCDMA/FDD) 850/1900/2100MHz, Quad-band EGSM 850/900/1800/1900 MHz, GSM CSD, 3GPP LTE
- Bluetooth: fully integrated, fully sealed 2.4 GHz communications port (Bluetooth®)[11]
- WiFi: 802.11 b,g, access point and client mode, WPA/WPA2/WEP64/WEP128 encryption
- External communication devices for corrections supported on – Serial, USB, Ethernet, and Bluetooth ports
- Data storage: 4 GB internal memory; over three years of raw observables (approx. 1.4 MB /day), based on recording every 15 seconds from an average of 14 satellites
- CMR+, CMRx, RTCM 2.1, RTCM 2.3, RTCM 3.0, RTCM 3.1 input and output
- 24 NMEA outputs, GSOF, RT17 and RT27 outputs

WebUI

- Offers simple configuration, operation, status, and data transfer
- Accessible via WiFi, Serial, USB, and Bluetooth

Supported Trimble Controllers

- Trimble TSC3, Trimble Slate, Trimble CU, Trimble Tablet Rugged PC

CERTIFICATIONS

FCC Part 15 (Class B device), 22, 24; R&TTE CE Mark; C-Tick, A-Tick; PTCRB; WFA

Specifications subject to change without notice.

TRIMBLE AUTHORIZED DISTRIBUTION PARTNER

NORTH AMERICA
Trimble Navigation Limited
10368 Westmoor Dr
Westminster CO 80021
USA

EUROPE
Trimble Germany GmbH
Am Prime Parc 11
65479 Raunheim
GERMANY

ASIA-PACIFIC
Trimble Navigation
Singapore Pty Limited
80 Marine Parade Road
#22-06, Parkway Parade
Singapore 449269
SINGAPORE

MATRICE 600

The Matrice 600 (M600) is DJI's new flying platform designed for professional aerial photography and industrial applications. It is built to closely integrate with a host of powerful DJI technologies, including the A3 flight controller, Lightbridge 2 transmission system, Intelligent Batteries and Battery Management system, for maximum performance and quick setup.

WATCH INTRO VIDEO

MATRICE 600 SPECS

AIRCRAFT

STRUCTURE

Diagonal Wheelbase	1133 mm
Aircraft Dimensions	• 1668 mm x 1518 mm x 759 mm (Propellers, frame arms and GPS mount unfolded) • 640 mm x 582 mm x 623 mm (Frame arms and GPS mount folded)
Package Dimensions	620 mm x 320 mm x 505 mm
Intelligent Flight Battery Quantity	6
Weight (with six TB47S batteries)	9.1 kg

PROPULSION SYSTEM

Motor Model	DJI 6010
Propeller Model	DJI 2170

OTHER

Supported DJI Gimbals	Zenmuse X3; Zenmuse X5 series; Zenmuse XT; Ronin-MX; Zenmuse Z15 series HD gimbals: Z15-A7, Z15-BMPCC, Z15-5D III, Z15-GH4
Retractable Landing Gear	Standard
Operating Temperature	14° to 104° F (-10° to 40° C)

CHARGER

Model	A14-100P1A
Voltage Output	26.3 V
Power Rating	100 W

BATTERY (OPTIONAL)

Model	TB48S
Capacity	5700 mAh
Voltage	22.8 V
Type	LiPo 6S
Energy	129.96 Wh
Net Weight	680 g
Operating Temperature	14° to 104° F (-10° to 40° C)
Storage Temperature	• Less than 3 months: -4° to 113° F (-20° to 45° C) • More than 3 months: 72° to 82° F (22° to 28° C)
Charge Temperature	41° to 104° F (5° to 40° C)
Max Charging Power	180 W

PERFORMANCE

Hovering Accuracy (P-Mode, with GPS)	Vertical: ±0.5 m, Horizontal: ±1.5 m
Max Angular Velocity	Pitch: 300°/s, Yaw: 150°/s
Max Pitch Angle	25°
Max Speed of Ascent	5 m/s
Max Speed of Descent	3 m/s
Max Wind Resistance	8 m/s
Max Flight Altitude above Sea Level	2500 m
Max Speed	18 m/s (No wind)
Hovering Time (with six TB47S batteries)*	No payload: 35 min, 6 kg payload: 16 min
Hovering Time (with six TB48S batteries)*	No payload: 40 min, 5.5 kg payload: 18 min * The hovering time is based on flying at 10 m above sea level in a no-wind environment and landing with 10% battery level.

FLIGHT CONTROL SYSTEM

Model	A3

REMOTE CONTROLLER

Operating Frequency	• 920.6 MHz to 928 MHz (Japan) • 5.725 GHz to 5.825 GHz • 2.400 GHz to 2.483 GHz

	Matrice 600
EIRP	• 10 dBm @ 900 M/li> • 13 dBm @ 5.8 G • 20 dBm @ 2.4 G
Video Output Port	HDMI, SDI, USB
Dual Users Capability	Master-and-Slave control
Mobile Device Holder	Supports smartphones and tablets
Output Power	9 W
Operating Temperature	14° to 104° F (-10° to 40° C)
Storage Temperature	• Less than 3 months: -4° to 113° F (-20° to 45° C) • More than 3 months: 72° to 82° F (22° to 28° C)
Charge Temperature	32° to 104° F (0° to 40° C)
Built-in Battery	6000 mAh, 2S LiPo
Max Tablet Width	170 mm

BATTERY (STANDARD)

Model	TB47S
Capacity	4500 mAh
Voltage	22.2 V
Type	LiPo 6S
Energy	99.9 Wh
Net Weight	595 g
Operating Temperature	14° to 104° F (-10° to 40° C)
Storage Temperature	• Less than 3 months: -4° to 113° F (-20° to 45° C) • More than 3 months: 72° to 82° F (22° to 28° C)
Charge Temperature	41° to 104° F (5° to 40° C)
Max Charging Power	180 W

MATRICE 600 VIDEOS

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SHOWCASE

Velodyne LiDAR®

HDL-32E

HIGH RESOLUTION REAL-TIME 3D LiDAR SENSOR

Automotive | Mapping | Robotics | Industrial | Security | UAV

HDL-32E

Stylishly small and ruggedly built with an unrivaled field of view, Velodyne's HDL-32E LiDAR sensor was designed to exceed the demands of the most challenging, real-world industrial applications including autonomous vehicle control and operation, mobile terrestrial mapping, aerial 3D mapping and security surveillance.

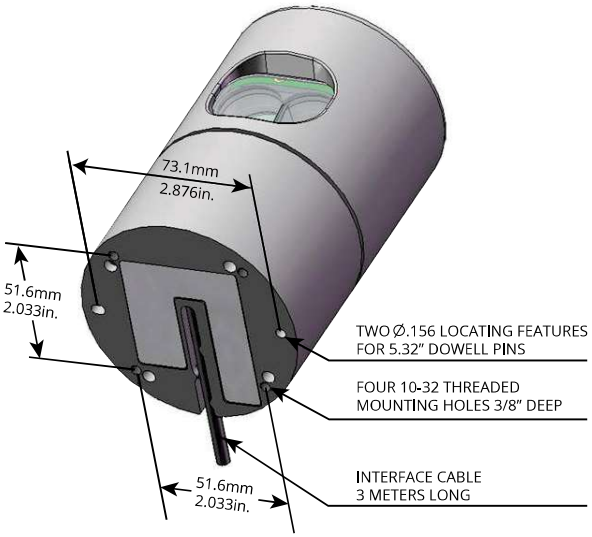
The HDL-32E measures only 144 mm by 85 mm and weighs 1.0 kg (plus 0.3 kg for cabling). Its compact size and weight makes it for all LiDAR applications, in particular those with constrained form factors and pricing requirements but still demand high performance.

Unprecedented Field of View and Point Density

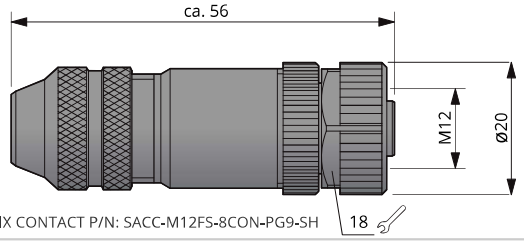
The HDL-32E's innovative multi-channel array enables navigation and mapping systems to observe more of their environment than any other LiDAR sensor. The HDL-32E utilizes 32 LiDAR channels aligned from +10.67° to -30.67° to provide an unmatched vertical field of view, and its patented rotating head design delivers a real-time 360° horizontal field of view. The HDL-32E generates a point cloud of up to 695,000 points per second with a range of up to 100 m and a typical accuracy of ±2 cm. The resulting comprehensive point cloud coverage within a single data stream makes the HDL-32E an indispensable part of any sensor suite.

HDL-32E

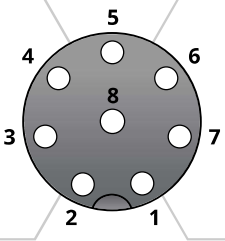
DIMENSIONS



M12 CONNECTOR ON SENSOR SIDE



PHOENIX CONTACT P/N: SACC-M12FS-8CON-PG9-SH



Pin	Wire Color	Function
8	Black	Ground
7	Red	+12 V
6	Yellow	GPS Pulse Per Second (PPS)
5	White	GPS Serial Data
4	Light Orange	Ethernet TX+
3	Orange	Ethernet TX-
2	Light Blue	Ethernet RX+
1	Blue	Ethernet RX-

HDL-32E

High Definition Real-Time 3D LiDAR Sensor

The HDL-32E provides high definition 3-dimensional information about the surrounding environment.

Specifications:

Sensor:

- Time of Flight Distance Measurement with Calibrated Reflectivities
- 32 Channels
- Measurement Range: Up to 100 m
- Accuracy: ±2 cm (Typical)
- Single and Dual Returns (Strongest, Last)
- Field of View (Vertical): +10.67° to -30.67° (41.33°)
- Angular Resolution (Vertical): 1.33°
- Field of View (Horizontal): 360°
- Angular Resolution (Horizontal/Azimuth): 0.1° – 0.4°
- Rotation Rate: 5 Hz – 20 Hz
- Integrated Web Server for Easy Monitoring and Configuration

Laser:

- Laser Product Classification: Class 1 Eye-safe per IEC 60825-1:2007 & 2014
- Wavelength: 903 nm
- Beam Size @ Screen: 12.7 mm (Horizontal) x 9.5 mm (Vertical)
- Beam Divergence Horizontal: 0.18° (3.0 mrad); Vertical: 0.07° (1.2 mrad)

Mechanical/ Electrical/ Operational

- Power Consumption: 12 W (Typical)
- Operating Voltage: 9 V – 18 V (with Interface Box and Regulated Power Supply)
- Weight: 1.0 kg (without Cabling and Interface Box)
- Dimensions: 85 mm Diameter x 144 mm Height
- Shock: 500 m/s^2 Amplitude, 11 ms Duration
- Vibration: 5 Hz to 2,000 Hz, 3 G_{rms}
- Environmental Protection: IP67
- Operating Temperature: -10°C to +60°C
- Storage Temperature: -40°C to +105°C

Output:

- 3D LiDAR Data Points Generated:
  - Single Return Mode: ~695,000 points per second
  - Dual Return Mode: ~1,390,000 points per second
- 100 Mbps Ethernet Connection
- UDP Packets Contain:
  - Time of Flight Distance Measurement
  - Calibrated Reflectivity Measurement
  - Rotation Angles
  - Synchronized Time Stamps (µs resolution)
- Orientation: 6DoF Inertial Sensor Measurements
- GPS: $GPRMC NMEA Sentence from GPS Receiver (GPS not included)

97-0038 Rev-K

Product Ordering Information:

Product Name	SKU Ordering Number	Sensor		Interface Box			
		Connector	Cable Length*	Included	Connector to Sensor	Cable Length*	I/O Connectors
HDL-32E	80-HDL-32E	None	3.0 m	Yes	None	-	RJ45, GPS and Power
HDL-32E	80-HDL-32E M12-IFB	M12 Female	0.3 m	Yes	M12 Male	1.6 m	RJ45, GPS and Power
HDL-32E	80-HDL-32E M12-0.3M	M12 Female	0.3 m	No	-	-	-
HDL-32E	80-HDL-32E M12	M12 Female	1.6 m	No	-	-	-

**Cable Length includes the connector.*

CLASS 1 LASER PRODUCT

Velodyne LiDAR, Inc. 345 Digital Drive, Morgan Hill, CA 95037 / lidar@velodyne.com / 408.465.2800 | www.velodynelidar.com

DATASHEET

POS MV

MAXIMIZE YOUR ROI WITH POS MV WAVEMASTER II

POS MV WaveMaster II is a user-friendly, turnkey system designed and built to provide accurate attitude, heading, heave, position, and velocity data of your marine vessel and onboard sensors.

POS MV is proven in all conditions, and is the georeferencing and motion compensation solution ofchoice for the hydrographic professional.

MV blends GNSS data with angular rate and acceleration data from an IMU and heading from the GPS Azimuth Measurement System (GAMS) to produce a robust and accurate full six degrees-of-freedom position and orientation solution.

Key Features

- Up to 0.02° roll and pitch performance
- IN-Fusion 2.0 ensures optimal GNSS aiding for any given conditions
- TrueHeave - no requirement to tune filter for specific conditions, no settling time so no run in time
- High accuracy inertial measurement units featuring SmartCal
- Data time tagged to microsecond accuracy

applanix
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DATASHEET

POS MV **WAVEMASTER II**

PERFORMANCE SUMMARY

POS MV WAVEMASTER II ACCURACY[1]

	DGPS	Fugro Marinestar[8]	IARTK	POSPac MMS PPP	POSPac MMS IAPPK	Accuracy During GNSS Outage
Position	0.5 - 2 m[2]	Horizontal: 10 cm 95% Vertical: 15 cm 95%	Horizontal: +/- (8 mm + 1 ppm x baseline length)[3] Vertical: +/- (15 mm + 1 ppm x baseline length)[3]	Horizontal: < 0.1 m Vertical: < 0.2 m	Horizontal: +/- (8 mm + 1 ppm x baseline length)[3] Vertical: +/- (15 mm + 1 ppm x baseline length)[3]	~ 9 m for 60 s outage(RTK) ~ 3 m for 30 s outages (RTK) ~ 2 m for 60 s outages (IAPPK)
Roll & Pitch[4]	0.03°	0.02°	0.02°	< 0.02°	0.015°	0.04°
Heading[4]	0.015° with 4 m baseline 0.03° with 2 m baseline	-		-	-	< 2° per hour degradation (negligible for outages <60 s)
Heave TrueHeave™	5 cm or 5%[5] 2 cm or 2%[6]	-		-	-	5 cm or 5%[5] 2 cm or 2%[6]

PCS OPTIONS

COMPONENT	DIMENSIONS	WEIGHT	TEMPERATURE	HUMIDITY	POWER
Rack Mount PCS	L = 442 mm, W = 356 mm, H = 46 mm	3.9 kg	-20 °C to +70 °C	10 - 80% RH	AC 120/230 V, 50/60 Hz, auto-switching 40 W
Small Form Factor PCS	L = 167 mm, W = 185 mm, H = 68 mm	2.5 kg	-20 °C to +60 °C	0- 100% RH	DC 10-34 V, 35 W (peak)

INERTIAL MEASUREMENT UNIT (IMU)

ENCLOSURE	DIMENSIONS	WEIGHT	TEMPERATURE	IP RATING
Between Decks	L = 158 mm, W = 158 mm, H = 124 mm	2.5 kg	-40 °C to +60 °C	IP65
Submersible	Ø100 mm (base plate Ø132 mm) X 104 mm[7]	2.7 kg	-40 °C to +60 °C	IP68

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

COMPONENT	DIMENSIONS	WEIGHT	TEMPERATURE	HUMIDITY
GNSS antenna	Ø178 mm, W = 73 mm	0.45 kg	-50 °C to +70 °C	0- 100% RH

ETHERNET INPUT/OUTPUT

Ethernet ..... (10/100 base-T)
Parameters..... Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data raw GNSS data
Display Port ..... Low rate (1 Hz) UDP protocol output
Control Port ..... TCP/IP input for system commands
Primary Port..... Real-time (up to 200 Hz) TCP/IP protocol output
Secondary Port ..... Buffered TCP/IP protocol output for data logging to external device

SERIAL RS232 INPUT OUTPUT

5 COM Ports..... User assignable to: NMEA output (0-5), Binary output (0-5), Auxiliary GNSS input (0-2), Base GNSS correction input (0-2)

NMEA ASCII OUTPUT

Parameters..... NMEA Standard ASCII messages: Position ($INGGA), Heading ($INHDT), Track and Speed ($INVTG), Statistics ($INGST) Attitude ($PASHR, $PRDID), Time and Date ($INZDA, $UTC)
Rate ..... Up to 50 Hz (user selectable)
Configuration..... Output selections and rate individually configurable on each assigned com port

HIGH RATE ATTITUDE OUTPUT

Parameter..... User selectable binary messages: attitude, heading, speed
Rate ..... Up to 200 Hz (user selectable)
Configuration..... Output selections and rate individually configurable on each assigned com port

AUXILIARY GNSS INPUTS

Parameter..... NMEA Standard ASCII messages: $GPGGA, $GPGST, $GPGSA, $GPGSV
Uses Aux input with best quality
Rate ..... 1 Hz

BASE GNSS CORRECTION INPUTS

Parameter..... RTCM V2.x, RTCM V3.x, CMR and CMR+, CMRx input formats accepted. Combined with raw GNSS observables in navigation solution
Rate ..... 1 Hz

DIGITAL I/O

1PPS..... 1 pulse-per-second Time Sync output, normally high, active low pulse
Event Input (2) ..... Time mark of external events. TTL pulses > 1 msec width, rising or falling edge, max rate 200 Hz

USER SUPPLIED EQUIPMENT

- PC for POSView Software (Required for configuration): Pentium 90 processor (minimum), 256 MB RAM, 2 GB free disk space, Ethernet adapter (10/100 Base-T Ethernet; IEEE 802.3 sntandard), Windows 7 SP1, Windows 7 Embedded, Windows 8, and Windows 10
- PC for POSPac MMS Post-processing Software: Intel Pentium series 1Ghz or or faster 64-bit processor (minimum), 2GB RAM, 2,6 GB free disk space, USB Port (For Security Key), Windows 7 SP1, Windows 8.1, Windows 10

[1] Sigma unless otherwise stated
[2] Depending on quality of differential corrections
[3] Assumes 1 m IMU-GNSS antenna offset
[4] No range limit
[5] Whichever is greater, for periods of 20 seconds or less
[6] Whichever is greater, for periods of 35 seconds or less
[7] Height excludes connector

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Specifications subject to change without notice.

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High Resolution Multibeam Systems for:

Hydrography

Offshore

Dredging

Defense

Research

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78735

T: 512 891 0000

www.r2sonic.com

OUR VISION IS SOUND™

SONIC 2022

Wideband Multibeam Echo Sounder

Features:

- Ultra Compact
- Wideband 170 kHz – 450 kHz
- Optional UHR™ 700 kHz
- Beam Widths to 0.6° x 0.6°*
- Selectable swath 10° to 160°
- Sounding Depth to 400m+
- Embedded processor/controller
- Low weight, volume and power consumption

System Description:

The Sonic 2022 is a compact wideband shallow water multibeam echo sounder, suitable for a wide variety of general mapping applications.

The Sonic 2022 provides user selectable operating frequencies between 170 kHz and 450 kHz to 1 Hz resolution, and optional 700 kHz, with unparalleled flexibility to trade off resolution and range and controlling interference from other active acoustic systems.

In addition to selectable operating frequencies, the Sonic 2022 provides variable swath coverage selections from 10° to 160°, the ability to rotate the swath sector, as well as roll stabilization. Both the frequency and swath coverage may be selected 'on-the-fly', in real-time during survey operations.

The Sonar consists of the outboard projector and receiver modules, and the inboard Sonar Interface Module (SIM). Third party auxiliary sensors are connected to the SIM. The sonar data is tagged with GPS time.

The sonar operation is controlled from a graphical user interface on a PC or laptop typically equipped with navigation, data collection and storage applications software.

The operator sets the sonar parameters in the sonar control window, while depth, imagery and other sensor data are captured and displayed by the applications software.

Commands are transmitted through an Ethernet interface to the Sonar Interface Module. The Sonar Interface Module supplies power to the sonar heads, synchronizes multiple heads, time tags sensor data, and relays data to the applications workstation and commands to the sonar head.

The receiver head decodes the sonar commands, triggers the transmit pulse, receives, amplifies, beamforms, bottom detects, packages and transmits the data through the Sonar Interface Module via Ethernet to the control PC.

The compact size, low weight, low power consumption 35W and elimination of separate topside processors also make Sonic 2022 very well suited for small survey vessel, ROV or AUV operations.

200 kHz	450 kHz	700 kHz
2 x 2°	0.9° x 0.9°	0.6° x 0.6°

Beam widths at selected frequencies (nadir)

* Beam width to 0.6° x 0.6° with UHR 700 kHz option

SONIC 2022 Multibeam Echo Sounder

Systems Specification:

Selectable Frequencies	170 kHz - 450 kHz to 1 Hz resolution Optional 700 kHz
Beamwidth, Across Track	0.6°*
Beamwidth, Along Track	0.6°*
Number of Soundings	Up to 1024 per swath, per head
Selectable Swath Sector	10° to 160°
Sounding Depth	400 m+**
Pulse Length	15 µs – 1115 µs
Pulse Type	Shaped CW
Ping Rate	Up to 60 Hz
Depth Rating	100 m
Operating Temperature	-10° C to 50° C
Storage Temperature	-30° C to 55° C

Electrical Interface

Mains	90-260 VAC, 45-65 Hz
Power Consumption	35 W (Sonar Head)
Uplink/Downlink:	10/100/1000Base-T Ethernet
Data Interface	10/100/1000Base-T Ethernet
Sync In, Sync out	TTL
GPS	1PPS, RS-232
Auxiliary Sensors	RS-232
Deck Cable Length	15 m

Mechanical

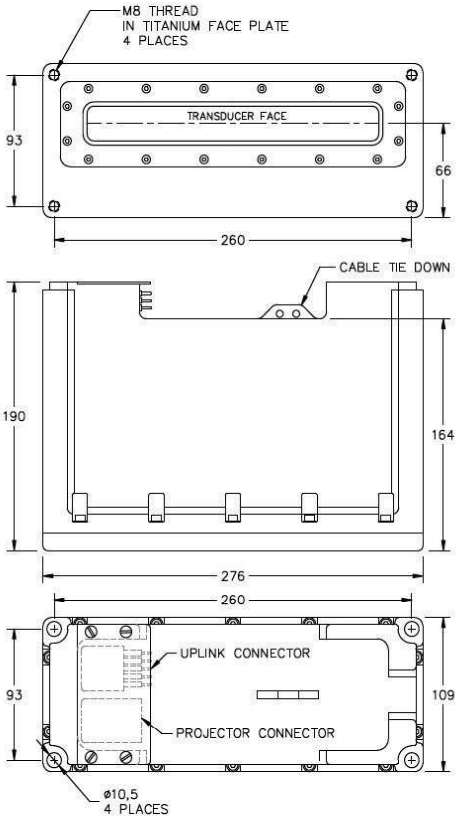
Receiver Dim (LWD)	276 x 109 x 190 mm
Receiver Mass	7 kg
Projector Dim (LWD)	273 x 108 x 86 mm
Projector Mass	3.3 kg
Sonar Interface Module Dim (LWH)	280 x 170 x 60 mm
Sonar Interface Module Mass	2.4 kg

Sonar Options

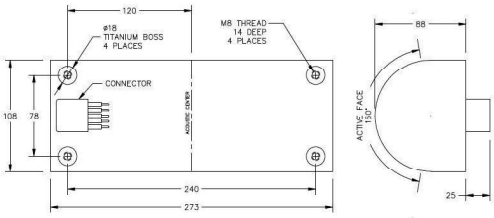
TruePix™ Imagery Output
Ultra-High Resolution UHR™ 700 kHz
Switchable Forward Looking Sonar Output
Raw Water Column Data Output
I2NS™ Integrated Inertial Nav. System
Mounting Hardware & Assemblies
4000/6000m Immersion Depth Ratings
Antifouling Coating Protection

* Beam width to 0.6° x 0.6° with UHR 700 kHz option
**Max sounding depths depend on environmental conditions

Sonar Interface Module



Sonic 2022 Receiver



Sonic 2022 Projector

Pioneers of Wideband High Resolution Multibeam Systems

High Resolution Multibeam Systems for:

Hydrography

Offshore

Dredging

Defense

Research

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