NOR_AO4 AREA
OFFSHORE WINDFARM
GEOPHYSICAL AND UXO SURVEY

NOR_TEC_47_RESULTS REPORT – GEOPHYSICAL-UXO SURVEY – AO4 OWF AREA_1.2_A

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ABBREVIATIONS

AAA	Anti-Aircraft Artillery
ADCP	Acoustic Doppler Current Profiler
ALARP	As Low as Reasonable Practicable
cm	Centimetre
CoG	Center of Gravity
DGEC	Direction générale de l'énergie et du climat
DP	Dynamic Positioning
DTM	Digital Terrain Model
EC	Export Cable
EGN	Empirical Gain Normalization
FLO	Fisheries Liaison Officer
GEO	Geophysicist
GI	Borehole location
GIS	Geographic Information System

ABBREVIATIONS

GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRS	Geodetic Reference System
h	Hour
IGRF	International Geomagnetic Reference Field
INERIS	L'Institut national de l'environnement industriel et des risques
INS	Inertial Navigation System
JSF	EdgeTech Sonar data file format
Kg	Kilogram
KHz	kilohertz
LAT	Low Astronomical Tide
LMA	Luftmine A
LMB	Luftmine B
LSA	Land Service Ammunition
m	Meters
M	Minutes
MAG	Magnetometer
MBES	Multibeam echosounder
mm	Millimetre
MMO	Marine Mammals Observation
MOB	Mobilisation
MRU	Motion Reference Unit
nT	nanoTesla
OSS	Offshore substation
OWF	Offshore windfarm
PC	Party Chief
PEP	Project Execution Plan
POB	Personnel On Board
PPP	Precise Point Positioning
PPS	Pulse Per Second

ABBREVIATIONS

PPSU	Pulse Power Supply Unit
pUXO	Possible unexploded ordnance
QA	Quality Assurance
QC	Quality Control
QGIS	Quantum GIS (Software)
QHSE	Quality, Health, Safety and Environment
RGB	Red, green, blue
ROTV	Remotely operated towed vehicle
ROV	Remotely Operated Vehicle
RTE	Réseau de Transport d'Electricité
RTK	Real Time Kinematics
s	Second
SHOM	Service hydrographique et océanographique de la Marine
SIT	Surrogate Item Trials
SRF	Ship's Reference Frame
SSS	Side Scan Sonar
SVP	Sound Velocity Profiler
SVS	Sound Velocity Sensor
TBC	To be confirmed
TXT	Standard text document file format
UHR	Ultra-High Resolution
USBL	Ultra-Short Base Line
UTC	Universal Time Coordinated or Coordinated Universal Time
UTM	Universal Transverse Mercator
UXO	Unexploded ordnance
VRF	Vertical Reference Frame
VSAT	Very Small Aperture Terminal
WGS84	World Geodetic System 1984
WT	Work time

1. INTRODUCTION

1.1. PROJECT OVERVIEW

Tecnoambiente carried out a geophysical survey over the proposed NOR_AO4 lot, located in the English Channel (Figure 1-1 and 1-2), more precisely off the coast of Normandy, in the Bay of Seine. The site is under consideration for a windfarm and offshore substation. The survey of the UXO box was carried out over the previously acquired seismic lines in Phase I, in 2021.

The dimensions of this area of interest are approximately 25 km x 23 km and according to the SHOM bathymetry, the site is located in water depths ranging from -40 to -60 m. The spatial surface this area represents is about 539.54 km^2.

This is an area with a strong military history. During World War II, it is where the main Allied landings in France took place, so it is considered an area with a strong presence of potential UXO.

The objective of this report is to present the data obtained in the geophysical/UXO phase of the NOR_AO4 work area, focusing only on the Offshore Windfarm area (OWF).

The original scope of works required the collection of data across a total of 16 UXO boxes within the proposed offshore windfarm area. An additional 6 UXO boxes were added to the initial scope, resulting in a total of 22 UXO boxes. Figure 1-3 shows the distribution of these boxes

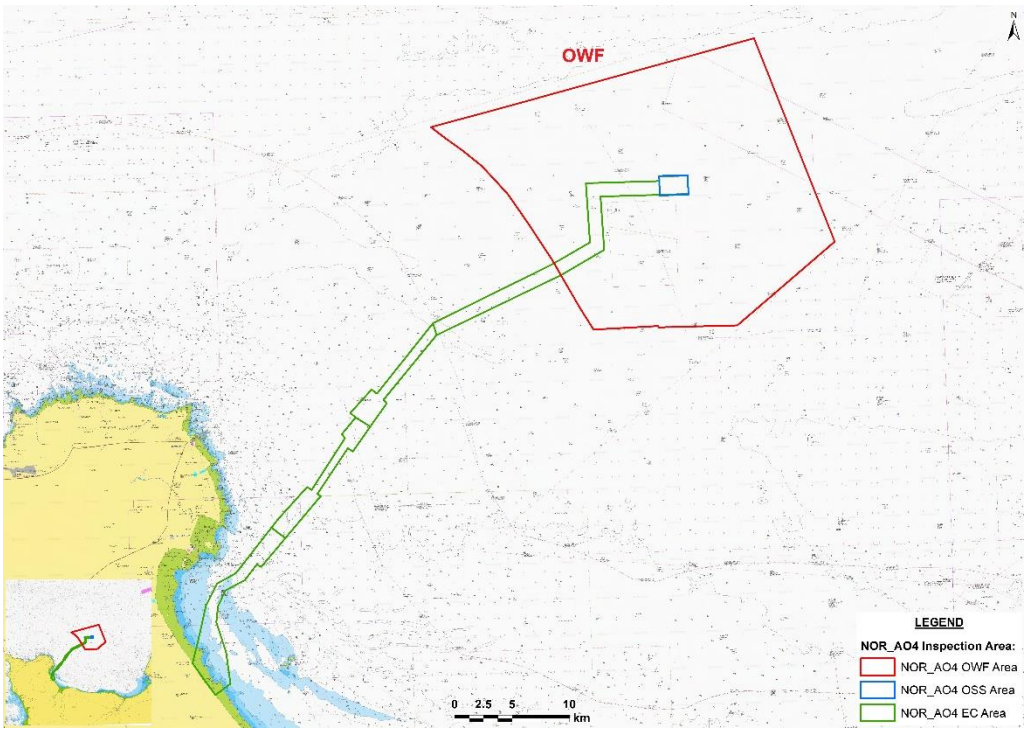


Figure 1-1: NOR_AO4 Survey area.

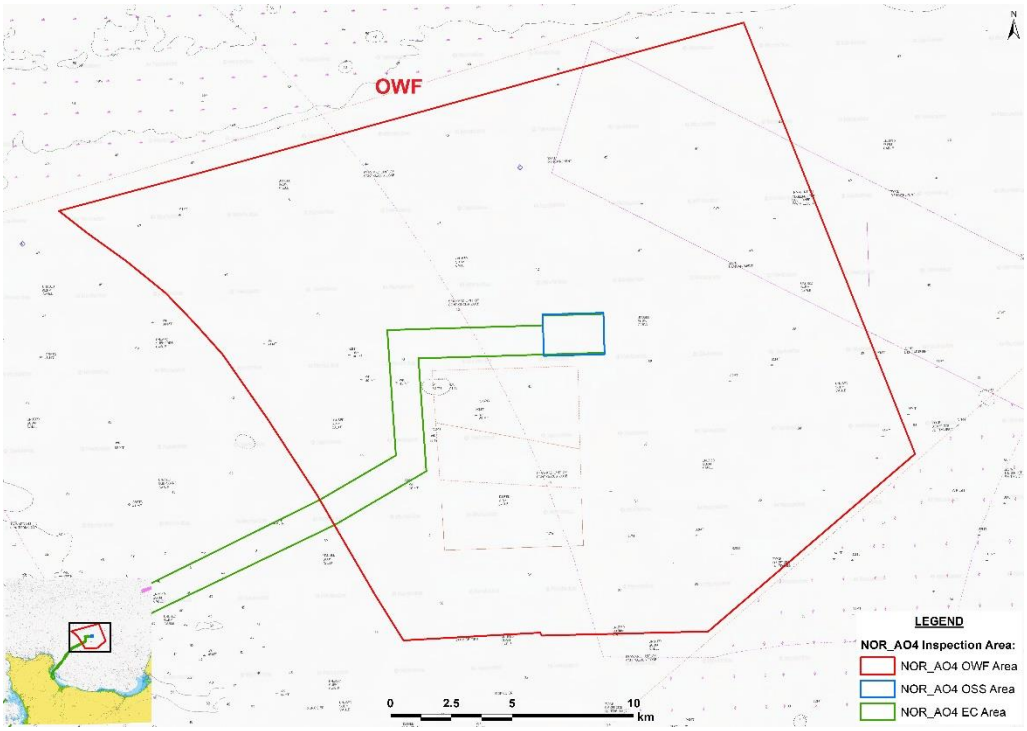


Figure 1-2: Windfarm area (OWF), Offshore Substation (OSS) and Export cable (EC) in the NOR_AO4 survey area.

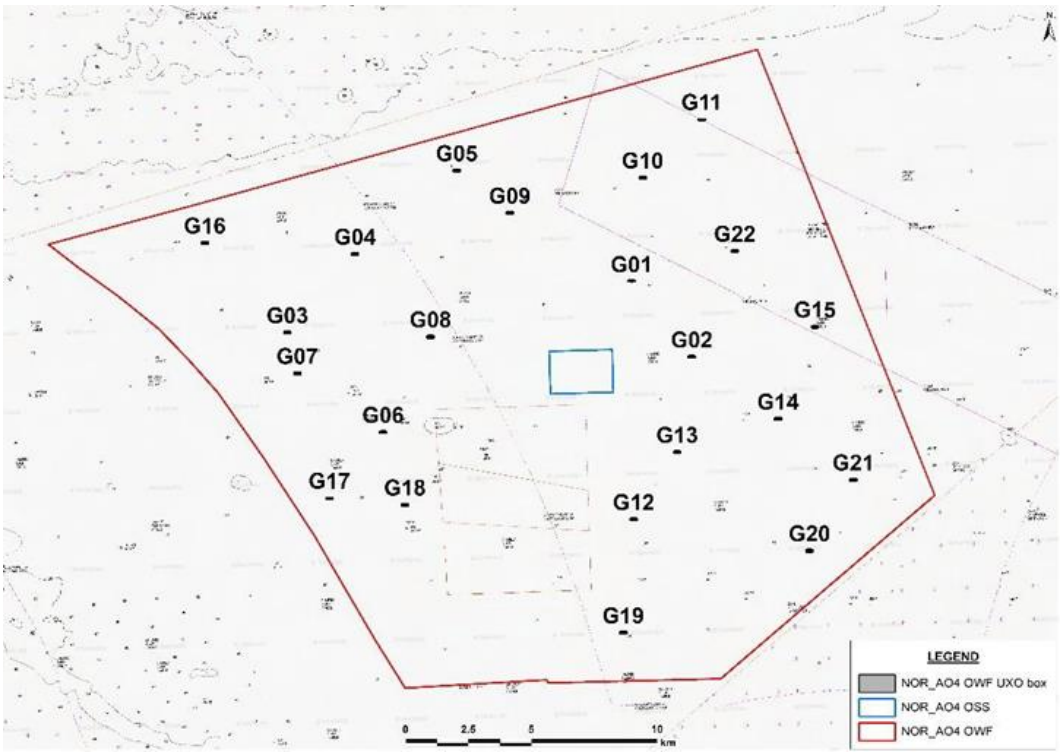


Figure 1-3: UXO boxes locations at the NOR_AO4 Offshore windfarm (OWF).

The UXO boxes comprises an area of 30 m x 30 m, with a run in / run out area of 200 metres utilised to optimise the acquisition of the magnetometer data. Figure 1-4 indicates the UXO box dimensions. Figure 1-5 illustrates the survey line plan layout at 6m separation.

The NOR_AO4 OWF UXO boxes central point coordinates (*WGS84 Zone 30N*) are as follows (Table 1):

Table 1: Central point coordinates for the UXO boxes at the NOR_AO4 Offshore windfarm (OWF).

Name	UTM X	UTM Y
GI_01	669495.460	5529336.580
GI_02_A	671892.520	5526337.290
GI_03_A	655776.670	5527308.100
GI_04	658507.490	5530429.060
GI_05	662549.120	5533752.070
GI_06_A	659590.770	5523342.040

Name	UTM X	UTM Y
GI_07	656232.440	5525687.690
GI_08_A	661492.620	5527137.410
GI_09_A	664616.080	5532064.060
GI_10	669938.520	5533467.660
GI_11	672283.990	5535791.460
GI_12	669582.200	5519875.040
GI_13_A	671395.490	5522548.840
GI_14	675316.260	5523870.960
GI_15_A	676827.800	5527534.350
GI_16_A	652573.670	5530872.810
GI_17	657494.910	5520724.710
GI_18_A	660450.550	5520451.410
GI_19	669167.360	5515364.430
GI_20	676566.010	5518625.990
GI_21	678308.690	5521448.150
GI_22	673597.110	5530548.160

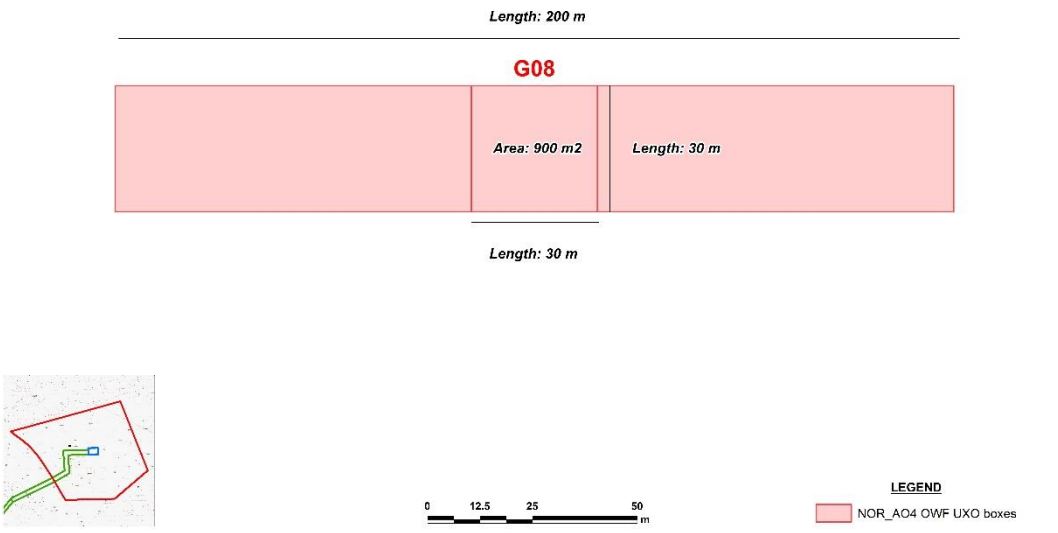


Figure 1-4: Example of UXO box dimensions at the NOR_AO4 Offshore windfarm (OWF).

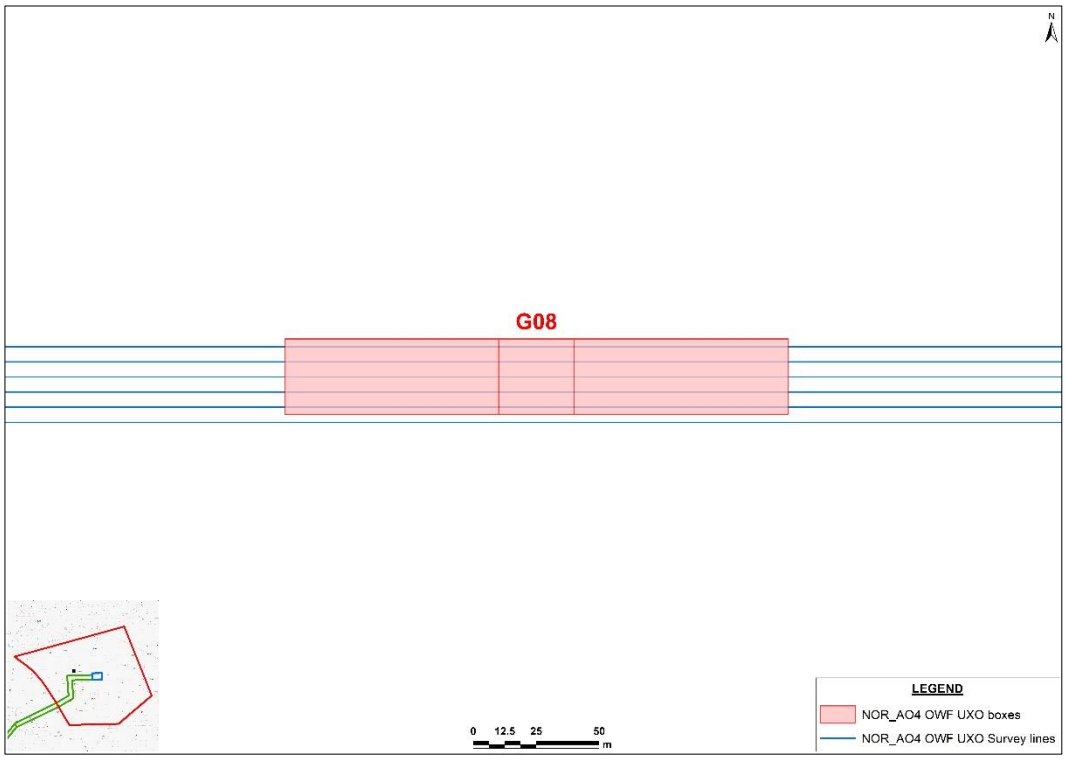


Figure 1-5: Example of UXO box survey line plan at the NOR_AO4 Offshore windfarm (OWF).

1.2. SCOPE OF WORKS

The objective of the site survey was to perform a geophysical and UXO survey over the proposed 22 GI points (Borehole locations) on the OWF site, comprising MBES, SSS and MAG datasets. The purpose of this was to:

- To define the final location of the GI points on the proposed box
- To detect magnetometer anomalies, and side scan and MBES contacts
- To review proposed borehole locations for geohazards

The main purpose of the study was to provide an ALARP certificate for intrusive geotechnical sampling over the NOR_AO4 OWF area.

1.3. GEODETIC PARAMETERS

1.3.1. Survey datum

These parameters are detailed below.

Table 2: Datum parameters table

DATUM	
Survey Datum:	WGS 84
Spheroid	GRS 1980
Semi-Major Axis (a)	6,378,137.000
Semi-Minor Axis (b)	6,356,752.31424
Inverse Flattening (1/f)	1/298.257223563

Table 3: Projection parameters table.

PROJECTION	
Projection	UTM
False Easting	500000
False Northing	0
Latitude of Origin	0º00’00.000000’’
Central Meridian	3º00’00.000000’’
UTM Zone	30 N
Scale Factor on CM	0.9996
Units:	Meters
VERTICAL DATUM	
Chart Datum	Bathyelli v2
Surface of reference	ZH/ell (Zero Hydrographic to the ellipsoid)

1.3.1. Vertical datum

Vertical datum applied in the QINSy navigation software is Bathyelli v2 geoid with zero hydrographic reference surface (ZH).

Le Havre is located in the N.CP-15 station, which is the reference station of the Bathyelli geoid model, and which belongs to the levelling network of the French IGN.

In order to transform datasets to LAT it would be necessary to apply a +0.3m offsets with regards to the Bathyelli hydrographic zero located N.CP-15 in Le Havre.

1.3.2. Tidal reduction

To carry out the survey as accurately as possible, Tecnoambiente utilised MarineStar PPP corrections via satellite signal. When using an accurate GNSS system (RTK correction), the tidal corrections are carried out in real-time through Qinsy computations, as shown in Figure 1-6.

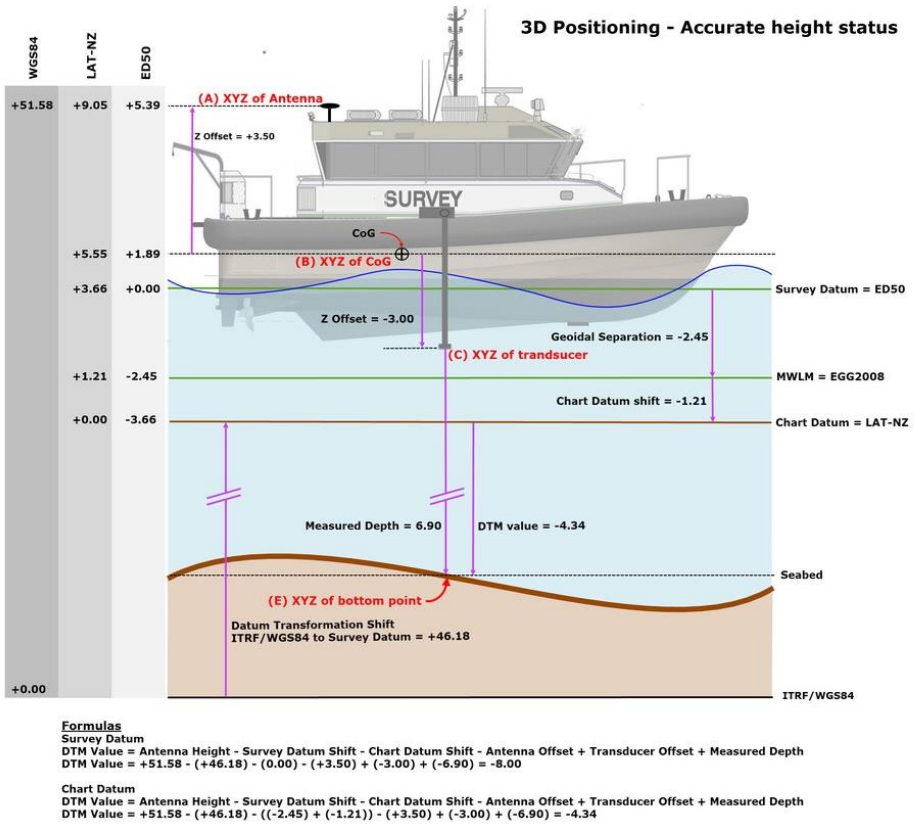


Figure 1-6: Qinsy's method for accurate height calculation.

The separation between WGS84 ellipsoid (GRS80) and the vertical datum is a model called Bathyelli v2, it is a set of surfaces, each of which defines the separation of one vertical datum from the WGS84 ellipsoid. If corrections drop out, they can be applied in post processing.

2. GEOPHYSICAL DATASET

2.1. QA/QC CHECK

The processed values obtained from the onboard processing team during the survey were checked before the ALARP certificate phase. This quality control check of the input data validates the quality of the processing method. Here is the QA/QC for the measurements made:

- QC0: check of the geophysical value
- QC1: Check of the sensor position
- QC2: Check of the altitude of sensor and dynamic coverage
- QC3: Check of the noise
- QC4: Check of the speed and sampling frequency

2.2. SIT SURVEY

The calibration test (SIT) was carried out using ferrous surrogates, weighing 10 kg and 72 kg respectively, in order to be consistent with the historical data (Ref 01) considering the lowest detectable magnetic signal, and the largest ammunition size, such as German airplane- deployed magnetic mines LMA (Luftmine A) and LMB (Luftmine B). This test makes it possible to estimate the precision of the survey positioning, the amplitude of the signal to be sought and the detectability distance.
After mapping an area to make sure it was clear of potential targets, the surrogates were immerged. Several altitudes were utilised to undertake the calibration test above the surrogate: 3 m, 5 m, and 6 m (Figure 2-1). On the 5 and 6 m altitude map, the surrogate of 10 kg was no longer detectable (Ref 05); however, the amplitude of the signal at the 3 m altitude for the 10kg weight was approximately 13nT.

From these SIT data we were able to estimate:

- The uncertainty of the survey at 2.42 m. average (Tables 4 and 5)
- A detection range of 6 m for a ferrous mass greater than 10 kg
- A detection range of 4 m for a ferrous mass of about 10 kg which could correspond to LMA/LMB munitions.

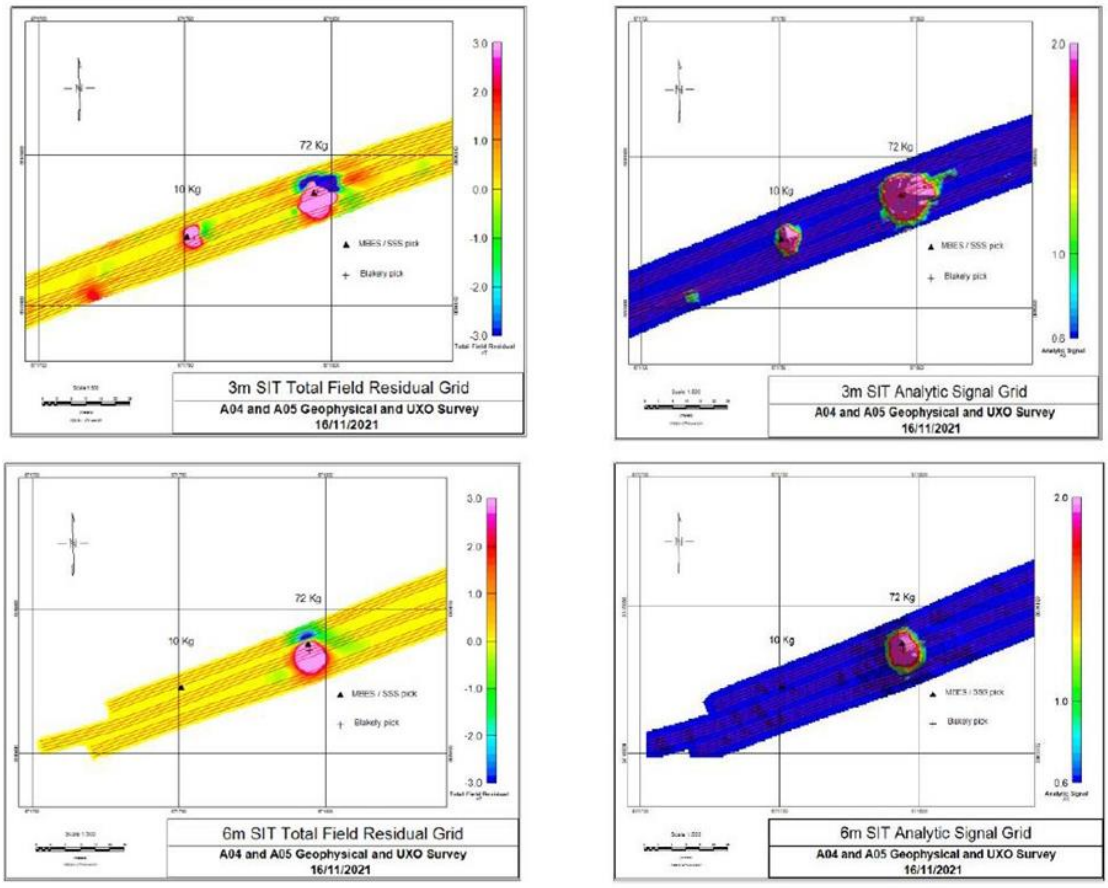


Figure 2-1: Result from the SIT, Residual field, and Analytic signal at 3m and 6 m altitude.

Table 4: Position verification of 10 Kg item.

	Source	Easting (m)	Northing (m)	Δ Easting (m)	Δ Northing (m)	Total Deviation(m)
10 Kg Surrogate Item	SSS position	671750.8	5515622.7	N/A	N/A	N/A
	Blakely test @3m	671753.0	5515622.5	2.3	-0.2	2.3
	Blakely test @5m	N/A	N/A	N/A	N/A	N/A
	Blakely test @6m	N/A	N/A	N/A	N/A	N

Table 5: Position verification of 72 Kg item.

	Source	Easting (m)	Northing (m)	Δ Easting (m)	Δ Northing (m)	Total Deviation(m)
72 Kg Surrogate Item	MBES position	671794.0	5515638.4	N/A	N/A	N/A
	Blakely test @ 3m	671795.5	5515638.0	1.5	-0.4	1.5
	Blakely test @ 5m	671795.0	5515635.5	1.0	-2.9	3.0
	Blakely test @ 6m	671794.5	5515635.5	0.5	-2.9	2.9

Thanks to the SIT trial performed before the data acquisition, it was possible to detect LMA/LMB mines that were laying on the seabed. Depth of burial data for locating buried LMA/LMB mines was found to be inaccurate and was discarded. The very low probability of finding this type of buried target is described in the ALARP certificates.

3. DATA ACQUISITION

3.1. SURVEY ACQUISITION SCHEME

To ensure full coverage of the UXO boxes within the AO4 offshore windfarm area, data acquisition during the survey was carried out as follows:

Table 6: UXO data acquisition scheme information

Methodology	Survey lines	Range
Multibeam echosounder system (MBES)	6 m	75 m
Side Scan Sonar (SSS)		100 m
Gradiometer (MAG)		8 m

The following figure shows the basic data acquisition scheme for the UXO phase.

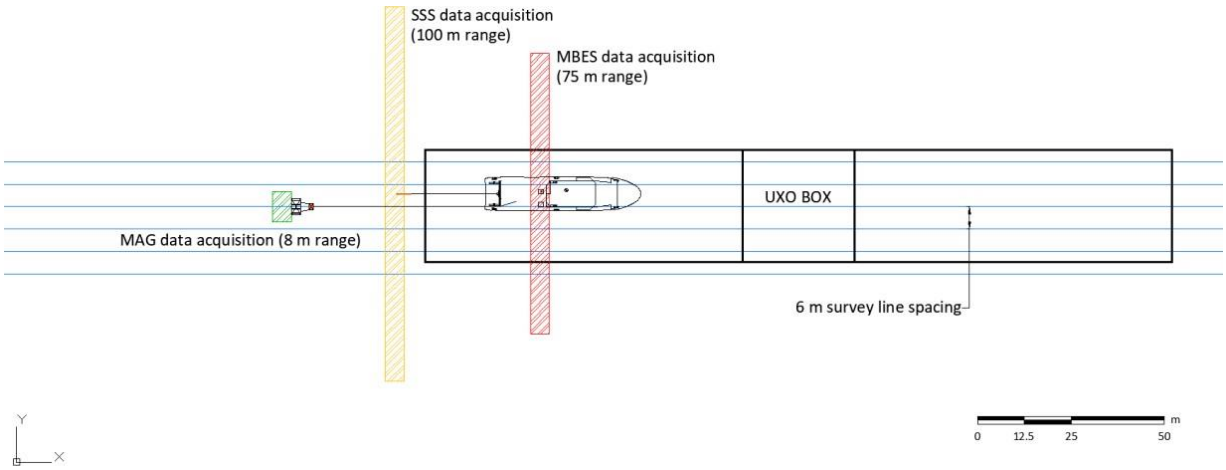


Figure 3-1: UXO data acquisition scheme.

The data acquisition of the three methodologies is performed not only in the target area, but the acquisition is extended to adjacent areas. This is done for two main reasons: on one hand, the line plan covers a larger area as a run-in/run-out zone to stabilize the sensors on the seabed; and on the other hand, to cover a larger area than the target area and thus obtain more data in case the UXO box has to be moved to a quieter area if necessary.

3.2. MULTIBEAM ECHOSOUNDER

The objective of this phase of data acquisition is the detection of possible MBES targets lying on the seabed. Due to the coverage requirements of gradiometer data acquisition, this required total coverage of the seabed within the OWF UXO boxes, and hence a survey line spacing of 6 metres was utilised.

During data acquisition, the vessel's master must follow previously programmed routes along the project lines, shown on the computer screen (Helmsmann indicator). If the actual course deviates from the programmed route by more than a specified amount, or when there is a problem with a peripheral, such as a loss of GPS corrections, the vessel master is warned by the use of visual and audible alarms.

While the master follows the navigation lines, the acquisition module of the hydrography program captures all of the position data sent by the GPS, the raw values of the movement reference unit (Hydrins III) and the heading of the equipment; to correct the location of the soundings sent by the multibeam echosounder. This correction is made for each transmission pulse in real-time.

Parallel to data entry, data acquired by the equipment and peripherals are synchronized. This process is carried out by Qinsy and is complemented by the input of the time and the pulse per second (PPS) provided by the MRU, so that all data is time synchronised.

The guidelines followed by Tecnoambiente during the surveying for MBES data acquisition are as follows:

- IT-CM-36 SVP Deployment Recovery, Rev1.0
- IT-CM-01. Guidelines for Hydrography Project management, 5
- IT-CM-04. Bathymetric survey, 1
- IT-CM-14 Survey Basics Guidance, 1
- IT-CM-15 Online Surveying procedure, 3

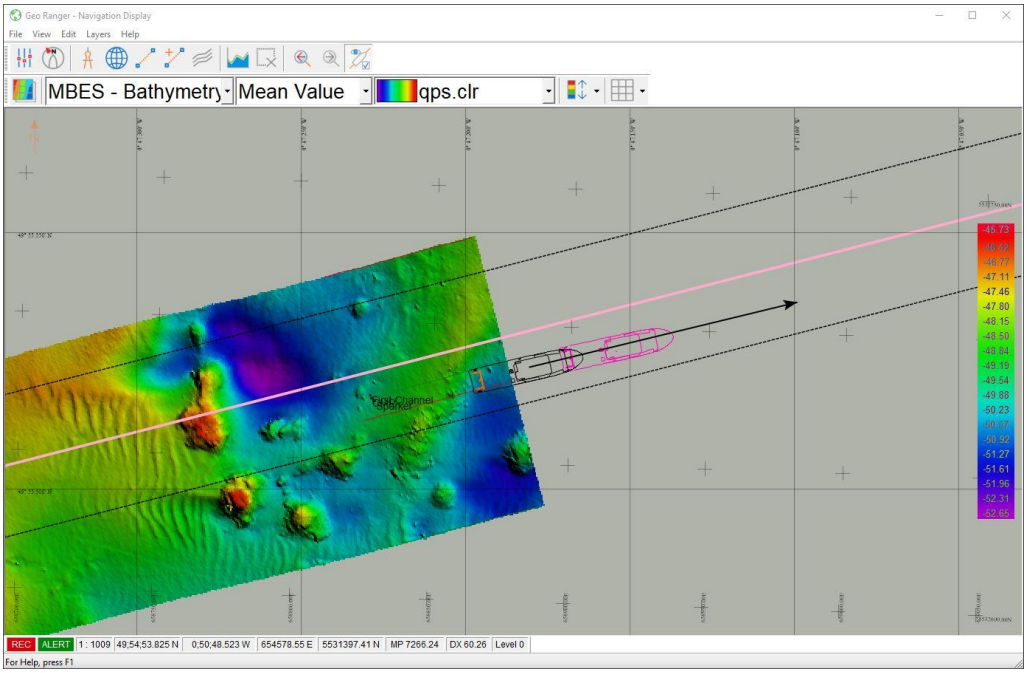


Figure 3-2: MBES bathymetry data acquisition with the Qinsy software.

During data acquisition, limits were applied to reduce soundings noise. These limits in the recording correspond to static gates of the equipment software that reduce the acquired registers noise, in accordance with statistical calculations of vertical uncertainty.

During the processing phase of acquired data, the lines on the screen are processed, in order to manually correct any noise that appears in the records. Noise is produced by multiple factors such as, multipath in position, air bubbles, cetaceans, motor interference from the vessel, etc., in the digital register of soundings. To make certain of the complete removal of any noise in the soundings, spike filters and spline filters were applied.

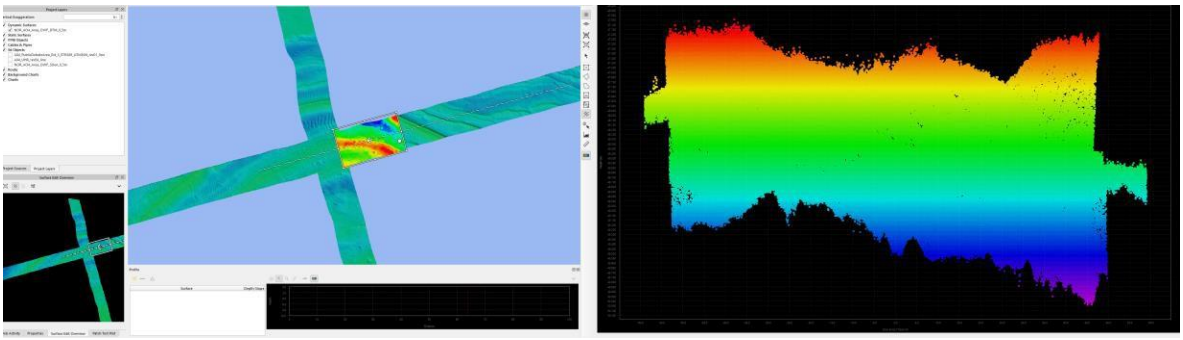


Figure 3-3: Processing screen of MBES bathymetry data with the Qimera software.

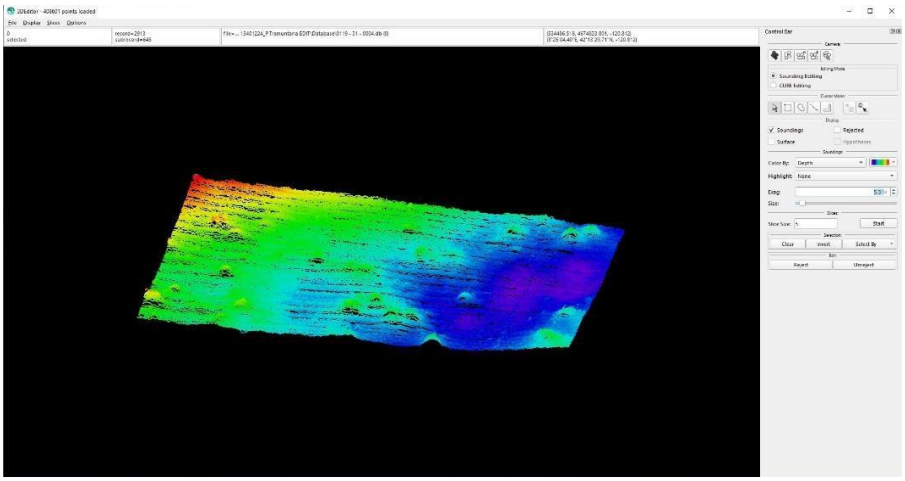


Figure 3-4: 3D image of the MBES bathymetry processing.

Once any possible existing errors in the records were deleted, a digital model of the terrain with 0.1 x 0.1 m grid size was produced, with a minimum cell size to obtain the maximum resolution of the seabed.

Digital terrain models (DTM) are created in Qimera. Once done, the DTM's are exported as 32bits RGB Geotiff, for each of the UXO boxes.

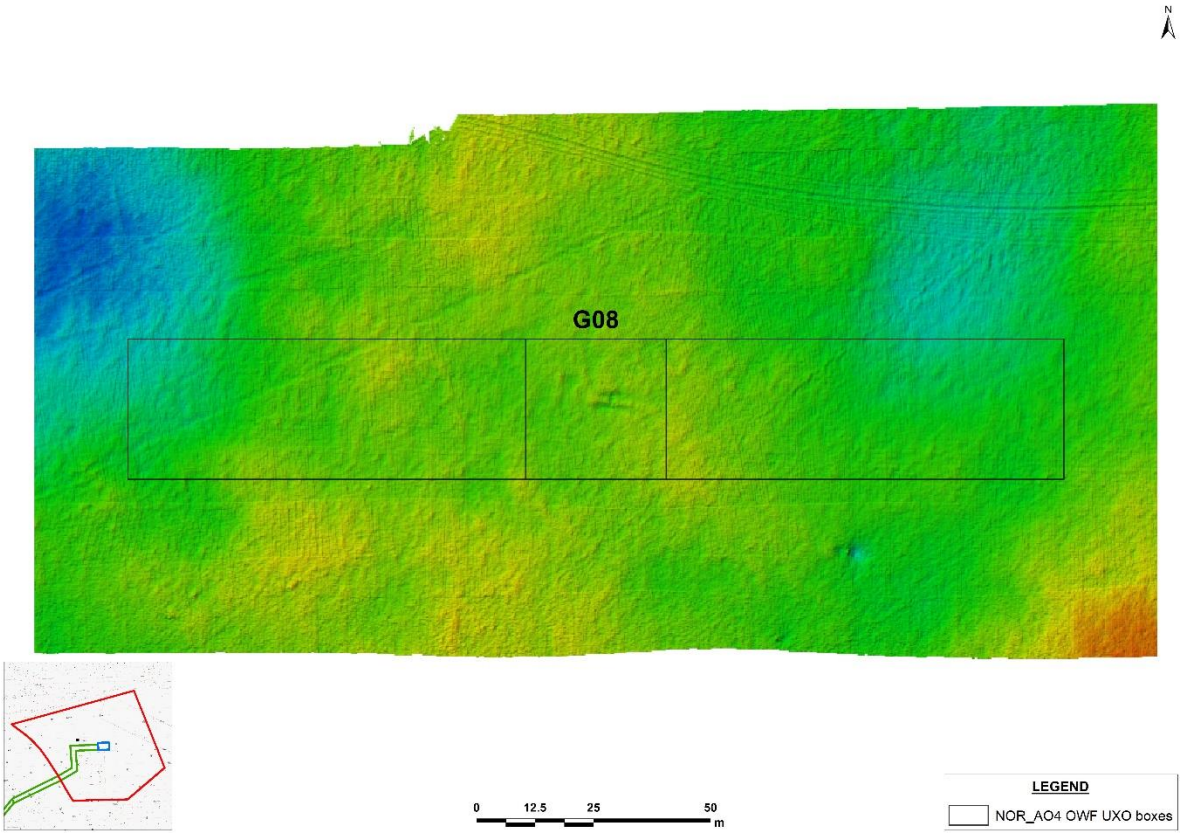


Figure 3-5: Example of the bathymetric data for NOR_AO4 OWF.

3.3. SIDE SCAN SONAR – UXO SURVEY

The objective of this phase of data acquisition is the detection of possible sonar targets lying on the seabed. Due to the coverage requirements of gradiometer data acquisition, this required total coverage of the seabed within the UXO boxes, and hence a survey line spacing of 6 metres was utilised.

A side scan sonar system comprises a processing unit connected through a cable to a wet unit that transmits and receives acoustic energy. Side scan sonar can determine seabed morphology and configuration by means of acoustic signals. It can also determine its composition, identifying different seabed strata as hard (rocky or consolidated), soft or sedimentary, as well as identifying areas of seagrass.

Side scan sonar systems can work in different frequency ranges: systems working in high frequencies, (between 500 kHz and 900kHz) offer higher resolution but lower ranges, with systems working in low frequencies (100 kHz), offer lower resolution but higher ranges. For this survey, a frequency of 900KHz was utilised. The reflection of the signal coming from the seabed is detected by the same transducers, amplified and transmitted to the control unit, and recorded and displayed on the computer screen, providing an acoustic map. With this data, it is possible to identify different seabed morphologies, together with the visualization of any seabed objects.

When the vessel is underway, the winch operator can start deploying cable until the fish gets to the desired working depth of about 6 m above the seabed.

The guidelines followed by Tecnoambiente during the surveying for SSS data acquisition are:

- IT-CM-01. SBL-SSS,1
- IT-CM-21. SSS Launch and Recovery, 0
- IT-CM-13. Geophysical Data Acquisition. General Procedure, 2
- IT-CM-14. Survey Basics Guidance, 0
- IT-CM-15. Online Surveying procedure, 3
- IT-CM-18. USBL Pole Deployment, 1

Once the SSS data were acquired and then exported into JSF format, the files are imported into the SonarWiz 7 software. Channels 3 and 4 were used for recording the high frequency data.

After data importation into the SonarWiz 7 software, an initial navigation correction was made for each imported file, applying smoothing filters to avoid errors in the heading of the tow fish. The track position was smoothed using a mean value of 300 pings.

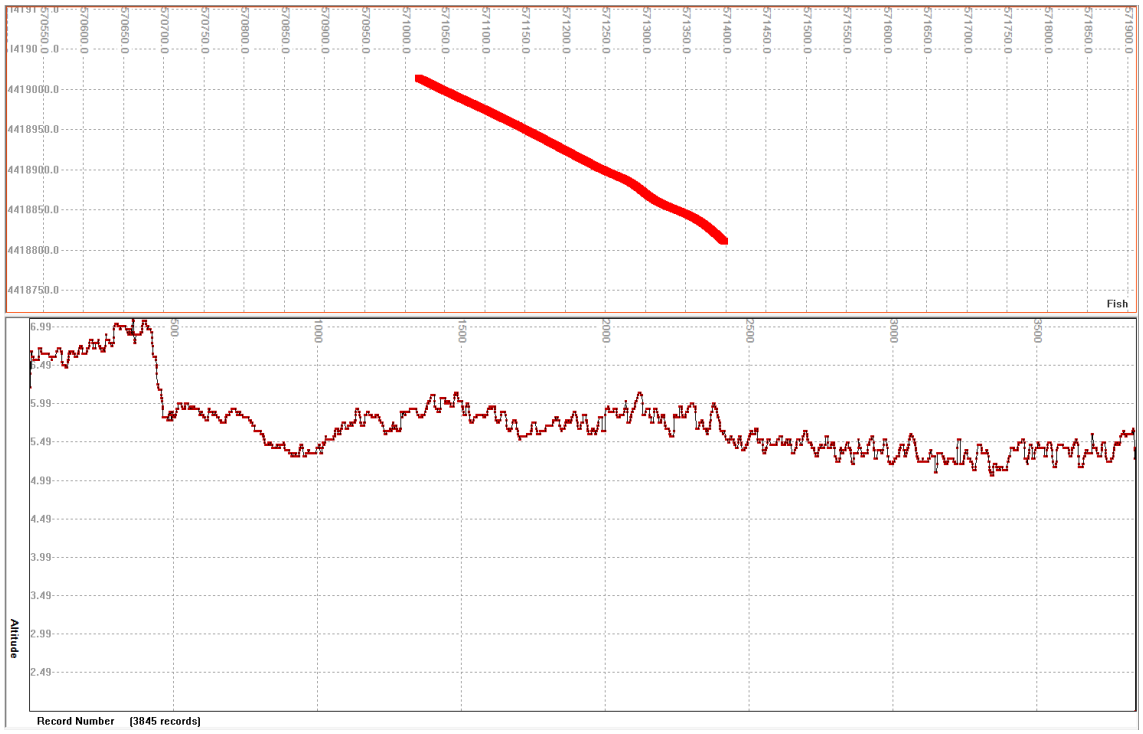


Figure 3-6: Navigation editor in SonarWiz 7.

After the aforementioned corrections were implemented, the water column for each file was eliminated, by applying the bottom-tracking acquired during the survey, as shown in Figure 3-7. If bottom-tracking of the tow fish failed during the survey, it was done automatically by applying filters or by drawing the seabed manually during post-processing. This enables slant range corrections for the digital data to be as accurate as possible.

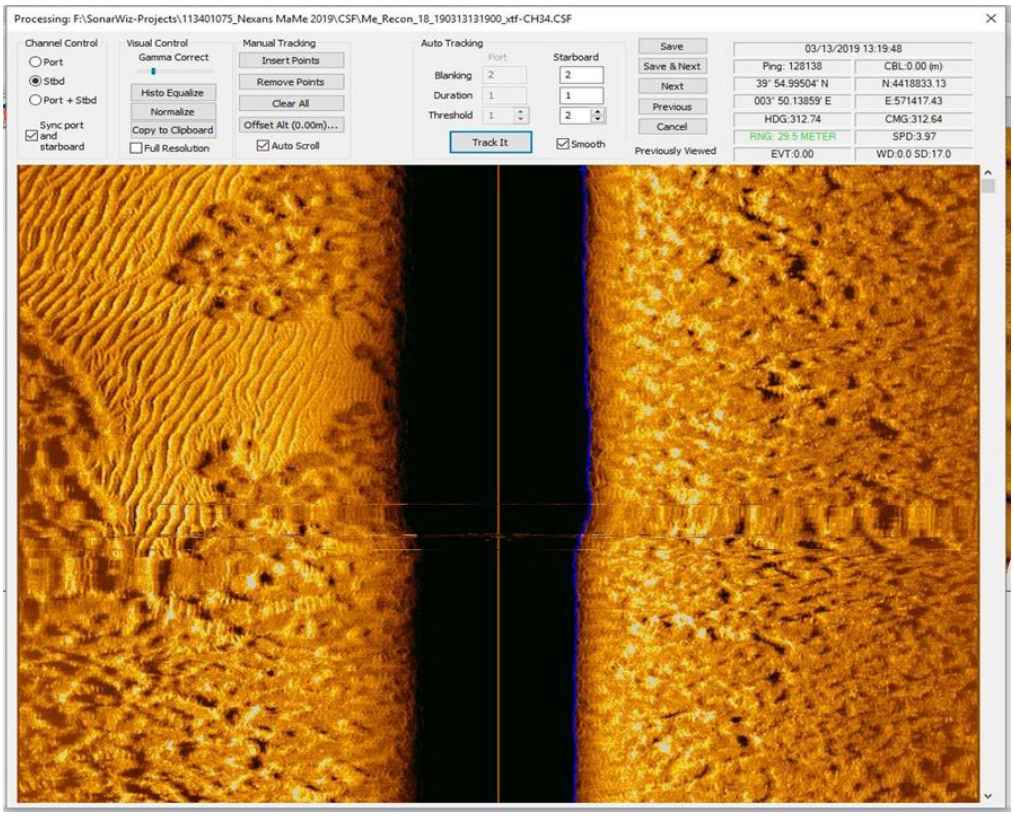


Figure 3-7: Bottom tracking processing drawn in blue in the SonarWiz software.

The following steps during SSS processing in the SonarWiz 7 software are the application and enabling of the EGN filter, and the enabling of the de-stripe filter.

At this point during data processing, a processed MBES geotiff is imported into the project. Using the MBES information, rotations to the SSS file are applied, in order to match feature orientations seen in the MBES data. Where necessary, a move offset can be applied to the SSS file, in order to match features within the MBES data.

Any observable contact within the area of interest is picked and its dimensions are measured.
The final processing step is the export of the sonar files into a GIS software package, where all of the information is integrated, and a sonar mosaic is generated. This is carried out by converting the JSF files into 32bits RGB Geotiff images, to obtain georeferenced images of the processed data, with a resolution of 0.1 m.

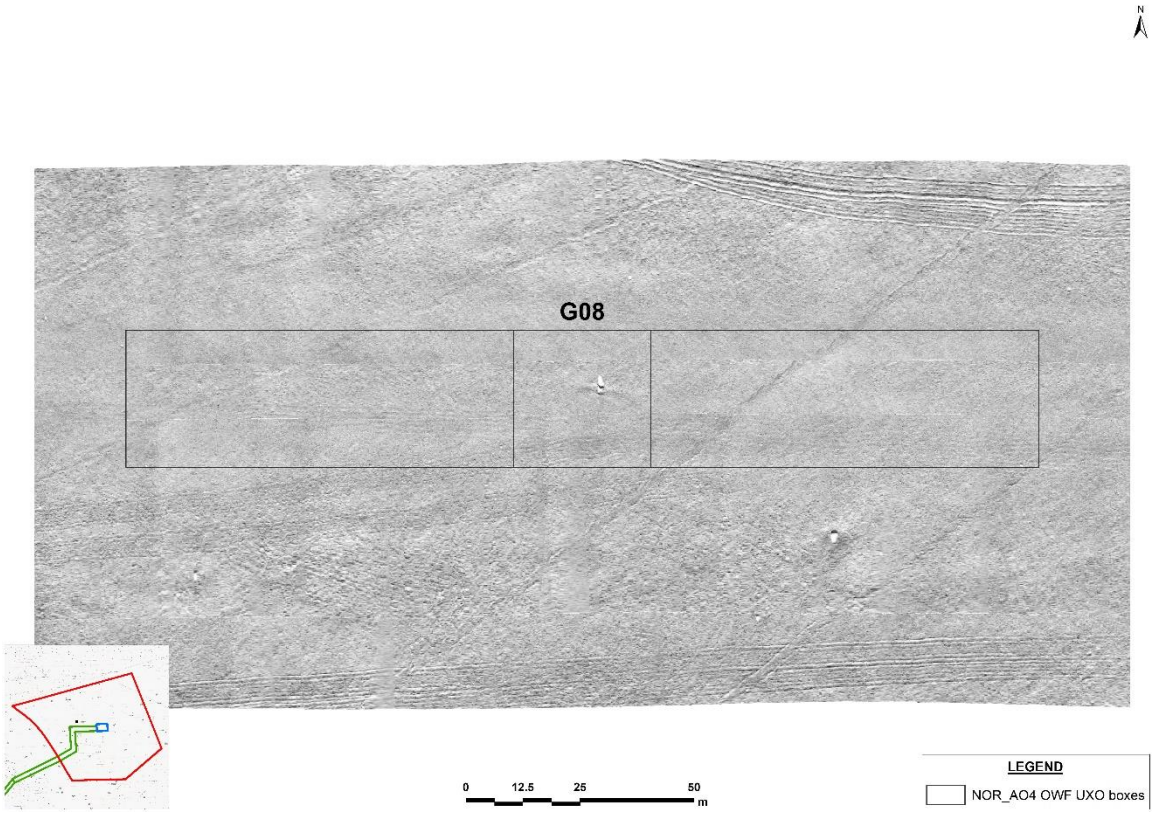


Figure 3-8: Example of the side scan sonar data for NOR_AO4 OWF.

The guidelines followed by Tecnoambiente during the surveying for SSS data processing are:

- IT-CM-01. SBL-SSS,1
- IT-CM-27. SSS Processing procedure, 0

3.4. GRADIOMETER – UXO SURVEY

Magnetometer data were recorded using four Geometrics G-882 magnetometers fitted in a custom frame and spaced 1.1 metres apart, horizontally. Survey line spacing was set at 6 metres. The frame has an automated bottom tracking function, allowing it to keep a fixed height above the seabed. After merging in Qinsy, all raw data were timestamped, and output as TXT files were recorded for each magnetometer (Mag 1, Mag 2, Mag 3, and Mag 4).

Figure 3-9: ROTV with the fixed frame system for MAG acquisition.

The guidelines followed by Tecnoambiente during the surveying for MAG-UXO data acquisition are:

- IT-CM-25. UXO Mooring Procedures,0
- IT-CM-18. USBL Pole Deployment, 1
- IT-CM-26. UXO Scanfish Launch and Recovery, 0

Data was processed using UXO Marine Mag module from OASIS software.

Positioning and altitude data were corrected to eliminate outliers (despiked), then filtered, and smoothed. Incorrect positions were removed, and the positions were filtered using a non-linear filter. All altitudes greater than 4 m were removed from the database.

The magnetometer data were corrected to eliminate aberrant values (“despiking”). They were also interpolated, but were also slightly smoothed, so as not to lose the weaker components of the signal.

The magnetometer values were then processed, in order to compensate for variations in the altitude of the fish (increase in the signal when the magnetometer approaches the seabed). The magnetometer values were recalculated at a constant virtual altitude of 3 m above the seabed. The altitudes were smoothed, using a B-Spline filter. Processed positions and altitudes were then exported, to calculate dynamic coverage.

Finally, the long-wavelength component of the Earth's magnetic field was calculated using several successive non-linear filters. This long wavelength component includes diurnal variations, geological variations, and noise, as well as the International Geomagnetic Reference Field (IGRF). This was then eliminated from the data set, resulting in a residual component, comprising primarily anthropogenic magnetic anomalies.

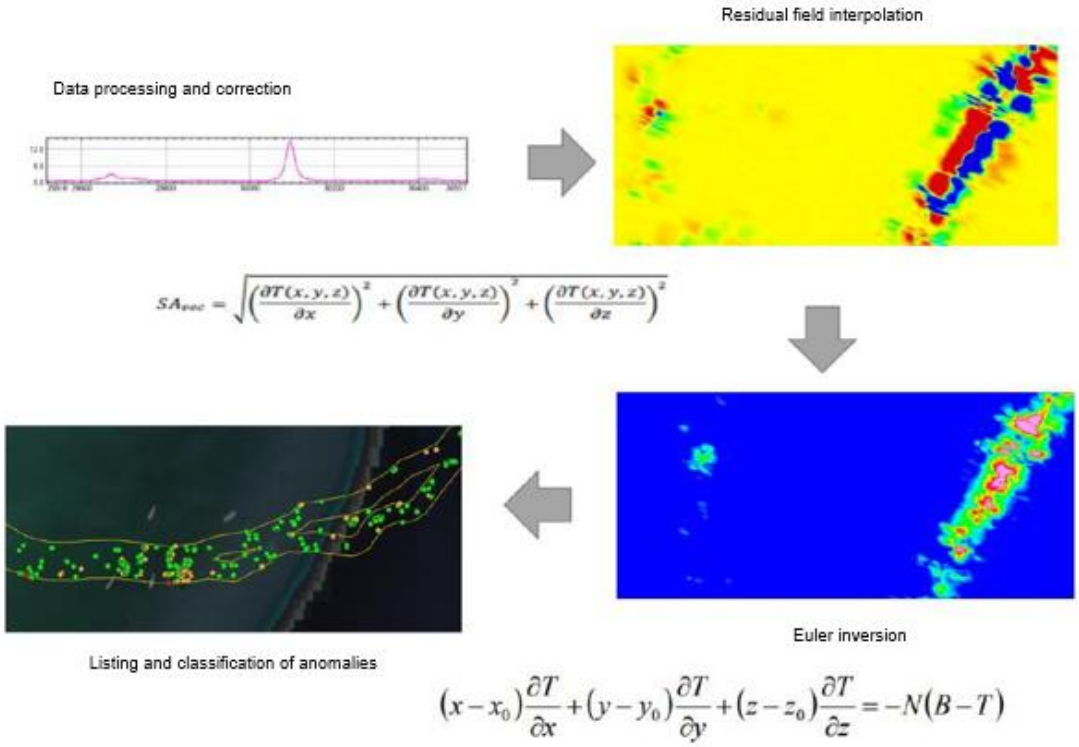


Figure 3-10: Processing workflow of magnetometer data.

A 2D map of the magnetic anomalies within the survey area was produced by interpolating these data, using a 0.25 m grid and 5 m blanking distance. The amplitude of the analytic signal was calculated using a 3D grid. The analytic signal is utilized for the mapping of structures and for the more precise positioning of any targets.

The results of the magnetometric measurements are included as two maps:

- A map of the residual magnetic field (in nT)
- A map of the analytical signal (in nT/m)

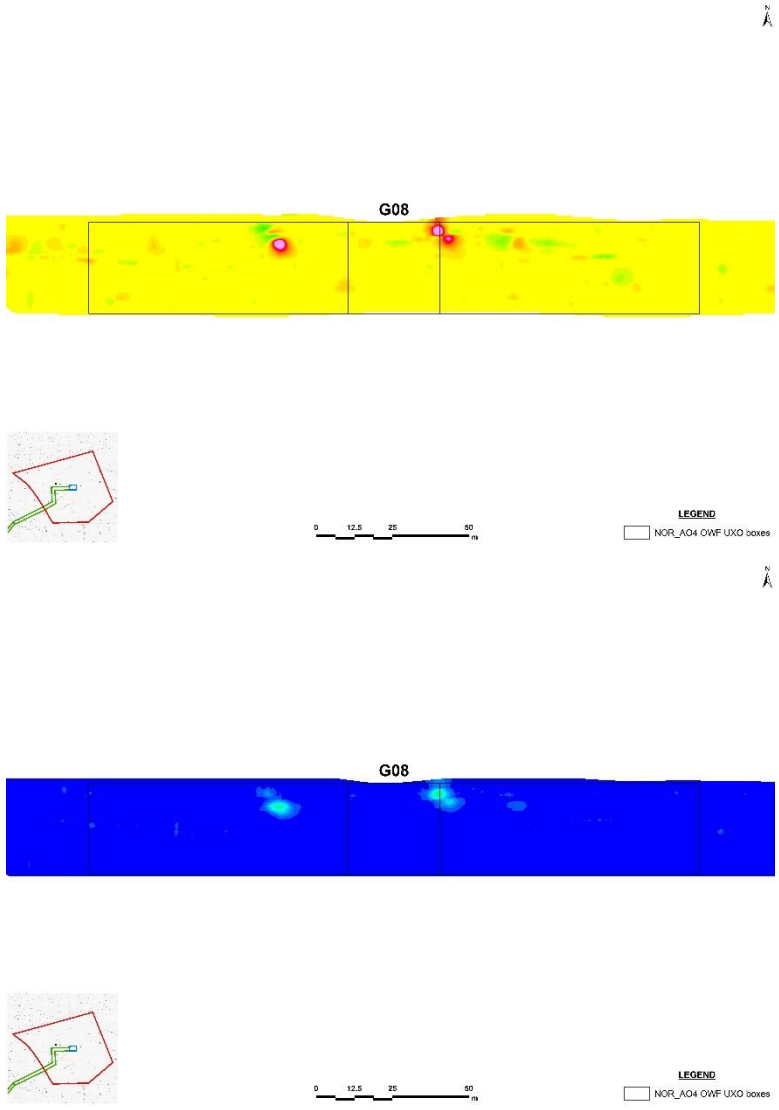


Figure 3-11: Example of the maps of the residual field and the analytic signal for NOR_AO4 OWF.

The magnetometer coverage depended on the spacing width of the surveyed lines and the height above seabed of the measuring device, making it possible to ensure the detection of an object at any point, by knowing the distance between the measuring sensor and the object. The requirements of the Scope of Work were met throughout the surveyed areas, i.e. detection of a 25 kg ferrous mass at a depth of 2 m and a maximum detection distance of 6 m (*Penella 1982*).

The dynamic coverage was calculated for a detection range (Δ) determined by the mass of the smallest object we were looking for and the depth below seabed of the soil intrusive activity.

The detection radius (d) under sensor was then calculated for each point with the formula:

$$d = \sqrt{\Delta^2 - (alt + DBSF)^2}$$

Where:

Δ = Detection range

DBSF= Depth below seafloor

alt= Altitude of sensor

For the detection range of 6 m and depth of 2 m defined for this survey, the formula is defined as follows:

$$d = \sqrt{6^2 - (alt + 2)^2}$$

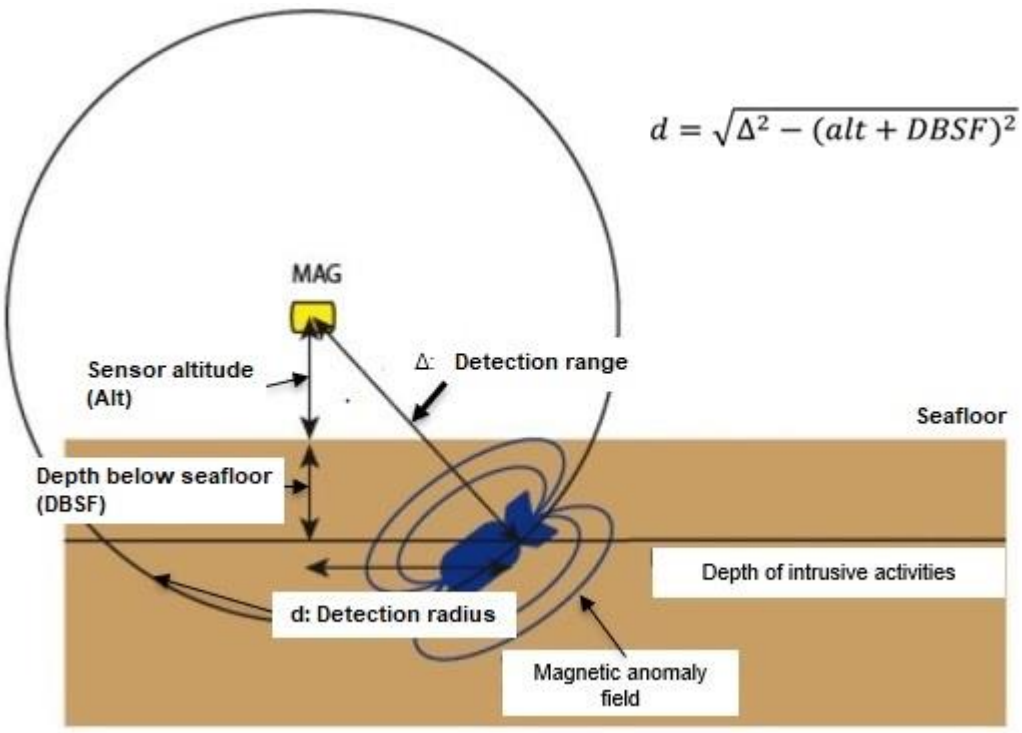


Figure 3-12:.Dynamic coverage calculations.

This means that for each point of data, a circle of detection with radius d is drawn around this point. The data were opened within a GIS software package (QGIS). Drawing these circles in the GIS software, using a buffer of detection ranges, enables us to map the detection coverage and identify any data gaps.

4. RESULTS

4.1. COVERAGE AREA

The survey took place over 22 GI boxes, for a magnetometer coverage of 188,794 m^2 (Table 7).

Table 7: Magnetometer coverage area (centroid of the GI box).

BOX	MAGNETOMETER SURVEY AREA WITH 100% DYNAMIC COVERAGE (m^2)
A04_G01	8567
A04_G02	8821
A04_G03	8420
A04_G04	8463
A04_G05	8570
A04_G06	8470
A04_G07	8592
A04_G08	8614
A04_G09	8625
A04_G10	8751
A04_G11	9381
A04_G12	8310
A04_G13	8797
A04_G14	8255
A04_G15	9379
A04_G16	8449
A04_G17	8020
A04_G18	8822
A04_G19	8518
A04_G20	8162
A04_G21	8353
A04_G22	8455
TOTAL	188,794

4.2. ANOMALY PICKING

4.2.1. Magnetic anomalies

Visualization of the residual field map (in nT) makes it possible to locate any dipole anomalies present. The map analysis threshold (sensitivity of the display via the adjustment of the colour scale) is very important to validate the interpretation. By gradually decreasing the analysis threshold, it is possible to image anomalies of lower intensity. After analysis of the data, anomalies were manually picked, using the colour scale presented in Figure 4-1.

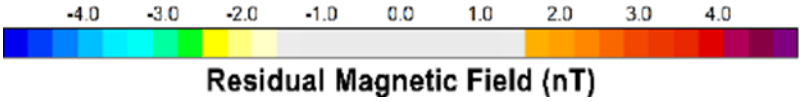


Figure 4-1: Colour scale and threshold used for analysis of magnetic anomalies.

Anomalies were also detected automatically from the analytical signal grid, with a 1.0 nT/m threshold (grid value cut-off of 1nT/m).

A total of one hundred and seventy-seven (177) magnetic anomalies were detected within the OWF survey area (listings are provided in in Appendix I).

4.2.2. MBES and side scan sonar contacts

MBES and side scan sonar contacts were picked within a 15 m radius of the centres of each of the GI boxes. Fifty-one (51) side scan sonar contacts and sixteen (16) MBES contacts were detected in the dataset (Listings in Appendix II and III).

4.3. DISCRIMINATION OF pUXO TARGETS

Magnetic anomalies indicate the presence of ferrous elements at or below the seabed. This is true for most types of unexploded ordnance (UXO), with the exception of the aluminium LMB.

Any magnetic anomaly can therefore correspond to a potential UXO

The historical study shows a proven risk of LMA/LMB for the AO4 region. These objects are weakly magnetic and can be considered as the equivalent of a 10 kg iron weight. This is the reason that this weight of ferrous mass was considered, during the preparation of the SIT. Consequently, the LMA/LMB risk is currently considered at seabed level, both by magnetometer detectability (about 13nT) and by the analysis of side scan sonar and MBES images.

Therefore:

- Any side scan sonar and MBES contact with a magnetic signature are considered as pUXO.
- Shape and length of side scan sonar and MBES data were analysed carefully for discrimination as non-UXO.
- Side scan sonar and MBES contacts without magnetic signatures and without any corresponding shape and length criteria are considered as non-UXO. But as these contacts correspond to potential obstructions on the seabed, they were mapped without any avoidance area indicated on the ALARP certificate maps.

5. AVOIDANCE DISTANCES

Following the analysis, we are looking for as low as reasonably practicable (ALARP), areas that can be considered clear of any pUXO. The avoidance criteria have been defined following the UXO threat and risk assessment, with geotechnical investigation risk mitigation strategy recognised and desktop studies (Ref. 01):

Thus, the avoidance distance can be calculated as follows (Figure 5-1):

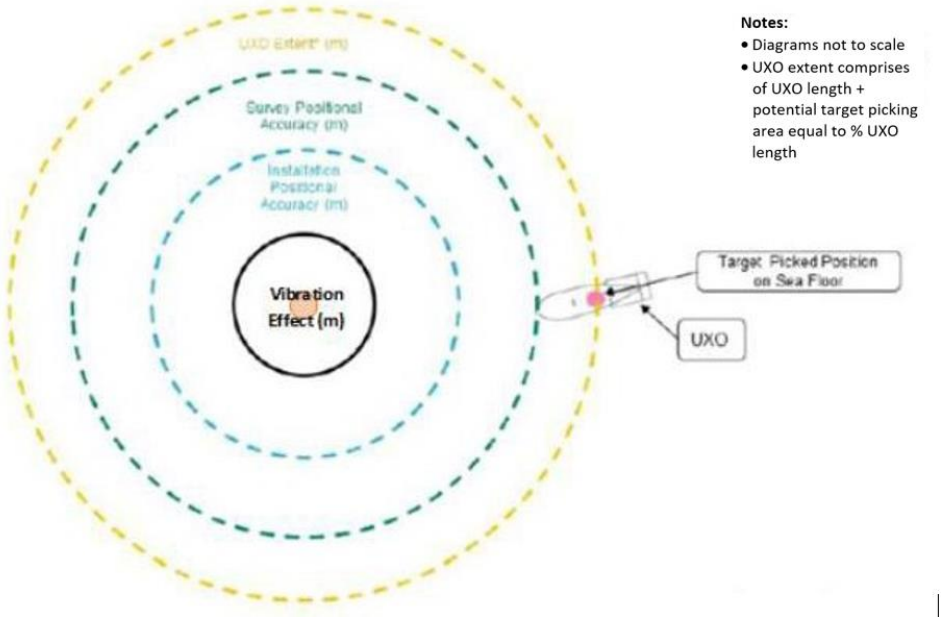


Figure 5-1: Avoidance distances.

Avoidance distance = Geotechnical tool width + Vibration effect distance + Geotechnical tool positioning accuracy + UXO survey accuracy + Ammunition length

The effect of the generation of seismic waves during vibro-driving or pile driving has to be considered in the case of geotechnical drilling or pile driving. These machines generate a wide variety of seismic waves (pressure, Rayleigh, shear) (Study report DRS17-164706-11171B, INERIS) that can trigger UXO detonation. This effect need not be considered for other geotechnical work, such as jack up or anchor installation.

For the OWF area, the 15 m buffer was applied as an avoidance distance, in accordance with the document delivered by 6 Alpha Associates Limited (Ref. 01).

A safety buffer of 15m is to be employed from any isolated magnetic anomaly.

This was achieved through geospatial processing by QGIS software.

Firstly, the areas that could not be considered as clear of any pUXO are mapped, grouping the pUXO targets (magnetic anomalies and/or sonar and MBES contacts) and potential saturated areas. Afterwards, the “avoidance areas” were mapped with an avoidance zone of 15 metres (a 15 m safety buffer around the anomaly) away from all the potential UXO (pUXO) anomalies, or any saturated or excluded areas. This avoidance area was also applied from the edge of the dataset inwards, towards the centre of the survey area.

The free space between these avoidance areas and the detection surface and the survey limits was then mapped, and a workable area was obtained. This defined the outline of the ALARP certificate (Figure 5-2).

When no ALARP zone was identified (Figure 5-3), an alternative location for the GI box was proposed.

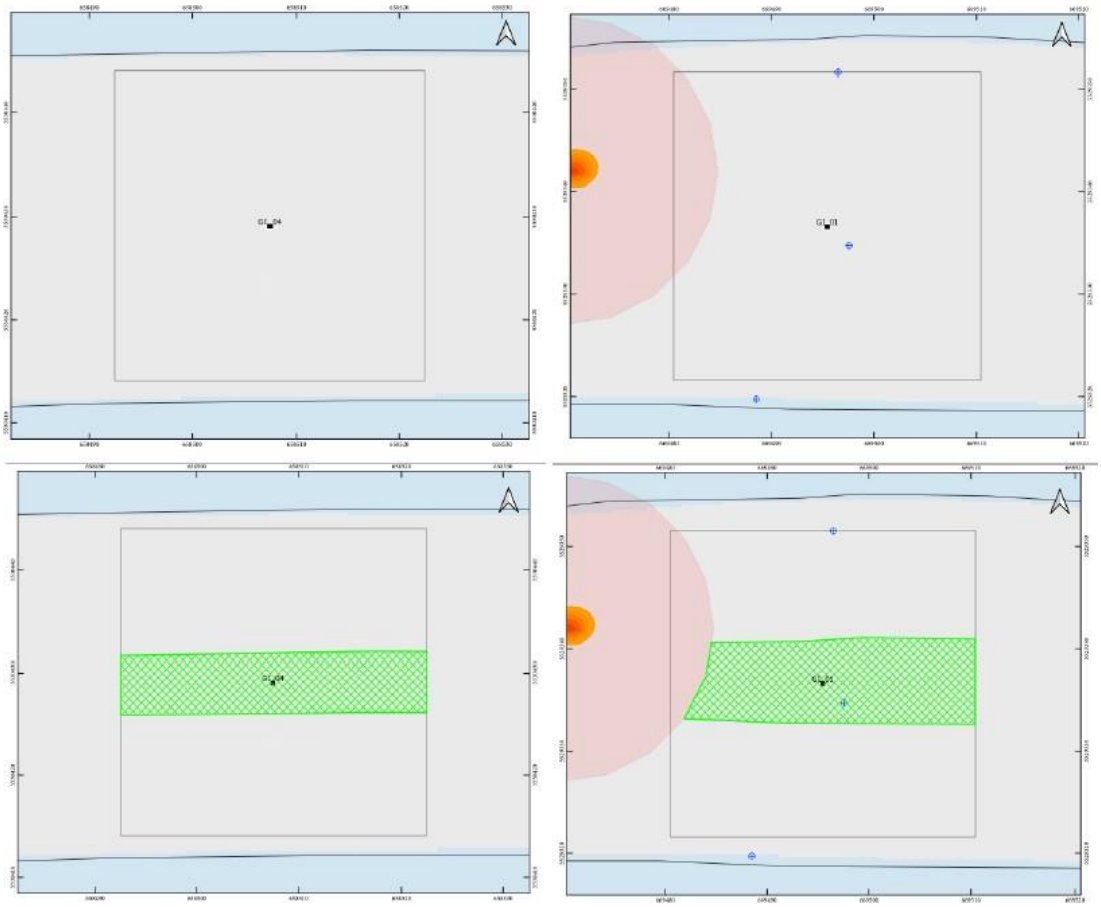


Figure 5-2: Case where the GI boxes location is not impacted or little impacted by avoidance areas: an ALARP zone is defined (in green).

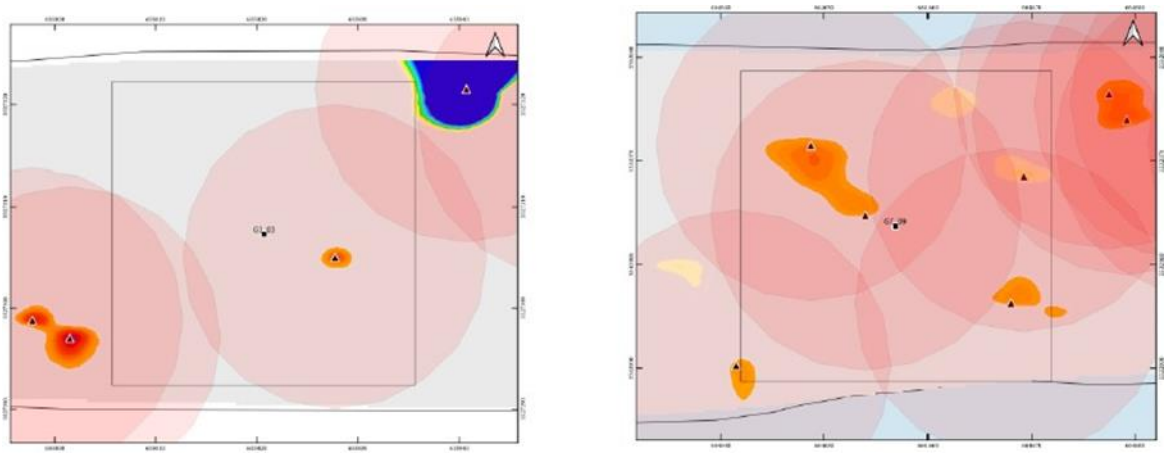


Figure 5-3: Case where the GI boxes location is largely or completely impacted by avoidance areas and no ALARP zone can be defined.

Figure 5-4: Legend of the ALARP maps.

6. CONCLUSION

ALARP areas totalling 4,208 m^2 were identified for the 22 GI locations. Nine proposed GI positions require alternative locations. These alternative locations are indicated in grey in Table 8.

Table 8: Final ALARP workable areas and GI box location.

ID	GI BOX	EASTING	NORTHING	WORKABLE AREA (m^2)
1	GI_01	669495.46	5529336.58	219
2	GI_02_A	671892.52	5526337.29	164
3	GI_03_A	655776.67	5527308.10	77
4	GI_04	658507.49	5530429.06	175
5	GI_05	662549.12	5533752.07	208
6	GI_06_A	659590.77	5523342.04	190
7	GI_07	656232.44	5525687.69	207
8	GI_08_A	661492.62	5527137.41	164
9	GI_09_A	664616.08	5532064.06	235
10	GI_10	669938.52	5533467.66	251
11	GI_11	672283.99	5535791.46	302
12	GI_12	669582.20	5519875.04	134
13	GI_13_A	671395.49	5522548.84	193
14	GI_14	675316.26	5523870.96	126
15	GI_15_A	676827.80	5527534.35	294
16	GI_16_A	652573.67	5530872.81	156
17	GI_17	657494.91	5520724.71	94
18	GI_18_A	660450.55	5520451.41	266
19	GI_19	669167.36	5515364.43	210
20	GI_20	676566.01	5518625.99	147
21	GI_21	678308.69	5521448.15	169
22	GI_22	673597.11	5530548.16	227
TOTAL				4,208

REFERENCES

In accordance with:

- Letter the “Inspection des poudres et explosifs” of the French Ministry of Defence and the “Direction générale du Travail” of the French Ministry of Labour of September18th, 2013, relating to pyrotechnic clearance carried out on civil land.
- Decree No. 2014-381 of March 28, 2014, regulatory part Art. R.733-1 to 16 and legislative part Art. L. 733-1 to 3.

In reference to:

- Decree No. 2005-1325 of October 26, 2005, amended from the Ministry of Defencerelating to the safety rules applicable during work in the context of a pyrotechnic clearance site and the two implementing decrees.

Ref.01. Unexploded Ordnance Threat and Risk Assessment with Geotechnical Investigation Risk Mitigation Strategy: 8492_1_A04Normandy_DNGVL_UXO_TARA_with_RMS_Client Draft_V3.0

Ref.02. Project AO4 De-risk Surveys Scope Of Work: SOS-01 - Scope Of Service AO4

Ref.03. Employer’s Requirements Marine Operations: SVY-ERS-03 – Survey Specification

Ref.04. Specification for UXO Survey Verification Test RTE Export Cables: ERS-03-A –SVT Specification

Ref.05. UXO Surrogate Items report: SIT report – AO4 and A05 geophysical and UXO survey.

Ref.06. NOR_AO4 Area - Seismic, geophysical and UXO survey - Mobilization Report: NOR_TEC_21_Mob report - AO4 survey area_ 0.2

Ref.07. NOR-AO4-UXO survey -Operational Report

Pennella 1982 Magnetometer techniques in the detection of projectiles Final Report, TR239, Naval explosive ordnance technology center

Rapport d'étude DRS 17-164706-11171-B, Impact des vibrations sur la stabilité descarrières souterraines, INERIS, 2017.

APPENDIX I – LIST OF THE MAGNETIC ANOMALIES DETECTED

Nb	TARGET_ID	X (M)	Y (M)	SA (nT/m)	Box	STATUS
1	AO4_G10_2	669893.50	5533458.75	3.37	AO4_G10	pUXO
2	AO4_G10_4	669984.75	5533467.50	3	AO4_G10	pUXO
3	AO4_G10_7	669913.25	5533476.50	10.5	AO4_G10	pUXO
4	AO4_G02_2	672000.75	5526328.00	2.66	AO4_G02	pUXO
5	AO4_G02_4	671966.25	5526330.00	1.2	AO4_G02	pUXO
6	AO4_G02_5	671947.00	5526332.25	1.62	AO4_G02	pUXO
7	AO4_G02_8	672003.00	5526337.25	1.94	AO4_G02	pUXO
8	AO4_G02_10	671954.50	5526339.00	1.22	AO4_G02	pUXO
9	AO4_G02_11	671966.75	5526339.00	1.51	AO4_G02	pUXO
10	AO4_G02_21	671875.25	5526344.00	1.77	AO4_G02	pUXO
11	AO4_G02_24	671995.25	5526344.50	4.99	AO4_G02	pUXO
12	AO4_G02_30	671939.75	5526347.75	1.85	AO4_G02	pUXO
13	AO4_G02_35	671968.25	5526347.75	1.28	AO4_G02	pUXO
14	AO4_G02_41	671991.75	5526349.00	16.38	AO4_G02	pUXO
15	AO4_G02_43	671927.50	5526350.25	1.32	AO4_G02	pUXO
16	AO4_G02_47	671966.77	5526350.88	0.9	AO4_G02	pUXO
17	AO4_G02_48	671963.64	5526336.58	0.88	AO4_G02	pUXO
18	AO4_G02_50	671819.70	5526354.18	0.99	AO4_G02	pUXO
19	AO4_G12_12	669641.50	5519863.50	17.73	AO4_G12	pUXO
20	AO4_G12_14	669670.50	5519863.50	2.77	AO4_G12	pUXO
21	AO4_G12_21	669697.00	5519864.00	11.52	AO4_G12	pUXO
22	AO4_G12_27	669635.25	5519864.50	13.19	AO4_G12	pUXO
23	AO4_G12_29	669701.25	5519864.75	12.5	AO4_G12	pUXO
24	AO4_G12_33	669686.25	5519865.25	6.09	AO4_G12	pUXO
25	AO4_G12_34	669628.25	5519865.50	16.04	AO4_G12	pUXO
26	AO4_G12_42	669665.25	5519865.75	5.44	AO4_G12	pUXO
27	AO4_G12_45	669633.00	5519866.75	4.01	AO4_G12	pUXO
28	AO4_G12_55	669682.25	5519867.25	1.71	AO4_G12	pUXO
29	AO4_G12_56	669695.50	5519868.25	5.09	AO4_G12	pUXO
30	AO4_G12_58	669538.75	5519869.50	1.64	AO4_G12	pUXO
31	AO4_G12_60	669534.50	5519874.50	1.68	AO4_G12	pUXO
32	AO4_G12_61	669558.00	5519877.00	1.66	AO4_G12	pUXO
33	AO4_G12_62	669641.50	5519877.50	1.15	AO4_G12	pUXO

Nb	TARGET_ID	X (M)	Y (M)	SA (nT/m)	Box	STATUS
34	AO4_G12_63	669517.00	5519877.75	1.17	AO4_G12	pUXO
35	AO4_G12_64	669648.75	5519878.00	1.09	AO4_G12	pUXO
36	AO4_G12_66	669617.25	5519880.00	1.06	AO4_G12	pUXO
37	AO4_G12_70	669522.25	5519884.25	1.27	AO4_G12	pUXO
38	AO4_G12_71	669535.00	5519885.25	1.14	AO4_G12	pUXO
39	AO4_G12_72	669502.75	5519886.00	1.13	AO4_G12	pUXO
40	AO4_G12_76	669692.25	5519887.25	1.51	AO4_G12	pUXO
41	AO4_G12_77	669700.75	5519887.25	1.41	AO4_G12	pUXO
42	AO4_G12_78	669600.50	5519888.50	1.01	AO4_G12	pUXO
43	AO4_G12_80	669679.93	5519881.12	0.67	AO4_G12	pUXO
44	AO4_G12_81	669665.25	5519891.16	0.79	AO4_G12	pUXO
45	AO4_G12_89	669462.97	5519886.72	0.99	AO4_G12	pUXO
46	AO4_G12_92	669508.84	5519884.53	0.81	AO4_G12	pUXO
47	AO4_G13_2	671416.75	5522534.50	1.18	AO4_G13	pUXO
48	AO4_G13_3	671306.75	5522535.25	1.2	AO4_G13	pUXO
49	AO4_G13_6	671352.25	5522535.75	1.1	AO4_G13	pUXO
50	AO4_G13_7	671367.00	5522536.00	1.08	AO4_G13	pUXO
51	AO4_G13_9	671196.00	5522536.25	1.35	AO4_G13	pUXO
52	AO4_G13_27	671285.50	5522544.00	7.67	AO4_G13	pUXO
53	AO4_G13_60	671309.50	5522545.25	3.57	AO4_G13	pUXO
54	AO4_G13_65	671308.00	5522547.00	2.18	AO4_G13	pUXO
55	AO4_G13_68	671342.00	5522549.00	1.58	AO4_G13	pUXO
56	AO4_G13_69	671210.75	5522552.00	1.09	AO4_G13	pUXO
57	AO4_G13_72	671310.75	5522557.75	1.13	AO4_G13	pUXO
58	AO4_G13_73	671358.25	5522558.25	2.38	AO4_G13	pUXO
59	AO4_G13_75	671370.50	5522559.00	1.04	AO4_G13	pUXO
60	AO4_G13_80	671385.51	5522530.16	1.17	AO4_G13	pUXO
61	AO4_G13_81	671341.36	5522560.55	0.58	AO4_G13	pUXO
62	AO4_G13_83	671294.69	5522532.65	0.9	AO4_G13	pUXO
63	AO4_G13_84	671256.12	5522536.62	0.85	AO4_G13	pUXO
64	AO4_G14_5	675196.75	5523867.50	5.48	AO4_G14	pUXO
65	AO4_G14_11	675266.50	5523869.50	6.41	AO4_G14	pUXO
66	AO4_G14_45	675261.50	5523873.00	2.75	AO4_G14	pUXO

Nb	TARGET_ID	X (M)	Y (M)	SA (nT/m)	Box	STATUS
67	AO4_G14_48	675198.50	5523875.25	35.57	AO4_G14	pUXO
68	AO4_G14_50	675273.25	5523875.50	5.75	AO4_G14	pUXO
69	AO4_G14_61	675270.00	5523880.75	2.51	AO4_G14	pUXO
70	AO4_G15_1	676739.25	5527520.25	44.58	AO4_G15	pUXO
71	AO4_G15_3	676729.75	5527520.50	1.91	AO4_G15	pUXO
72	AO4_G15_6	676669.00	5527521.75	2.05	AO4_G15	pUXO
73	AO4_G15_11	676740.50	5527523.00	15.14	AO4_G15	pUXO
74	AO4_G15_12	676749.50	5527523.25	7.55	AO4_G15	pUXO
75	AO4_G15_17	676756.50	5527525.50	3.75	AO4_G15	pUXO
76	AO4_G15_22	676746.75	5527527.00	29.61	AO4_G15	pUXO
77	AO4_G15_25	676730.25	5527527.50	3.1	AO4_G15	pUXO
78	AO4_G15_27	676668.00	5527528.00	1.57	AO4_G15	pUXO
79	AO4_G15_31	676697.50	5527529.25	2.42	AO4_G15	pUXO
80	AO4_G15_33	676748.00	5527529.50	43.31	AO4_G15	pUXO
81	AO4_G15_36	676744.00	5527531.75	50.88	AO4_G15	pUXO
82	AO4_G15_46	676706.75	5527537.50	2.15	AO4_G15	pUXO
83	AO4_G15_49	676666.75	5527538.00	3.12	AO4_G15	pUXO
84	AO4_G15_50	676751.75	5527538.75	98.4	AO4_G15	pUXO
85	AO4_G15_51	676797.25	5527538.75	1.45	AO4_G15	pUXO
86	AO4_G15_56	676744.00	5527540.25	1.23	AO4_G15	pUXO
87	AO4_G15_59	676664.75	5527541.50	2.19	AO4_G15	pUXO
88	AO4_G15_61	676692.00	5527541.50	1.59	AO4_G15	pUXO
89	AO4_G15_64	676749.00	5527542.25	87.29	AO4_G15	pUXO
90	AO4_G15_65	676754.00	5527542.25	28.77	AO4_G15	pUXO
91	AO4_G15_70	676767.50	5527542.75	4.97	AO4_G15	pUXO
92	AO4_G15_75	676750.25	5527544.50	46.47	AO4_G15	pUXO
93	AO4_G15_87	676691.25	5527546.75	6.07	AO4_G15	pUXO
94	AO4_G15_96	676743.75	5527547.00	5.1	AO4_G15	pUXO
95	AO4_G15_103	676703.75	5527547.50	12.17	AO4_G15	pUXO
96	AO4_G15_110	676756.25	5527548.50	140.7	AO4_G15	pUXO
97	AO4_G15_117	676758.25	5527551.75	103.35	AO4_G15	pUXO
98	AO4_G15_118	676661.25	5527552.00	1.33	AO4_G15	pUXO
99	AO4_G15_120	676770.75	5527552.25	1.65	AO4_G15	pUXO

Nb	TARGET_ID	X (M)	Y (M)	SA (nT/m)	Box	STATUS
100	AO4_G15_125	676761.83	5527532.24	0.66	AO4_G15	pUXO
101	AO4_G17_1	657476.25	5520712.00	2.56	AO4_G17	pUXO
102	AO4_G17_17	657394.50	5520728.50	1.83	AO4_G17	pUXO
103	AO4_G17_18	657473.25	5520729.50	2.65	AO4_G17	pUXO
104	AO4_G18_1	660543.50	5520436.25	1.47	AO4_G18	pUXO
105	AO4_G18_2	660481.50	5520437.25	1.02	AO4_G18	pUXO
106	AO4_G18_60	660439.00	5520453.50	7.91	AO4_G18	pUXO
107	AO4_G18_68	660389.00	5520455.25	1.26	AO4_G18	pUXO
108	AO4_G18_86	660552.75	5520460.75	7.34	AO4_G18	pUXO
109	AO4_G18_119	660596.38	5520434.22	1.21	AO4_G18	pUXO
110	AO4_G18_120	660520.32	5520452.63	2.99	AO4_G18	pUXO
111	AO4_G18_121	660560.93	5520455.83	2.37	AO4_G18	pUXO
112	AO4_G20_4	676636.00	5518614.75	1.67	AO4_G20	pUXO
113	AO4_G20_9	676677.50	5518617.00	10.38	AO4_G20	pUXO
114	AO4_G20_10	676671.25	5518618.75	0.56	AO4_G20	pUXO
115	AO4_G20_12	676655.00	5518617.50	3.13	AO4_G20	pUXO
116	AO4_G20_16	676505.25	5518620.25	1.1	AO4_G20	pUXO
117	AO4_G20_18	676612.75	5518621.00	1.61	AO4_G20	pUXO
118	AO4_G20_22	676666.75	5518622.25	1.01	AO4_G20	pUXO
119	AO4_G20_27	676656.75	5518624.00	1.99	AO4_G20	pUXO
120	AO4_G20_32	676610.50	5518625.75	1.44	AO4_G20	pUXO
121	AO4_G20_34	676626.00	5518629.50	2.73	AO4_G20	pUXO
122	AO4_G20_43	676614.25	5518635.75	1.48	AO4_G20	pUXO
123	AO4_G22_23	673498.50	5530545.25	2.08	AO4_G22	pUXO
124	AO4_G22_41	673521.75	5530557.00	2.9	AO4_G22	pUXO
125	AO4_G22_46	673627.18	5530555.83	1.75	AO4_G22	pUXO
126	AO4_G11_1	672374.75	5535777.50	1.2	AO4_G11	pUXO
127	AO4_G11_3	672178.75	5535783.25	2.29	AO4_G11	pUXO
128	AO4_G11_6	672358.25	5535790.50	1.24	AO4_G11	pUXO
129	AO4_G11_7	672361.75	5535791.75	1.9	AO4_G11	pUXO
130	AO4_G11_10	672366.25	5535794.25	2.07	AO4_G11	pUXO
131	AO4_G11_18	672350.00	5535797.50	7.81	AO4_G11	pUXO
132	AO4_G11_19	672355.75	5535797.50	7.34	AO4_G11	pUXO

Nb	TARGET_ID	X (M)	Y (M)	SA (nT/m)	Box	STATUS
133	AO4_G11_29	672342.50	5535799.00	1.51	AO4_G11	pUXO
134	AO4_G11_31	672352.50	5535800.25	1.28	AO4_G11	pUXO
135	AO4_G01_1	669469.75	5529342.00	1.17	AO4_G01	pUXO
136	AO4_G04_7	658583.48	5530414.14	0.75	AO4_G04	pUXO
137	AO4_G05_1	662665.00	5533757.50	1.63	AO4_G05	pUXO
138	AO4_G08_1	661467.00	5527145.25	2.31	AO4_G08	pUXO
139	AO4_G08_2	661522.75	5527147.00	1.32	AO4_G08	pUXO
140	AO4_G08_3	661519.25	5527149.25	2.46	AO4_G08	pUXO
141	AO4_G09_1	664759.50	5532048.00	1.16	AO4_G09	pUXO
142	AO4_G09_4	664641.50	5532050.25	2.35	AO4_G09	pUXO
143	AO4_G09_10	664543.75	5532056.25	1.69	AO4_G09	pUXO
144	AO4_G09_11	664668.00	5532056.25	1.54	AO4_G09	pUXO
145	AO4_G09_19	664589.75	5532057.00	1.03	AO4_G09	pUXO
146	AO4_G09_20	664749.75	5532057.75	1.19	AO4_G09	pUXO
147	AO4_G09_22	664543.75	5532059.75	1.39	AO4_G09	pUXO
148	AO4_G09_41	664654.00	5532064.75	1.52	AO4_G09	pUXO
149	AO4_G09_44	664730.00	5532067.50	2.44	AO4_G09	pUXO
150	AO4_G09_47	664754.25	5532068.00	1.15	AO4_G09	pUXO
151	AO4_G09_48	664763.00	5532068.25	1.7	AO4_G09	pUXO
152	AO4_G09_49	664669.25	5532068.50	1.18	AO4_G09	pUXO
153	AO4_G09_51	664714.25	5532069.25	4.22	AO4_G09	pUXO
154	AO4_G09_54	664728.75	5532070.00	2.47	AO4_G09	pUXO
155	AO4_G09_56	664755.25	5532070.50	1.08	AO4_G09	pUXO
156	AO4_G09_58	664648.75	5532071.50	1.41	AO4_G09	pUXO
157	AO4_G09_59	664687.25	5532071.75	1.55	AO4_G09	pUXO
158	AO4_G09_60	664696.25	5532071.75	1.55	AO4_G09	pUXO
159	AO4_G09_62	664763.75	5532072.00	1.51	AO4_G09	pUXO
160	AO4_G09_67	664679.25	5532074.00	1.82	AO4_G09	pUXO
161	AO4_G09_71	664685.25	5532075.50	2.31	AO4_G09	pUXO
162	AO4_G09_72	664688.75	5532075.75	2.23	AO4_G09	pUXO
163	AO4_G09_73	664677.50	5532076.50	1.33	AO4_G09	pUXO
164	AO4_G16_1	652518.75	5530863.75	9.66	AO4_G16	pUXO
165	AO4_G16_3	652542.25	5530873.00	1.02	AO4_G16	pUXO

Nb	TARGET_ID	X (M)	Y (M)	SA (nT/m)	Box	STATUS
166	AO4_G16_4	652618.00	5530877.00	2.61	AO4_G16	pUXO
167	AO4_G03_1	655801.50	5527297.00	2.21	AO4_G03	pUXO
168	AO4_G03_2	655797.75	5527298.75	2.03	AO4_G03	pUXO
169	AO4_G03_3	655756.25	5527301.00	1.36	AO4_G03	pUXO
170	AO4_G03_4	655827.75	5527305.00	1.71	AO4_G03	pUXO
171	AO4_G03_5	655879.00	5527307.50	1.26	AO4_G03	pUXO
172	AO4_G03_6	655913.75	5527307.75	1.33	AO4_G03	pUXO
173	AO4_G03_7	655851.00	5527318.00	1.52	AO4_G03	pUXO
174	AO4_G03_8	655840.75	5527321.50	25.12	AO4_G03	pUXO
175	AO4_G06_1	659507.00	5523327.75	1.17	AO4_G06	pUXO
176	AO4_G06_2	659624.75	5523330.50	1.49	AO4_G06	pUXO
177	AO4_G06_3	659620.75	5523333.25	1.44	AO4_G06	pUXO

APPENDIX II – LIST OF THE SIDE SCAN CONTACTS DETECTED

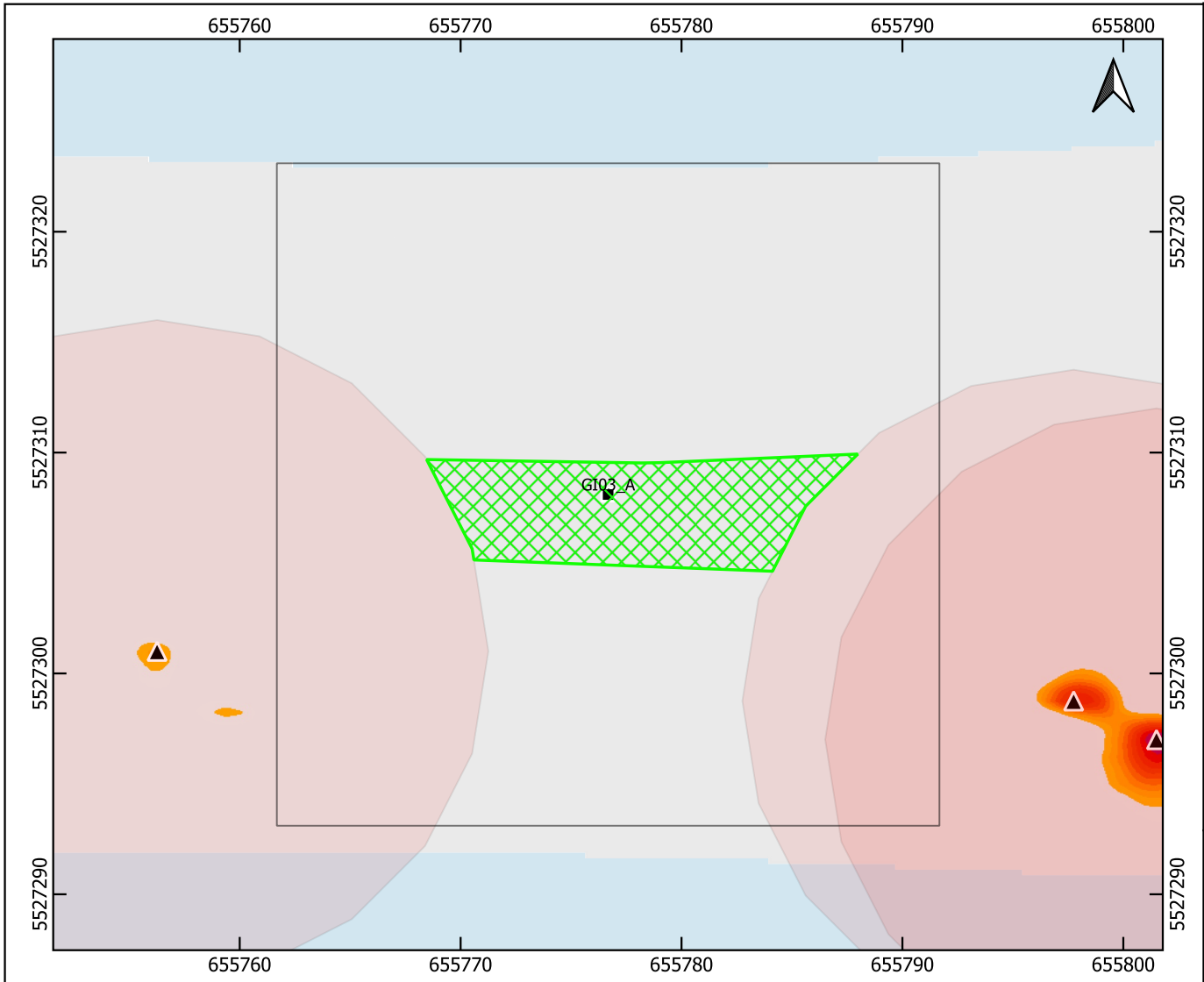
TARGET_ID	X (M)	Y (M)	STATUS
1	673636.35	5530558.33	non UXO
2	673638.62	5530522.14	non UXO
3	673559.01	5530531.96	non UXO
4	673558.6	5530543.01	non UXO
5	652568.18	5530878.92	non UXO
6	652540.04	5530861.05	non UXO
7	652525.02	5530871.91	non UXO
8	652521.96	5530872.38	non UXO
9	652582.32	5530852.62	non UXO
10	652579.39	5530881.74	non UXO
11	652503.4	5530888.09	non UXO
12	652479.84	5530882.58	non UXO
13	652477.2	5530862.69	non UXO
14	652487.97	5530862.38	non UXO
15	652495.19	5530862.11	non UXO
16	652519.22	5530886.18	non UXO
17	652518.17	5530887.02	non UXO
18	652653.98	5530863.8	non UXO
19	652653.27	5530865.27	non UXO
20	652653.28	5530868.24	non UXO
21	652655.99	5530845.02	non UXO
22	652545.77	5530857.91	non UXO
23	652484.05	5530812.33	non UXO
24	652431.28	5530825.41	non UXO
25	652447.31	5530848.1	non UXO
26	652453.25	5530863.25	non UXO
27	652432.18	5530888.22	non UXO
28	652448.47	5530880.46	non UXO
29	652464.4	5530825.37	non UXO
30	652498.78	5530900.1	non UXO
31	652530.88	5530919.53	non UXO
32	652502.96	5530927.51	non UXO
33	652497.35	5530920.26	non UXO

TARGET_ID	X (M)	Y (M)	STATUS
34	652575.1	5530899.28	non UXO
35	652563.27	5530917.88	non UXO
36	652564.23	5530917.22	non UXO
37	652564.1	5530915.86	non UXO
38	652563.66	5530912.25	non UXO
39	652574.13	5530930.09	non UXO
40	652542.27	5530921.8	non UXO
41	661560.03	5527108.67	non UXO
42	661508.8	5527139.32	non UXO
43	661508.89	5527140.76	non UXO
44	661487.04	5527127.69	non UXO
45	661544.22	5527128.1	non UXO
46	669497.57	5529334.73	non UXO
47	669470.16	5529334.58	non UXO
48	669496.51	5529351.54	non UXO
49	669518.99	5529315.59	non UXO
50	669488.51	5529319.71	non UXO
51	664612.99	5532064.26	non UXO

APPENDIX III – LIST OF THE MBES CONTACTS DETECTED

TARGET_ID	X (M)	Y (M)	STATUS
1	673559.38	5530543.11	non UXO
2	673554.33	5530550.76	non UXO
3	652487.57	5530861.1	non UXO
4	652452.96	5530861.3	non UXO
5	652447.55	5530880.03	non UXO
6	652479.32	5530881.64	non UXO
7	652583.11	5530851.16	non UXO
8	652567.52	5530877.97	non UXO
9	652521.46	5530870.52	non UXO
10	652578.15	5530880.88	non UXO
11	652653.37	5530862.56	non UXO
12	652655.67	5530843.89	non UXO
13	652431.76	5530887.59	non UXO
14	661558.98	5527107.44	non UXO
15	661508.3	5527138.5	non UXO
16	661508.4	5527141.3	non UXO

APPENDIX IV – ALARP CERTIFICATE MAPS



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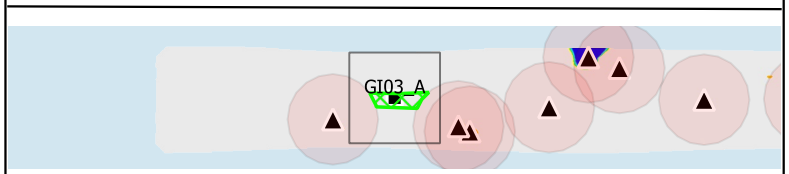
GEOQUIPMARINE

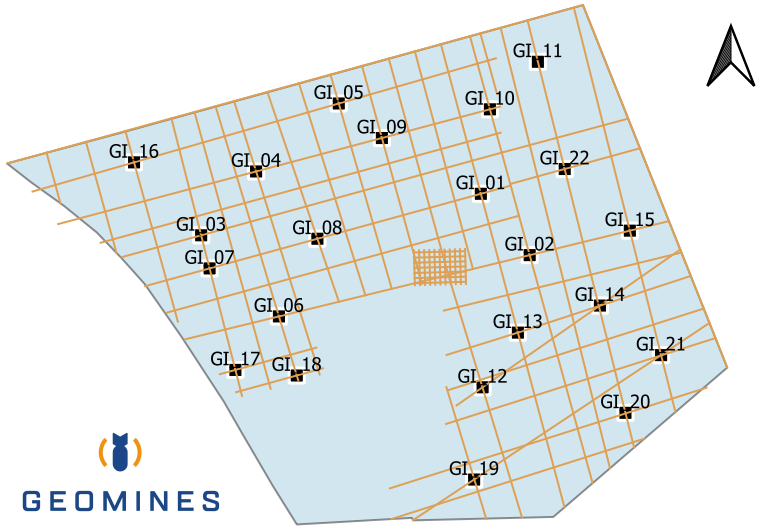
ANNEXE A: AO4 - GI03_A
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

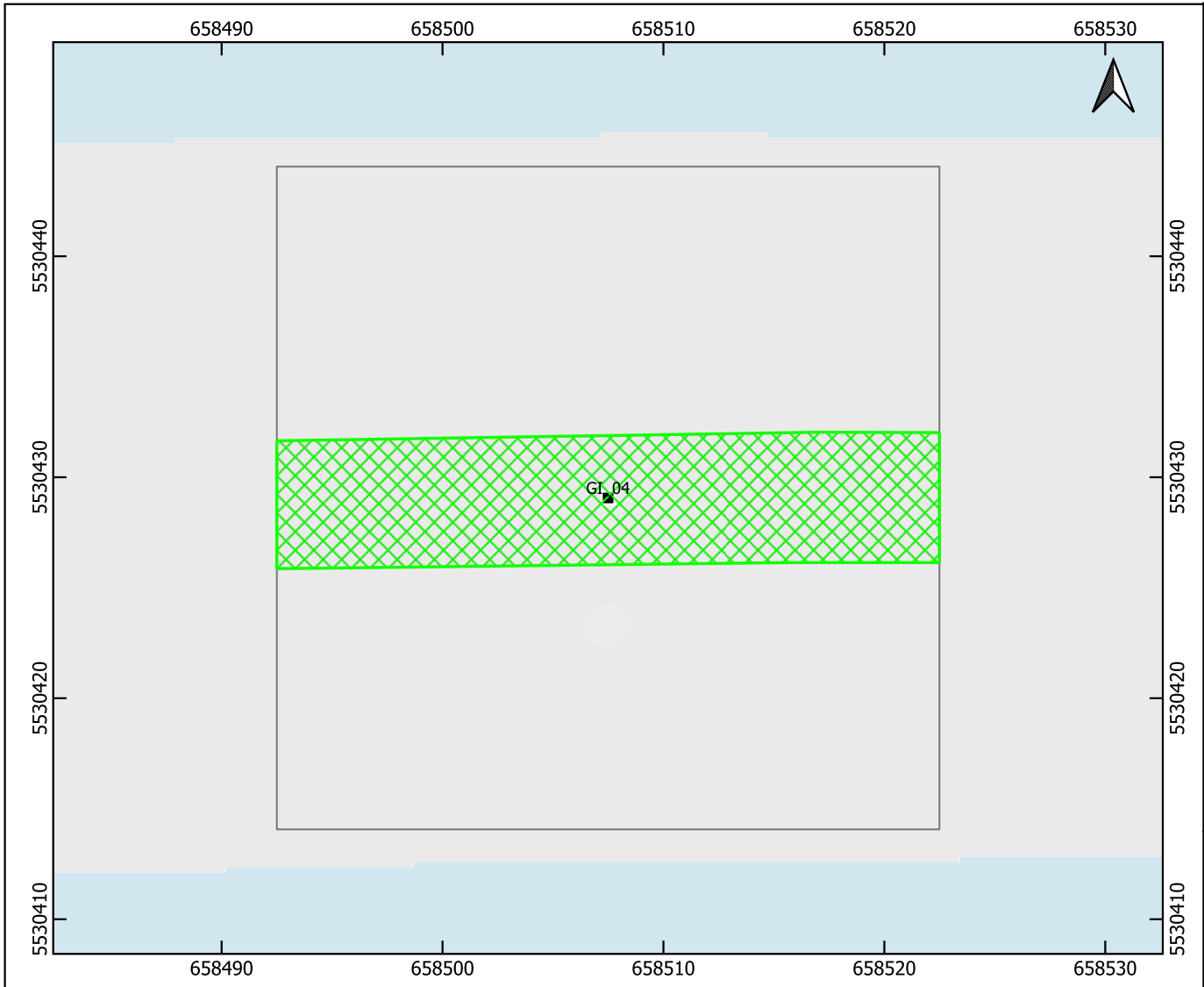
ALTERNATIVE LOCATION

ALARP Working area : 77 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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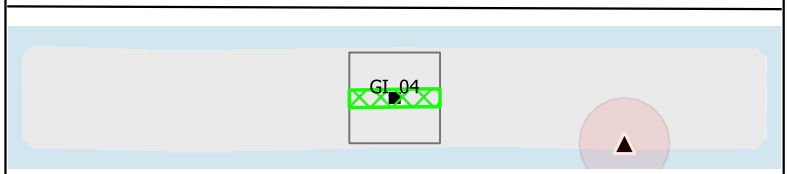
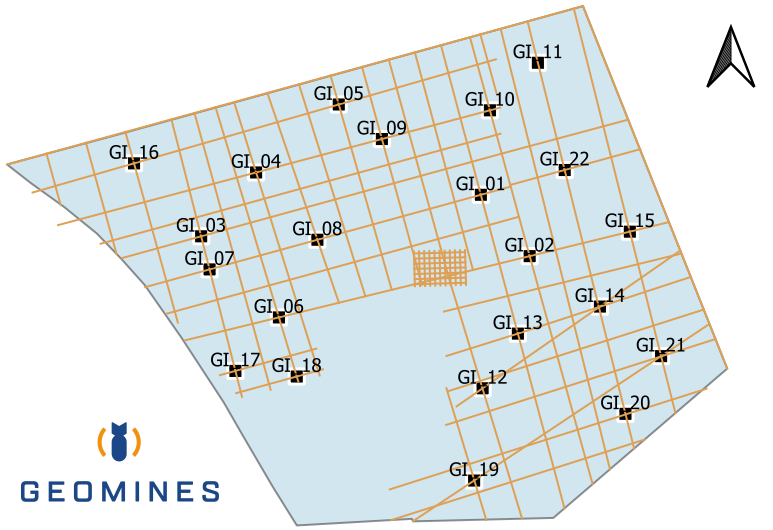
ANNEXE A: AO4 - GI_04
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

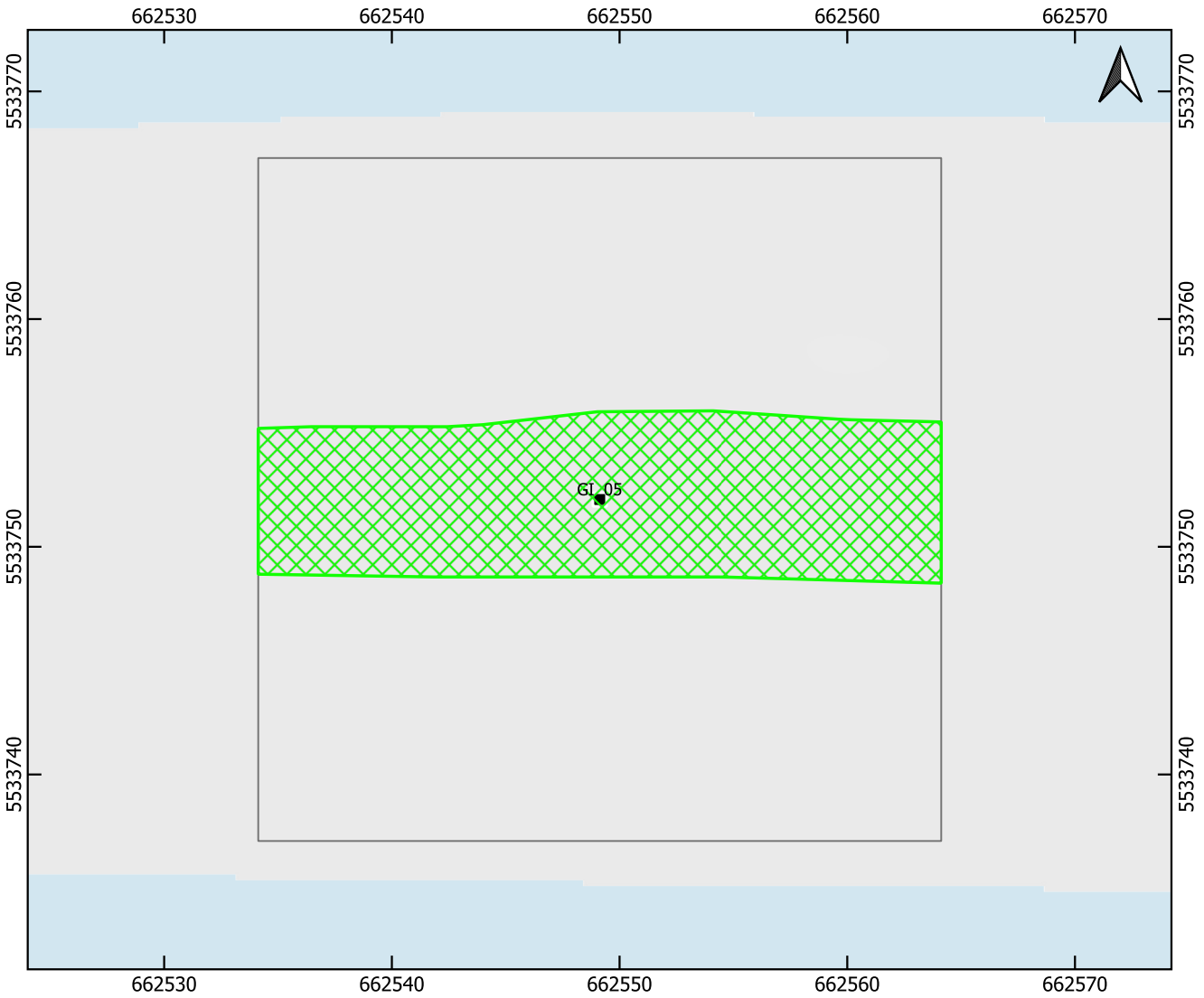
ORIGINAL LOCATION

ALARP Working area : 175 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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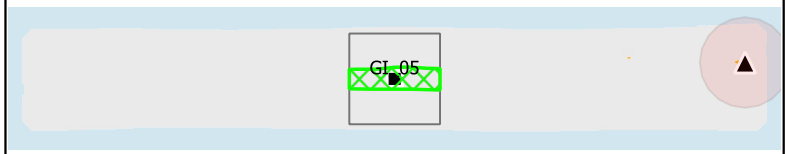
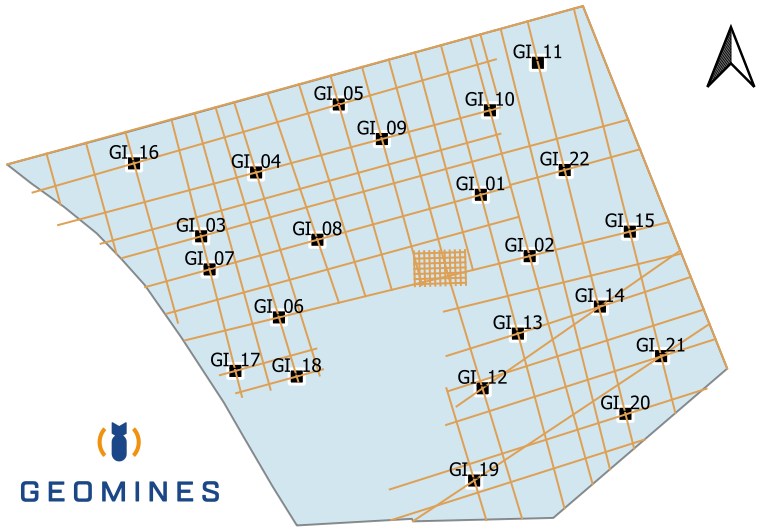
ANNEXE A: AO4 - GI_05
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

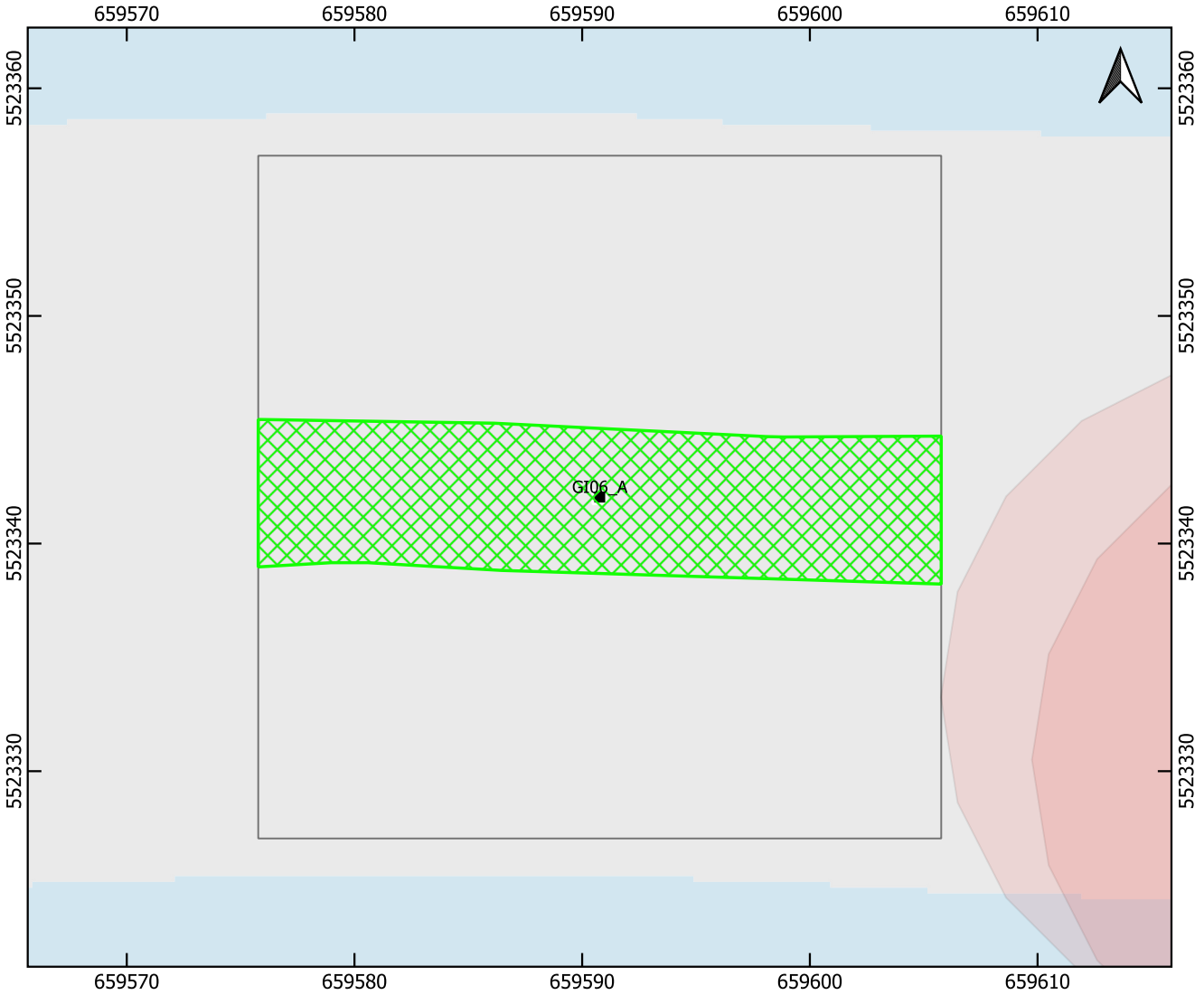
ORIGINAL LOCATION

ALARP Working area : 208 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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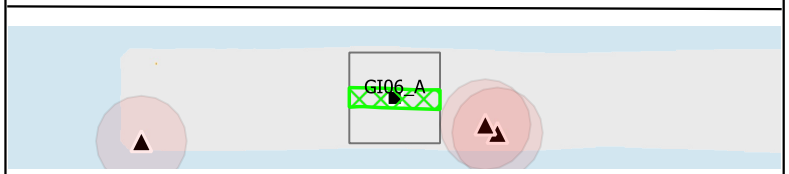
GEOQUIPMARINE

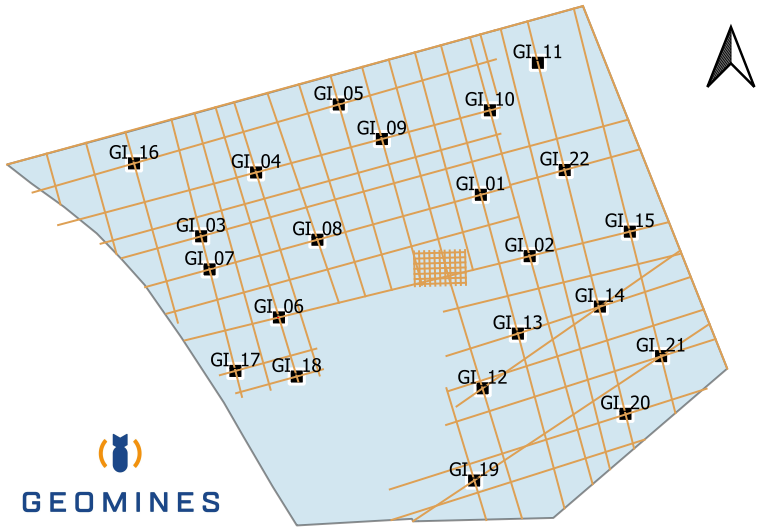
ANNEXE A: AO4 - GI06_A
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

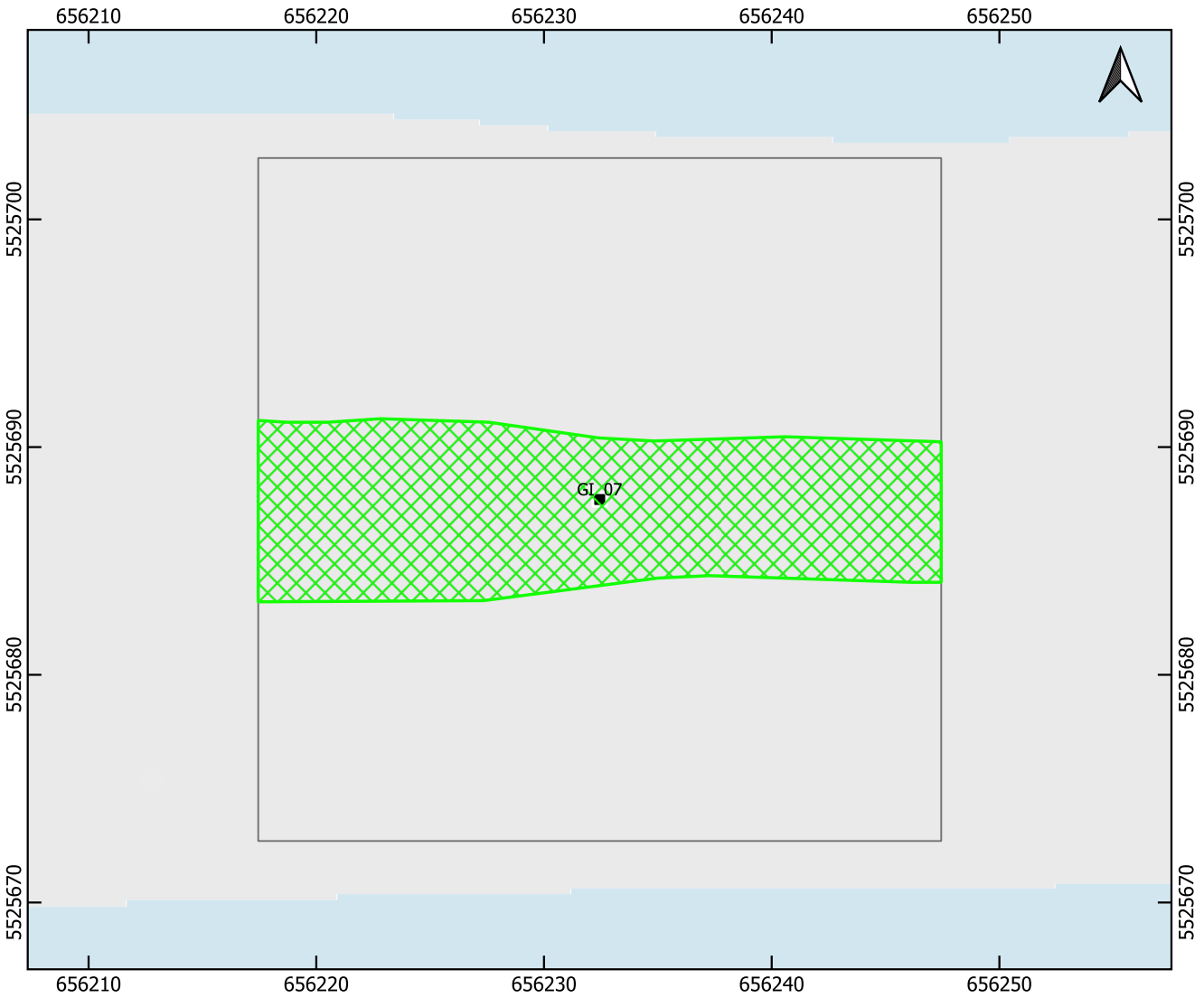
ALTERNATIVE LOCATION

ALARP Working area : 190 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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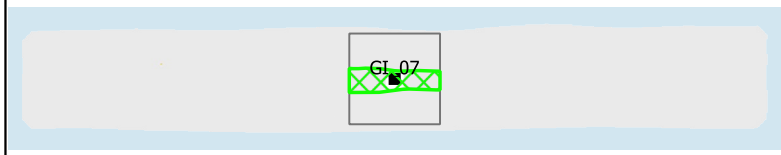
GEOQUIPMARINE

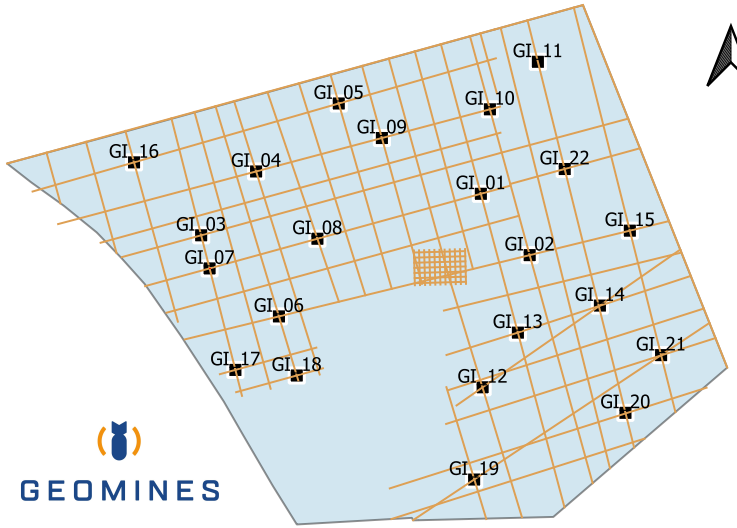
ANNEXE A: AO4 - GI_07
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

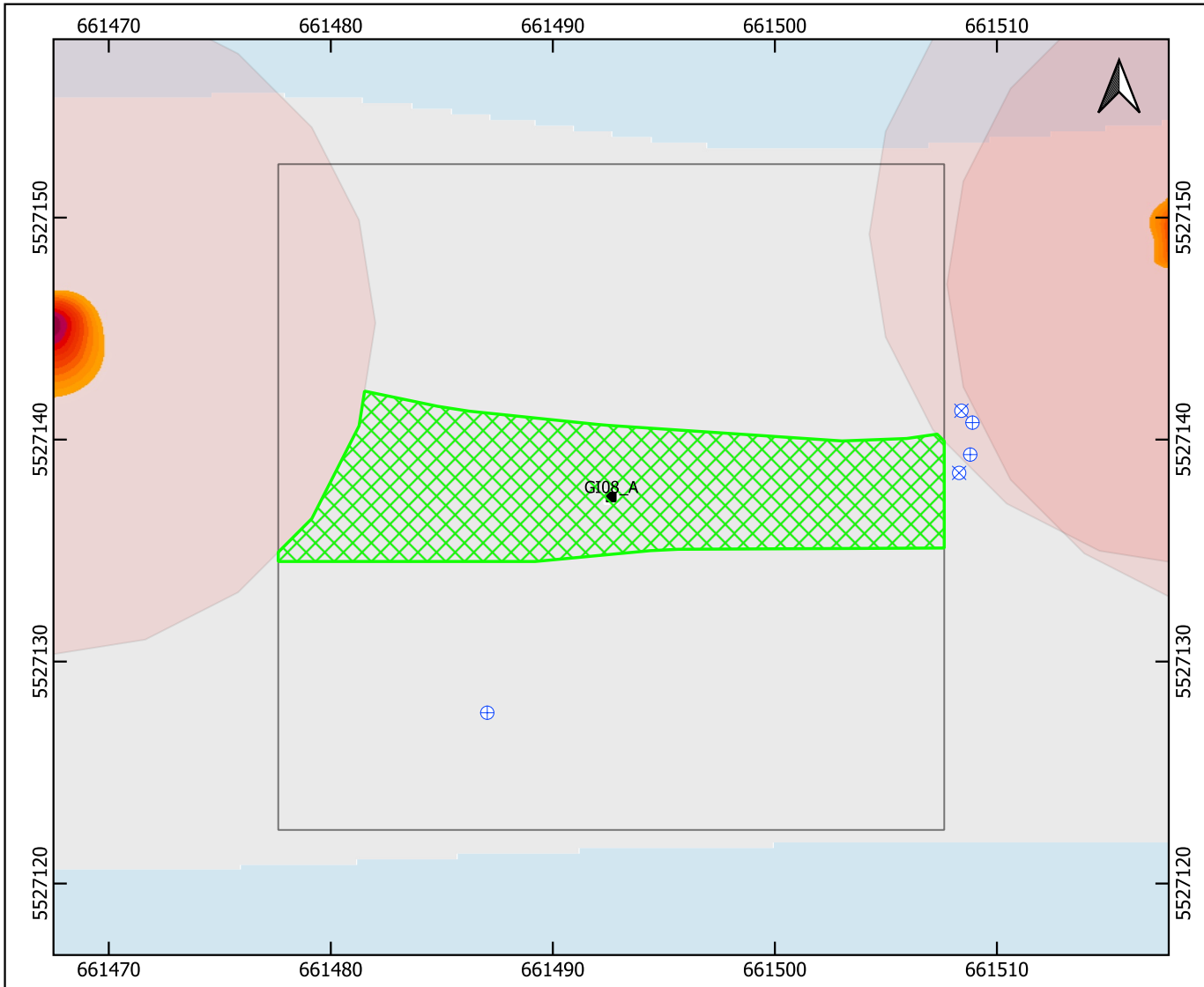
ORIGINAL LOCATION

ALARP Working area : 207 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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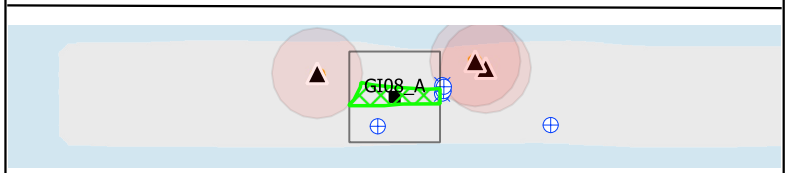
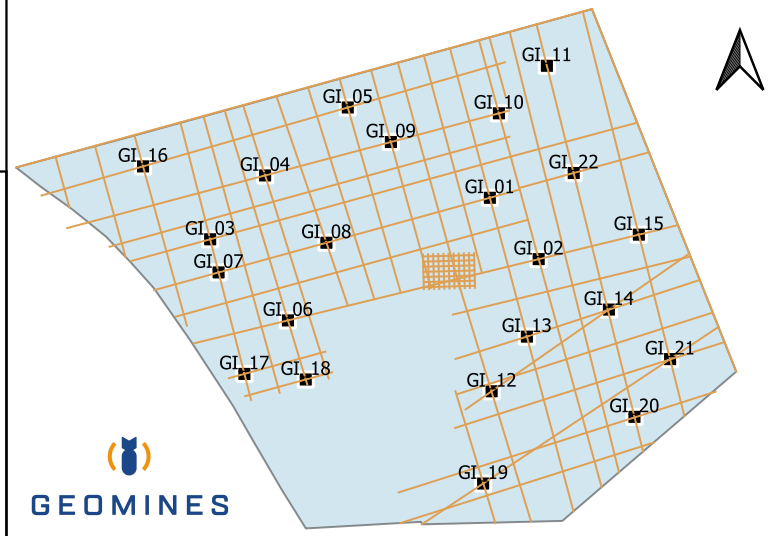
ANNEXE A: AO4 - GI08_A
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

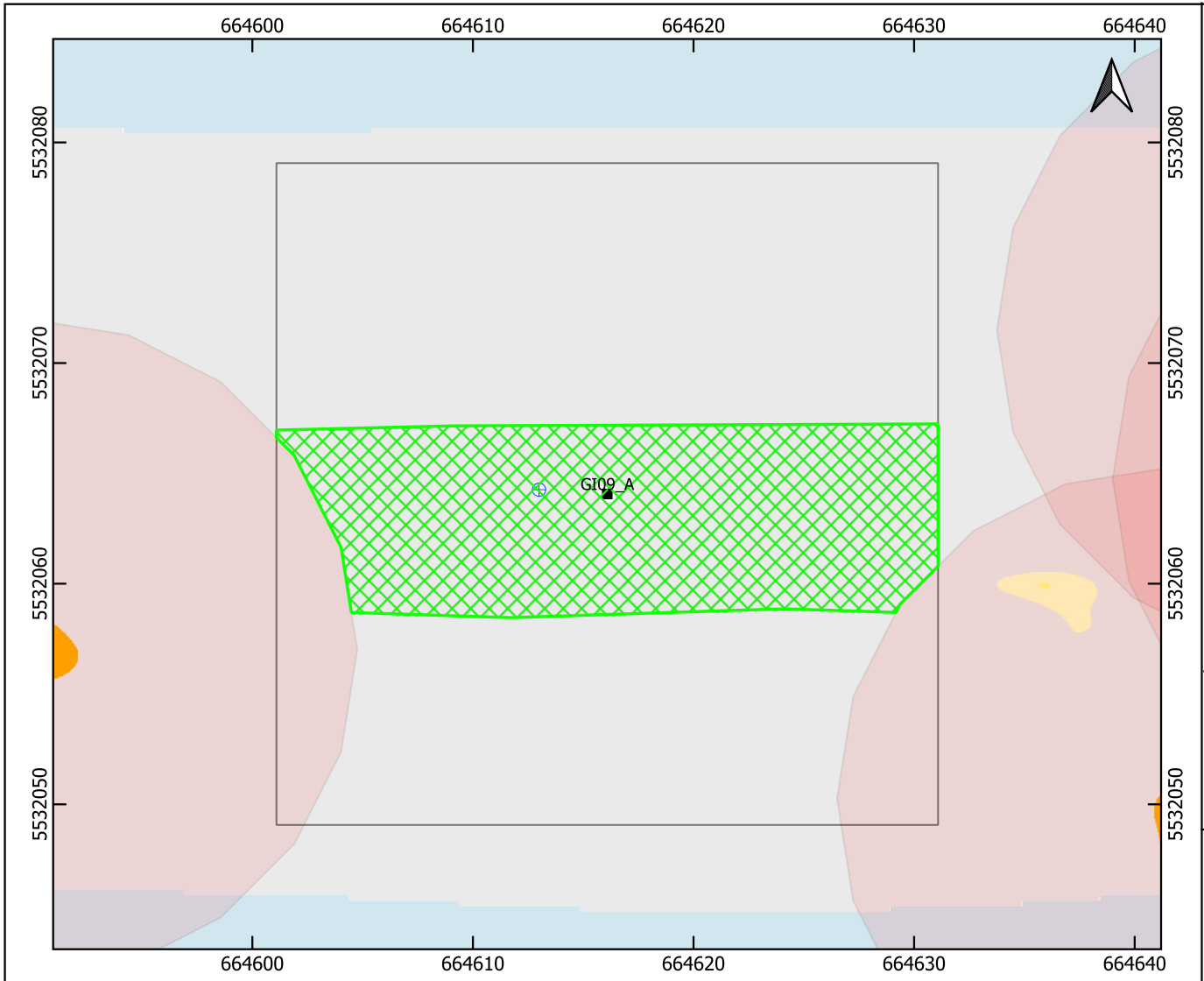
ALTERNATIVE LOCATION

ALARP Working area : 164 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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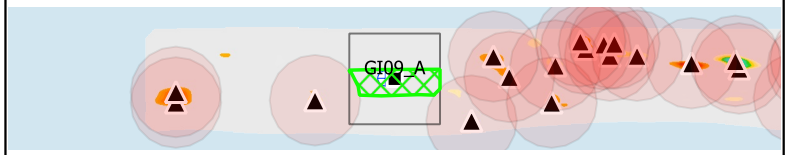
GEOQUIPMARINE

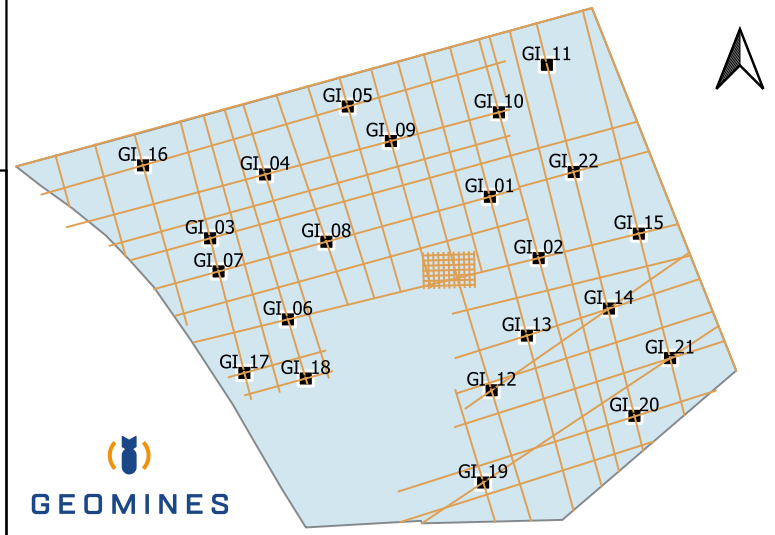
ANNEXE A: AO4 - GI09_A
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

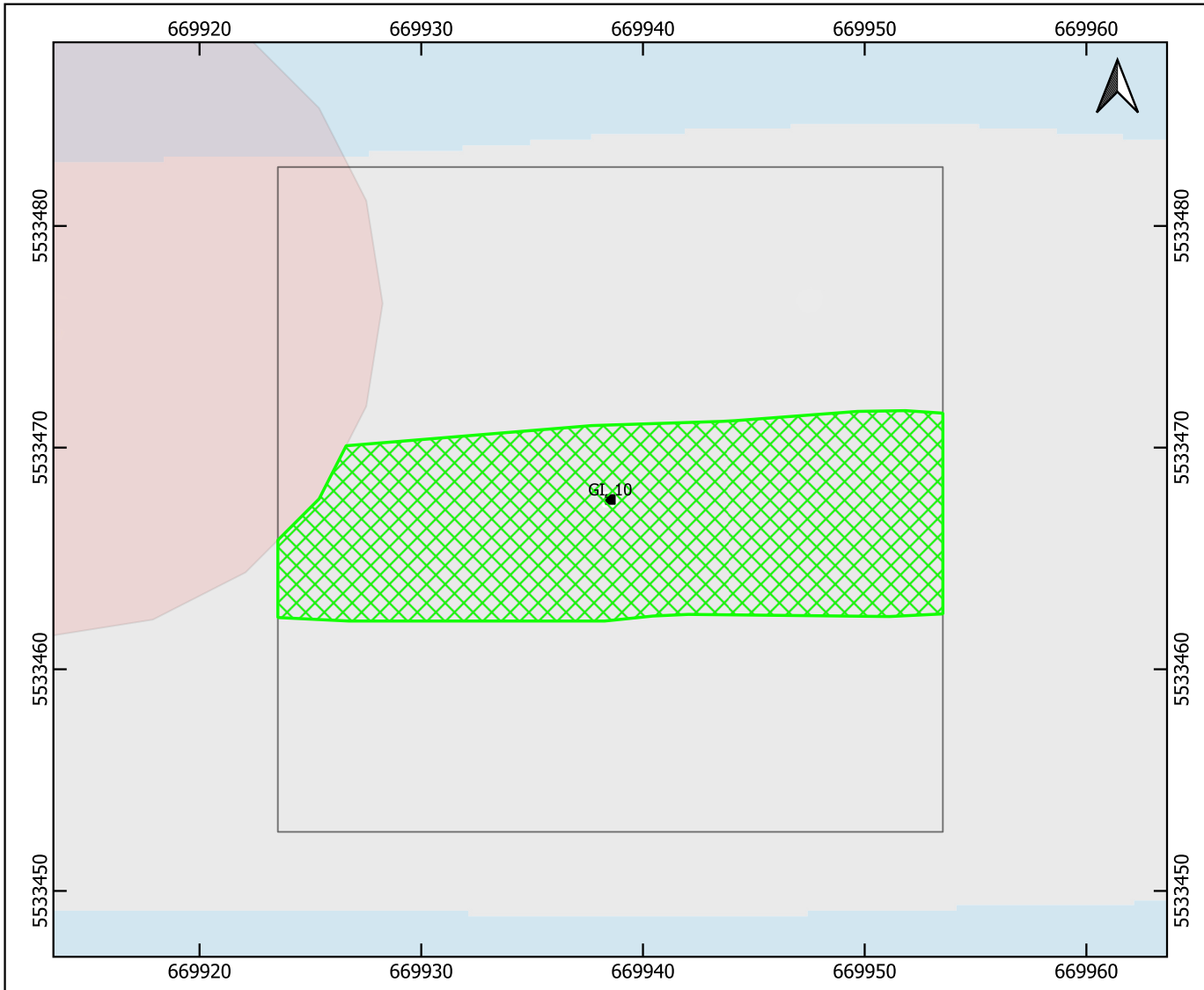
ALTERNATIVE LOCATION

ALARP Working area : 235 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

ORIGINAL LOCATION

ALARP Working area : 251 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)

ANNEXE A: AO4 - GI_10
ALARP CERTIFICATE GIS

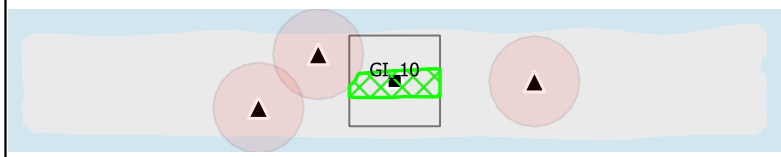
Scale: 1/300

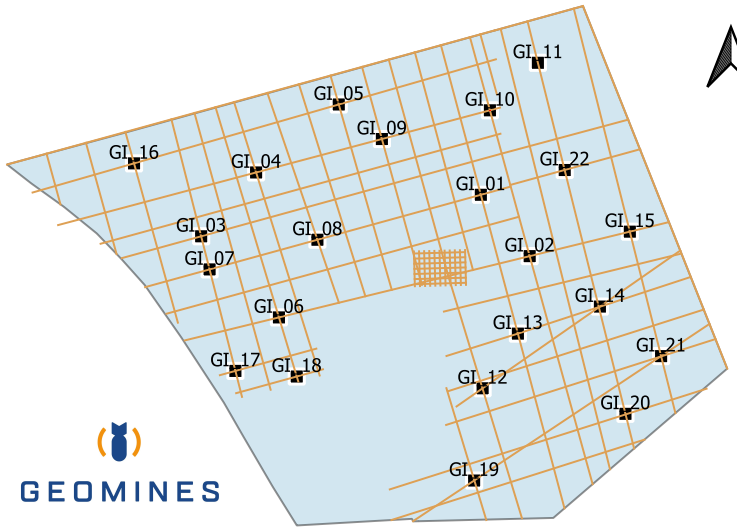
Date: 2021-11-29

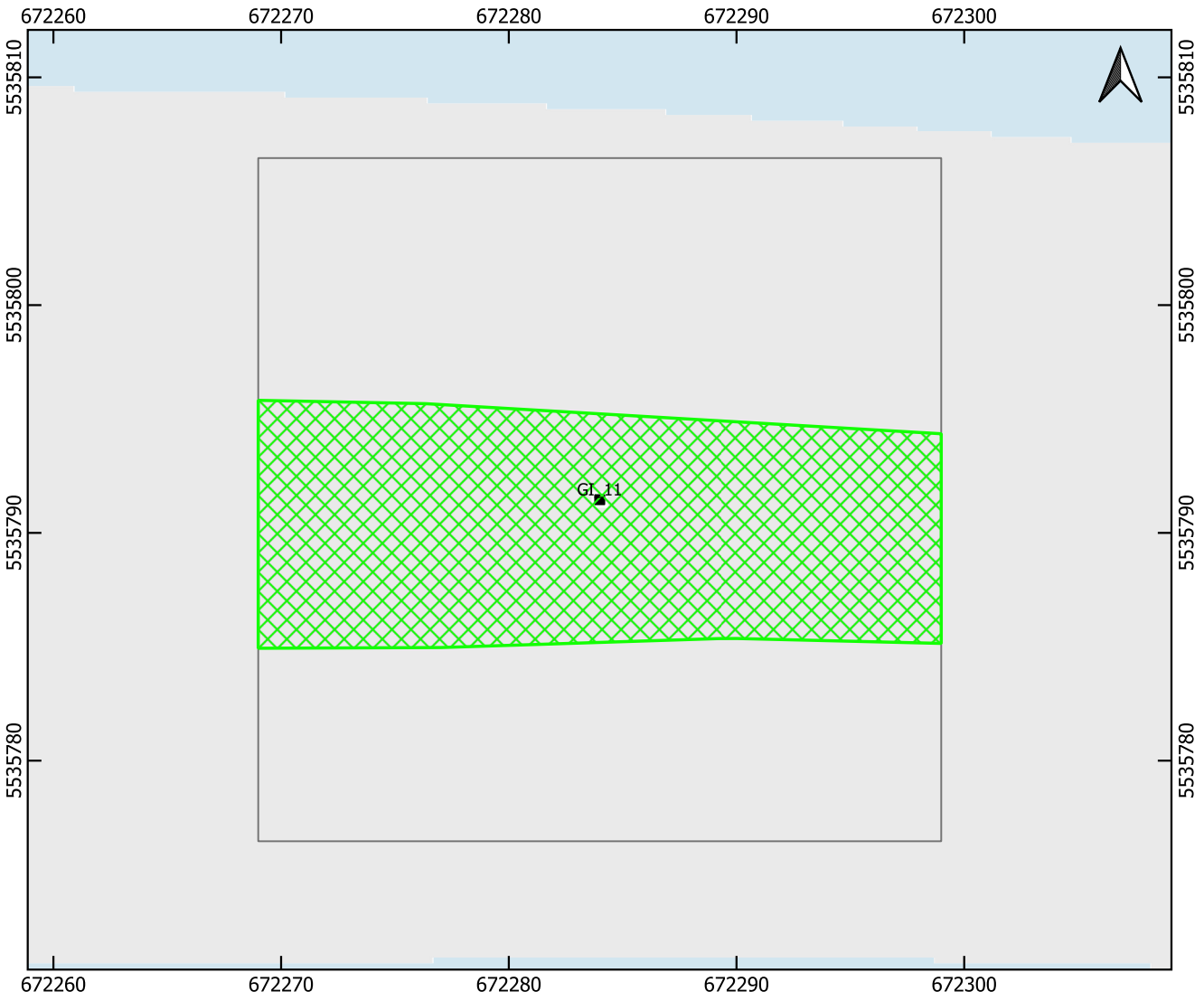
Geodesy : WGS 84 - UTM 30N

Version: V0

0 5 10 15 20 m







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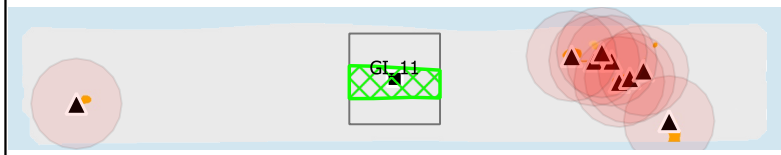
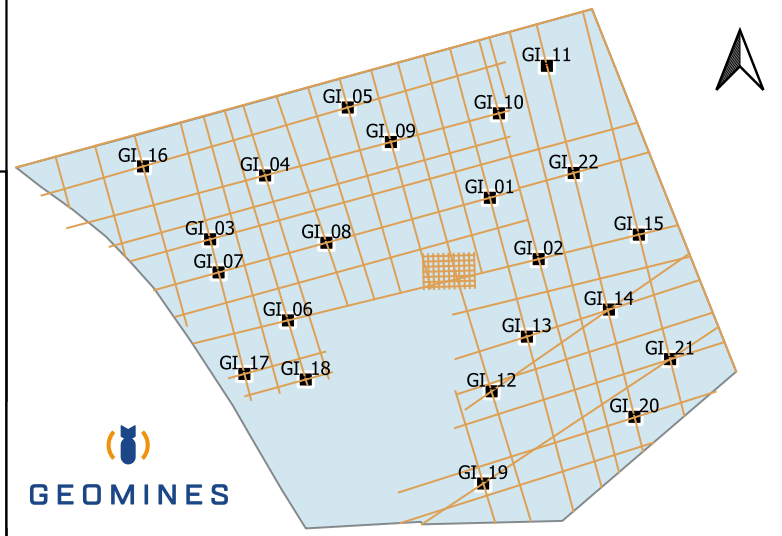
ANNEXE A: AO4 - GI_11
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

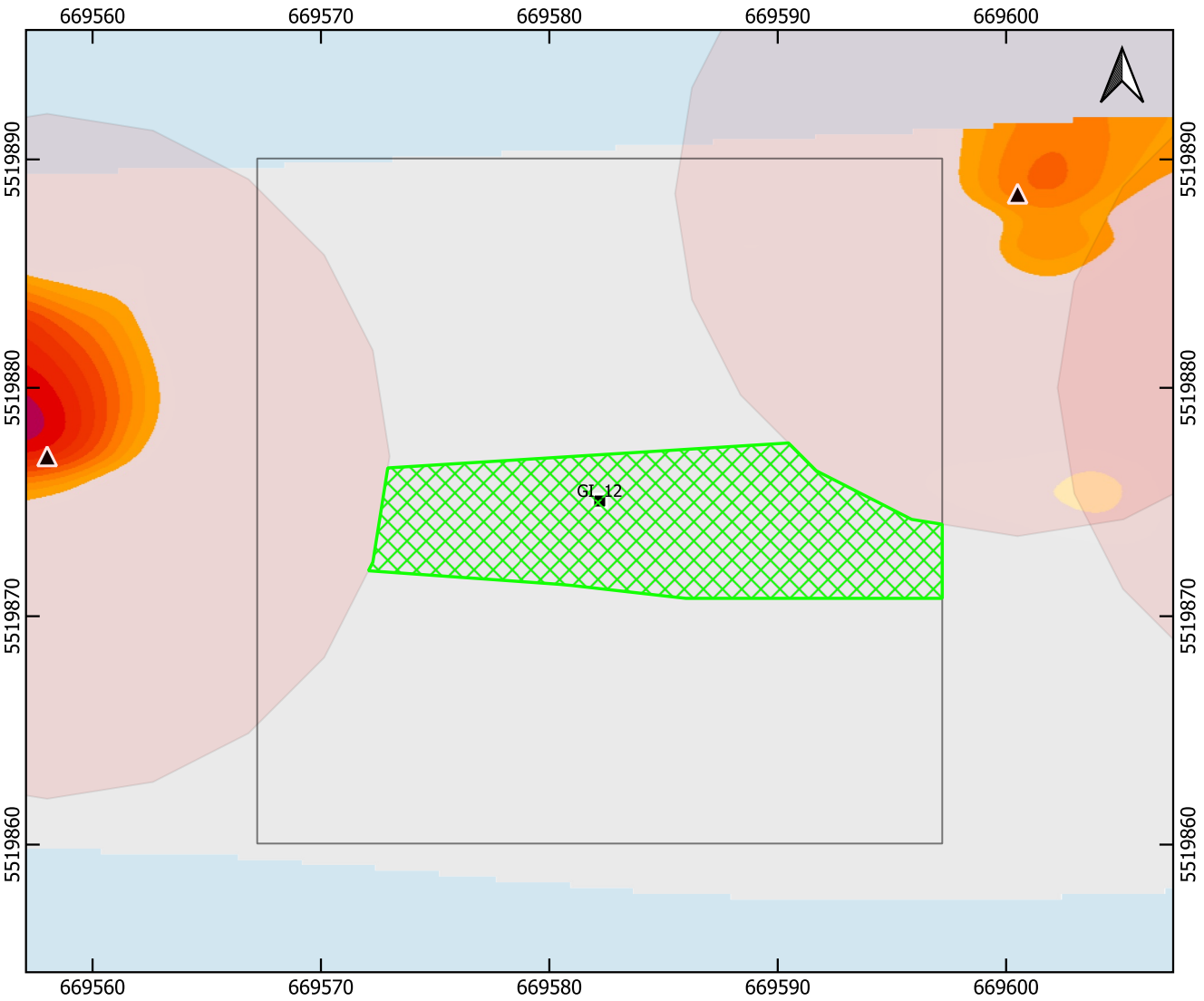
ORIGINAL LOCATION

ALARP Working area : 302 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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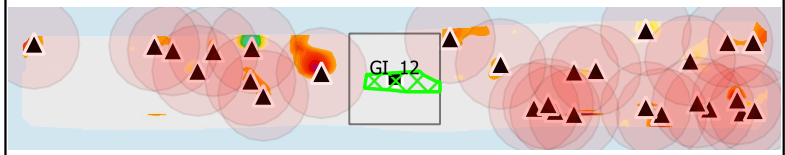
GEOQUIPMARINE

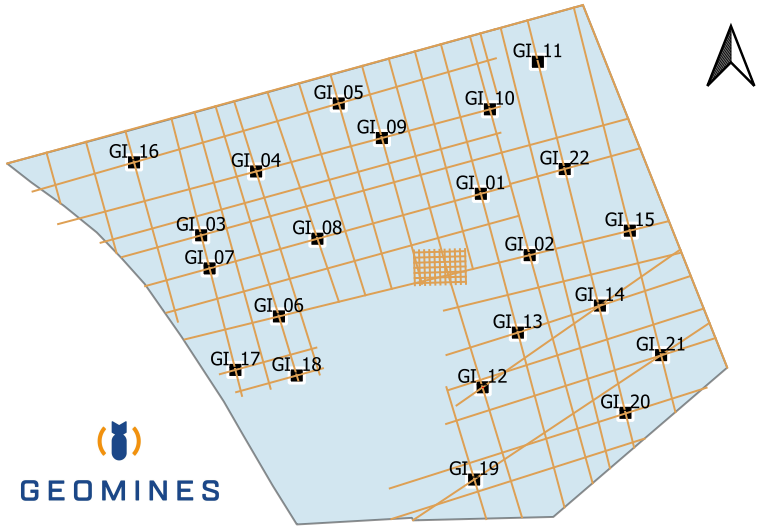
ANNEXE A: AO4 - GI_12
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

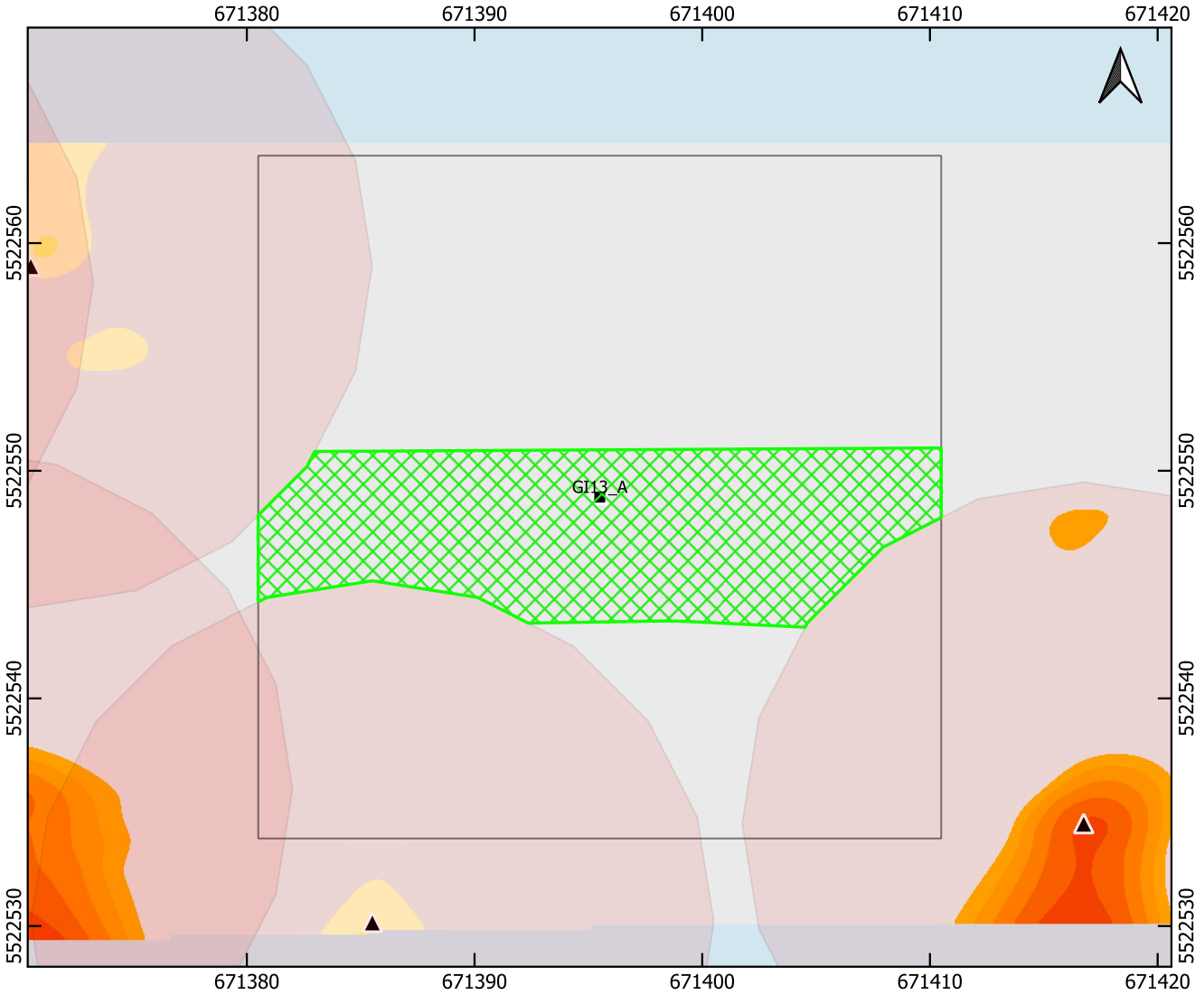
ORIGINAL LOCATION

ALARP Working area : 134 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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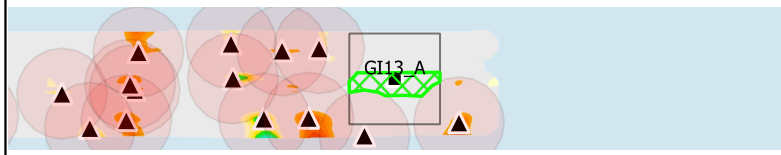
GEOQUIPMARINE

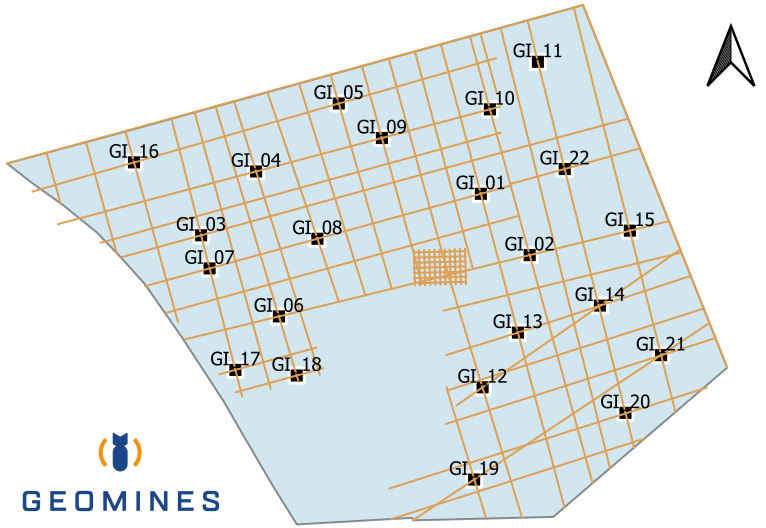
ANNEXE A: AO4 - GI13_A
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

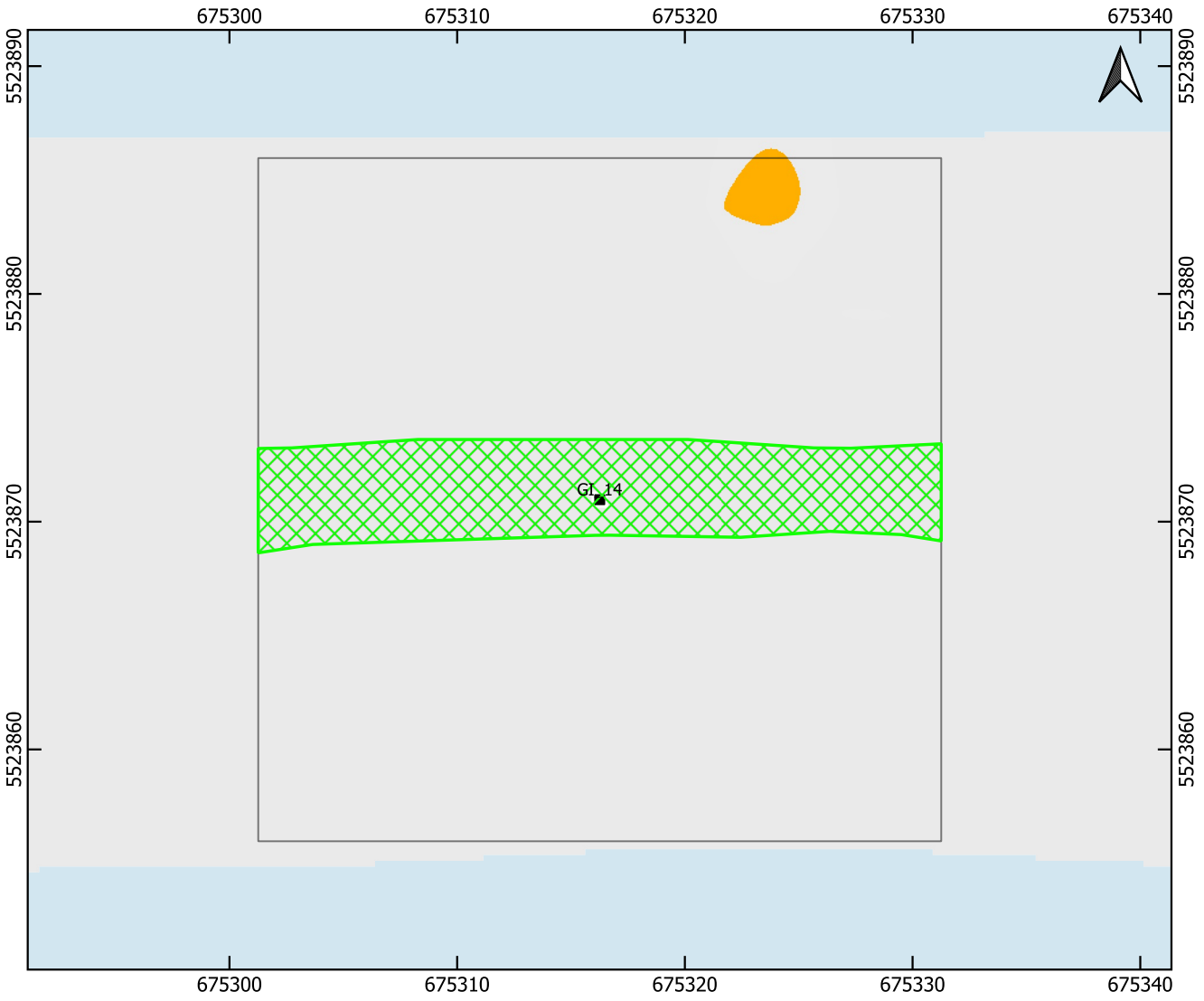
ALTERNATIVE LOCATION

ALARP Working area : 193 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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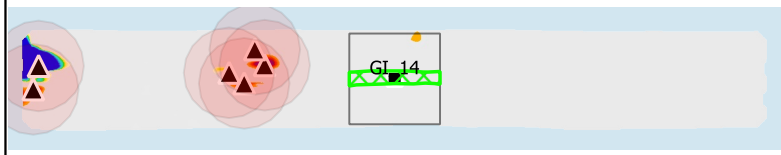
GEOQUIPMARINE

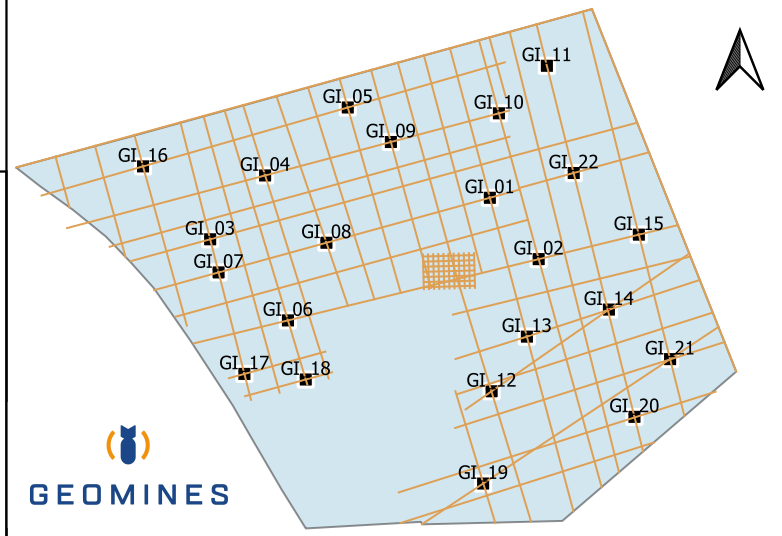
ANNEXE A: AO4 - GI_14
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

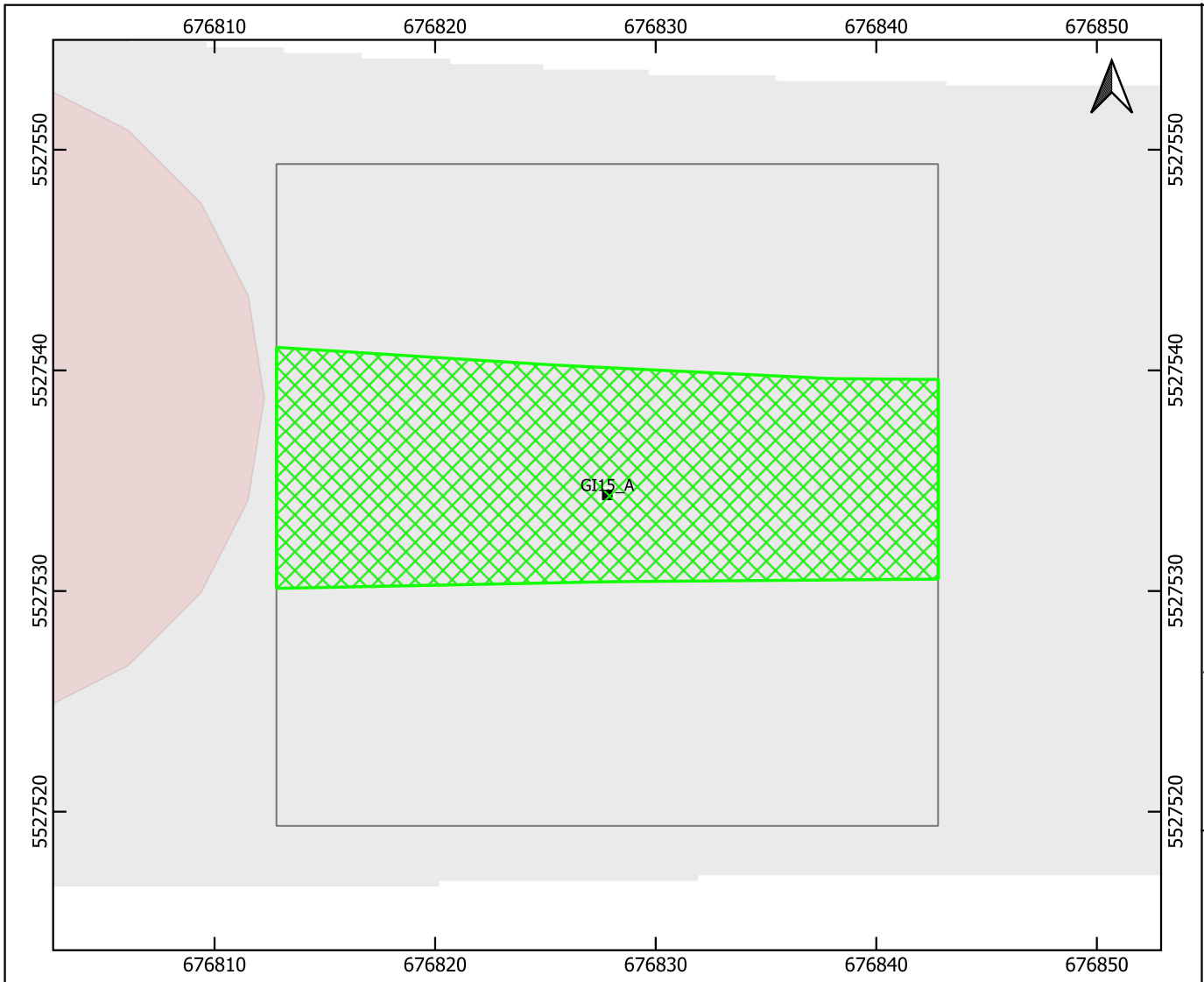
ORIGINAL LOCATION

ALARP Working area : 126 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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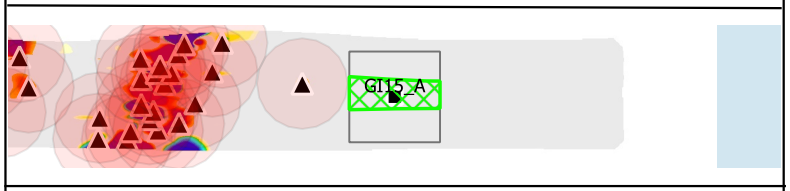
GEOQUIPMARINE

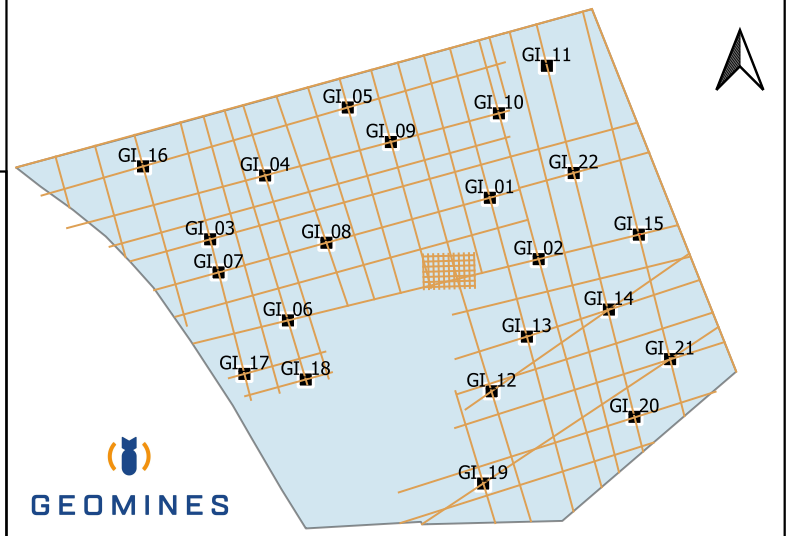
ANNEXE A: AO4 - GI15_A
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

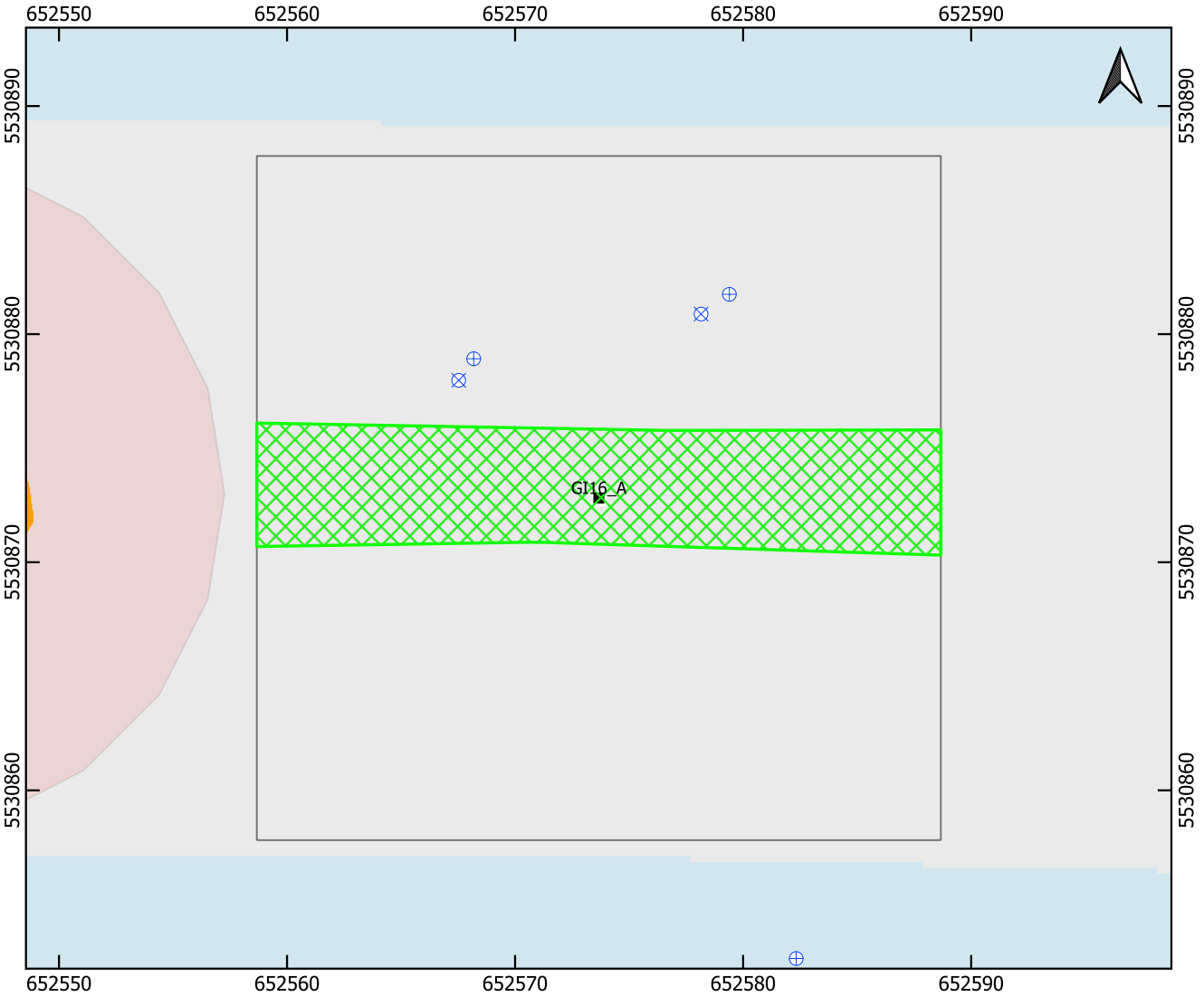
ALTERNATIVE LOCATION

ALARP Working area : 294 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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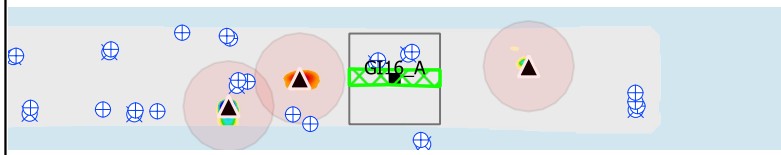
GEOQUIPMARINE

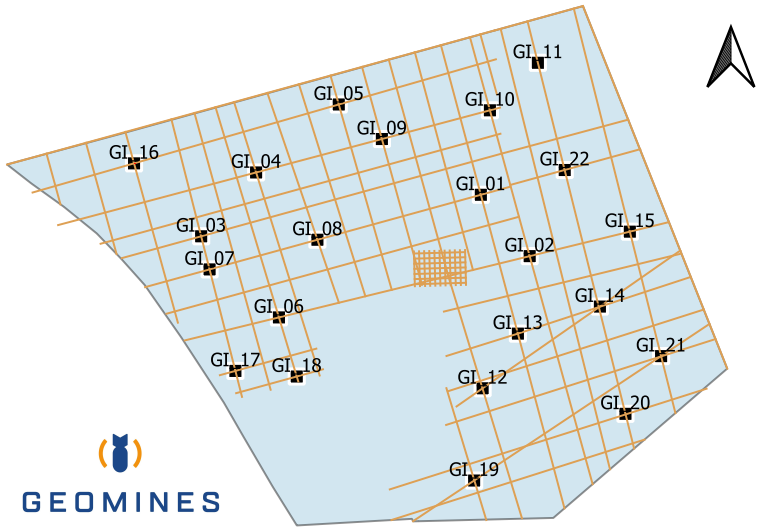
ANNEXE A: AO4 - GI16_A
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

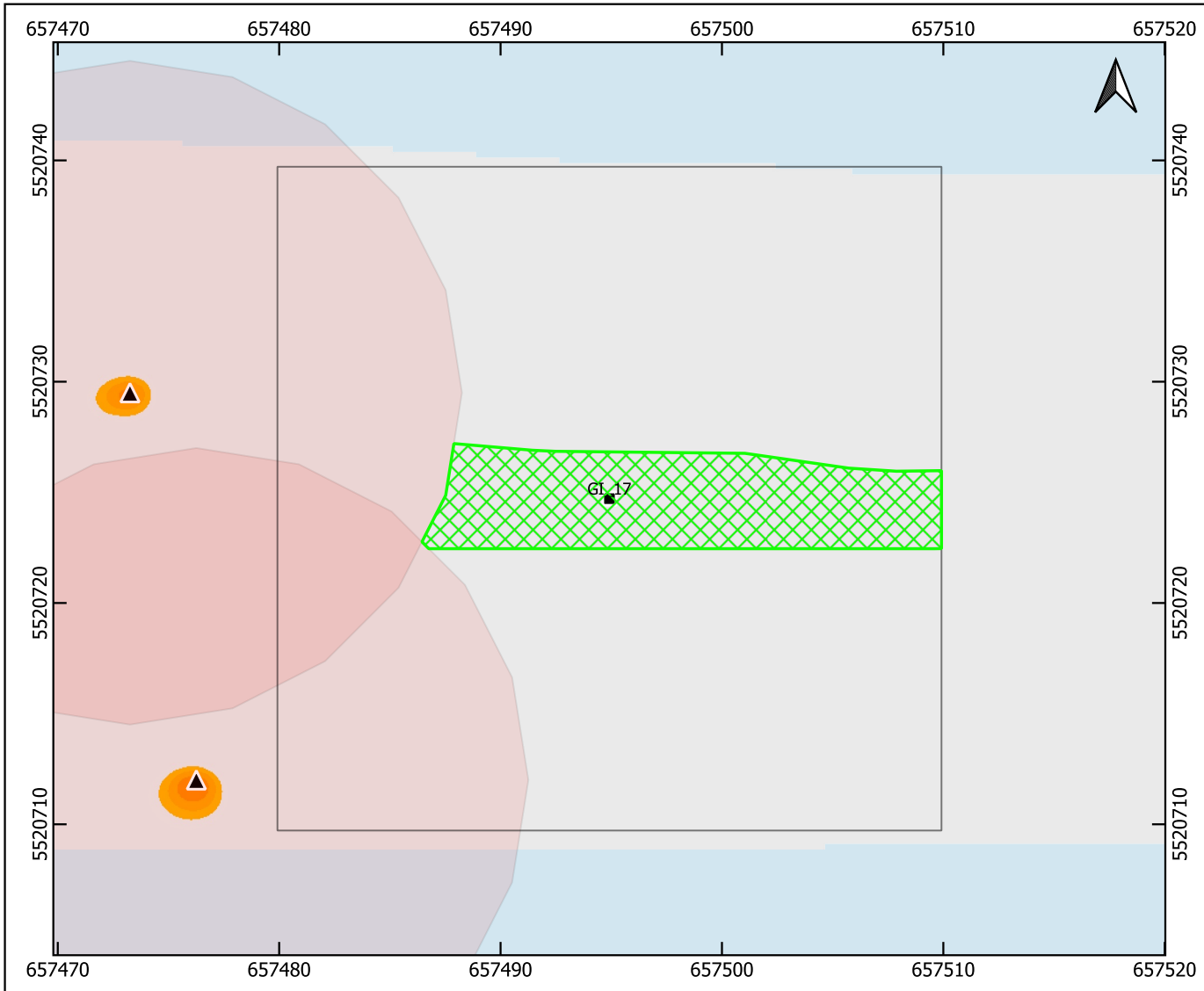
ALTERNATIVE LOCATION

ALARP Working area : 156 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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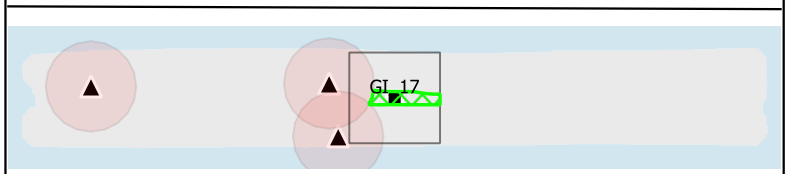
GEOQUIPMARINE

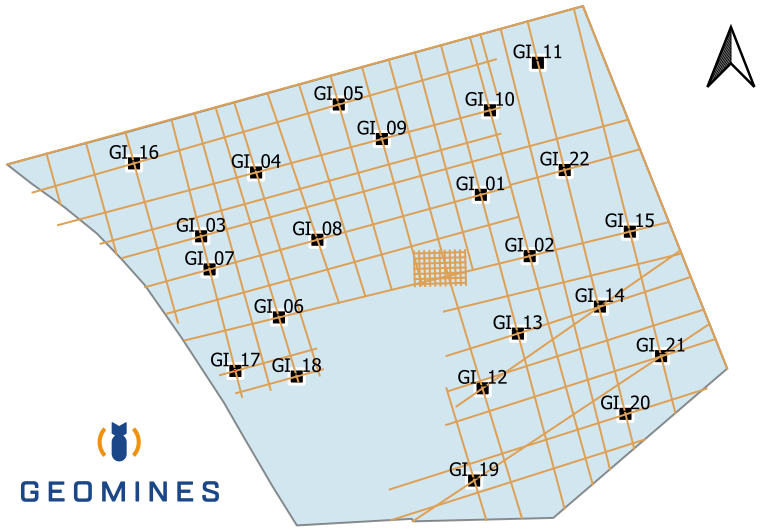
ANNEXE A: AO4 - GI_17
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

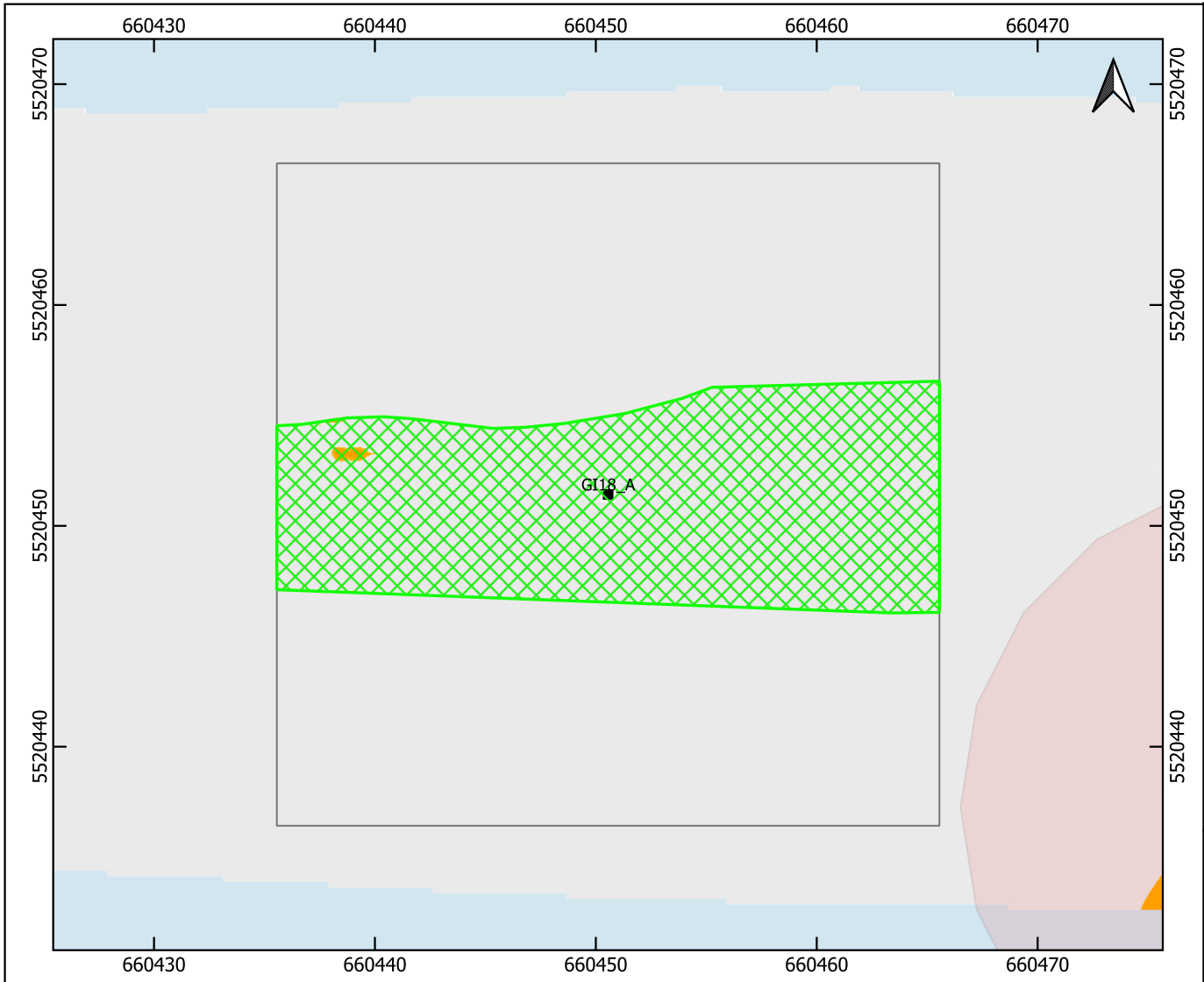
ORIGINAL LOCATION

ALARP Working area : 94 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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GEOQUIPMARINE

ANNEXE A: AO4 - GI18_A
ALARP CERTIFICATE GIS

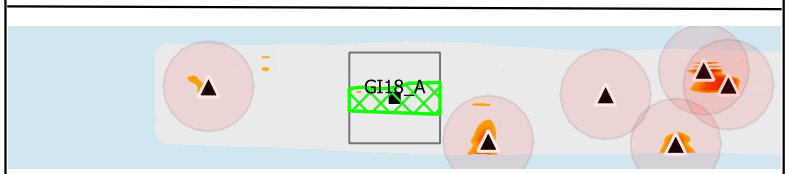
Scale: 1/300

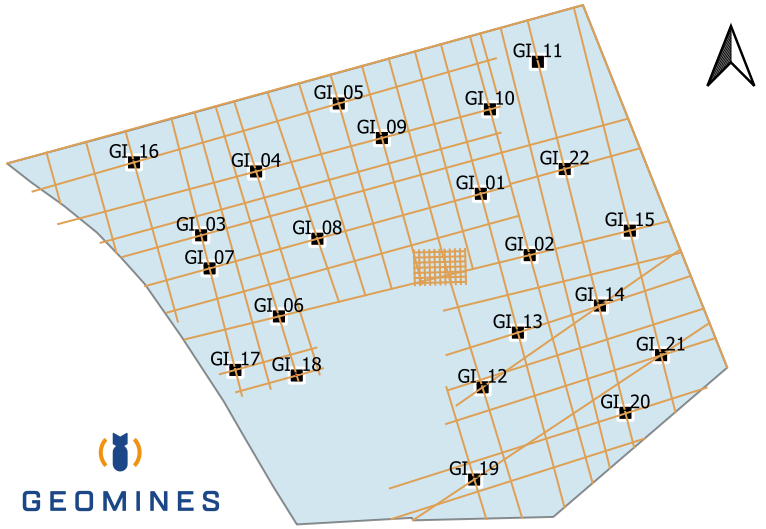
Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N

Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

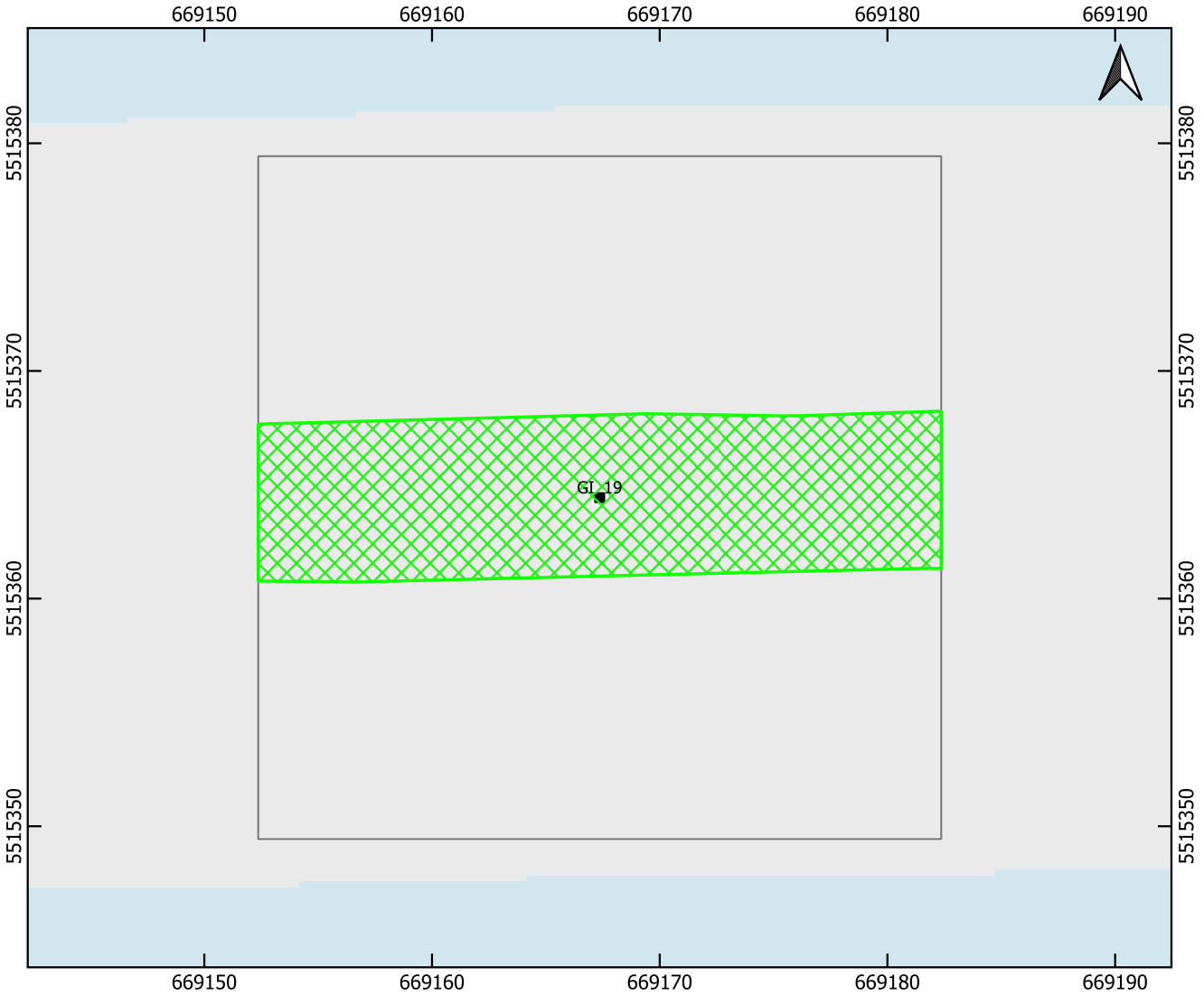
ALTERNATIVE LOCATION

ALARP Working area : 266 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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ÉCOLOGIQUE

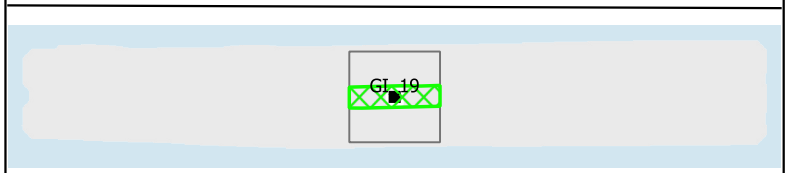
GEOQUIPMARINE

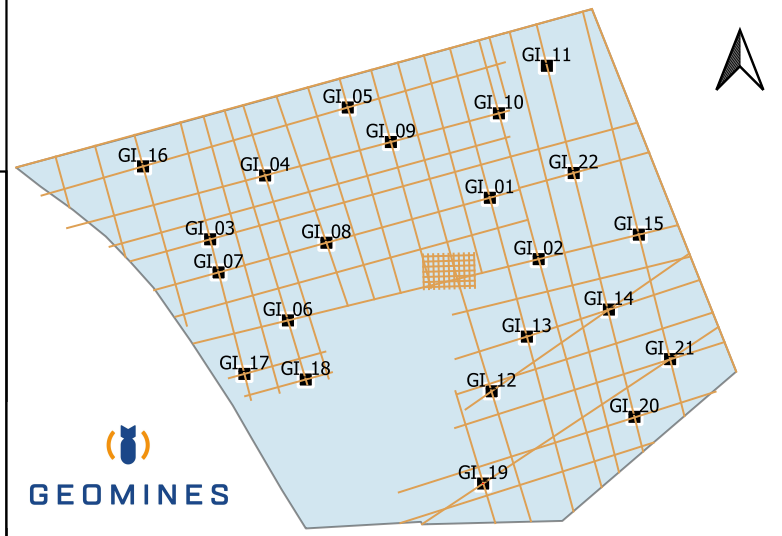
ANNEXE A: AO4 - GI_19
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

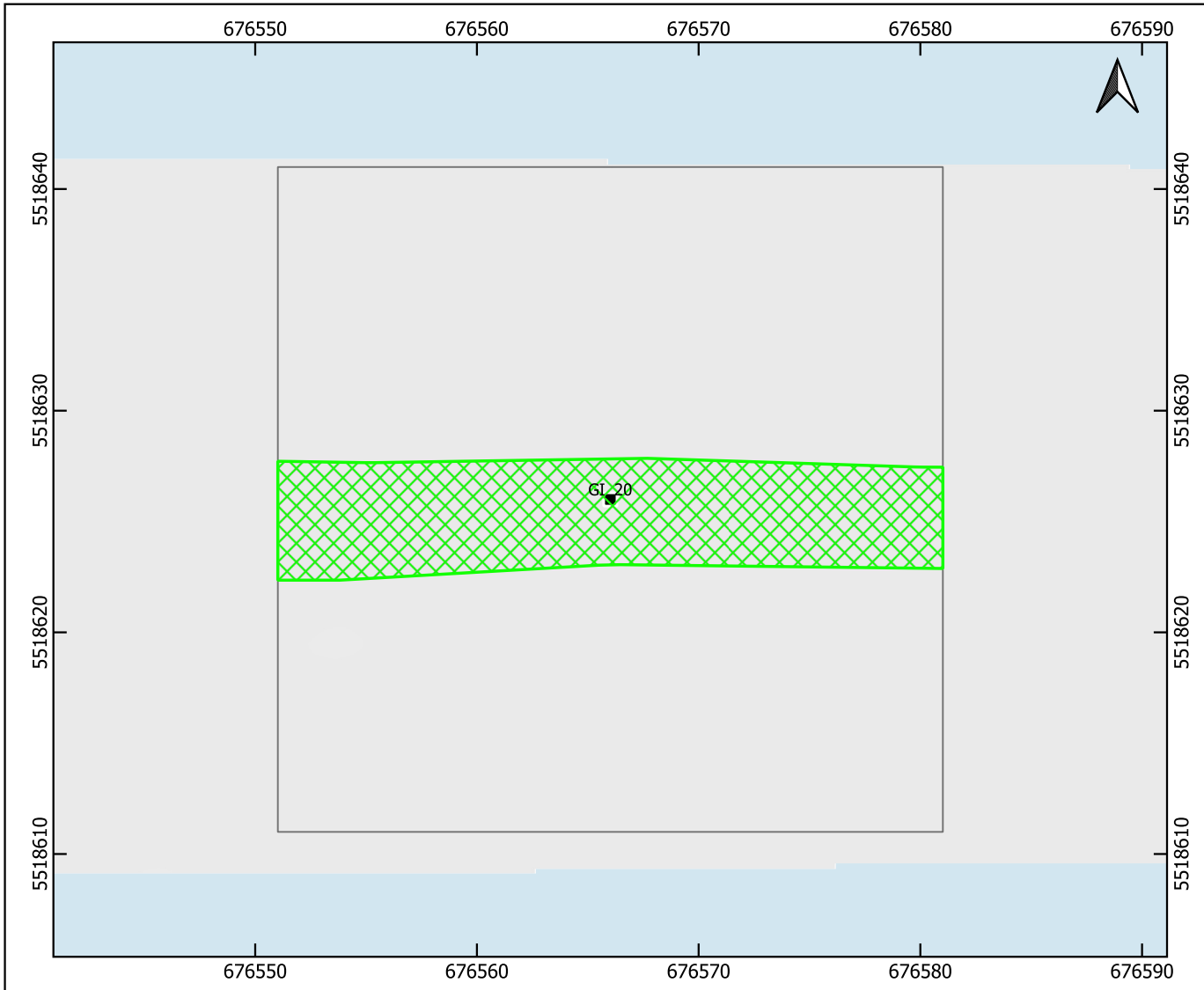
ORIGINAL LOCATION

ALARP Working area : 210 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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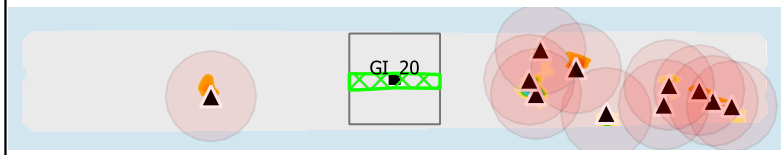
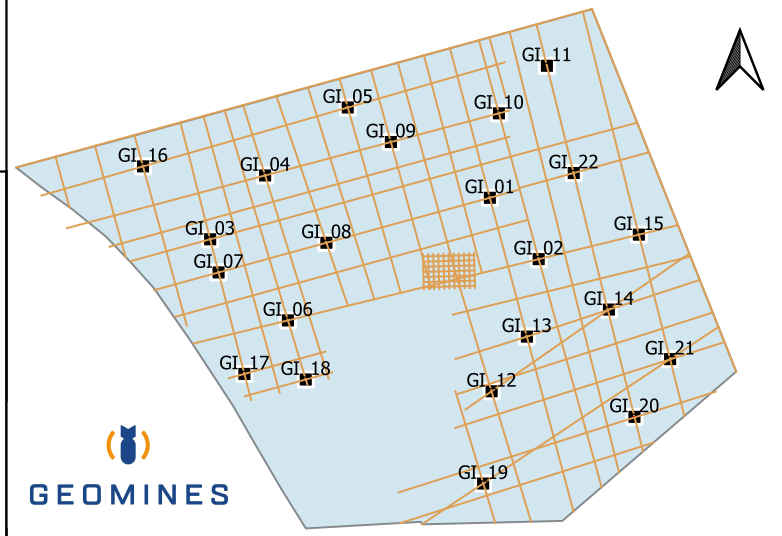
ANNEXE A: AO4 - GI_20
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

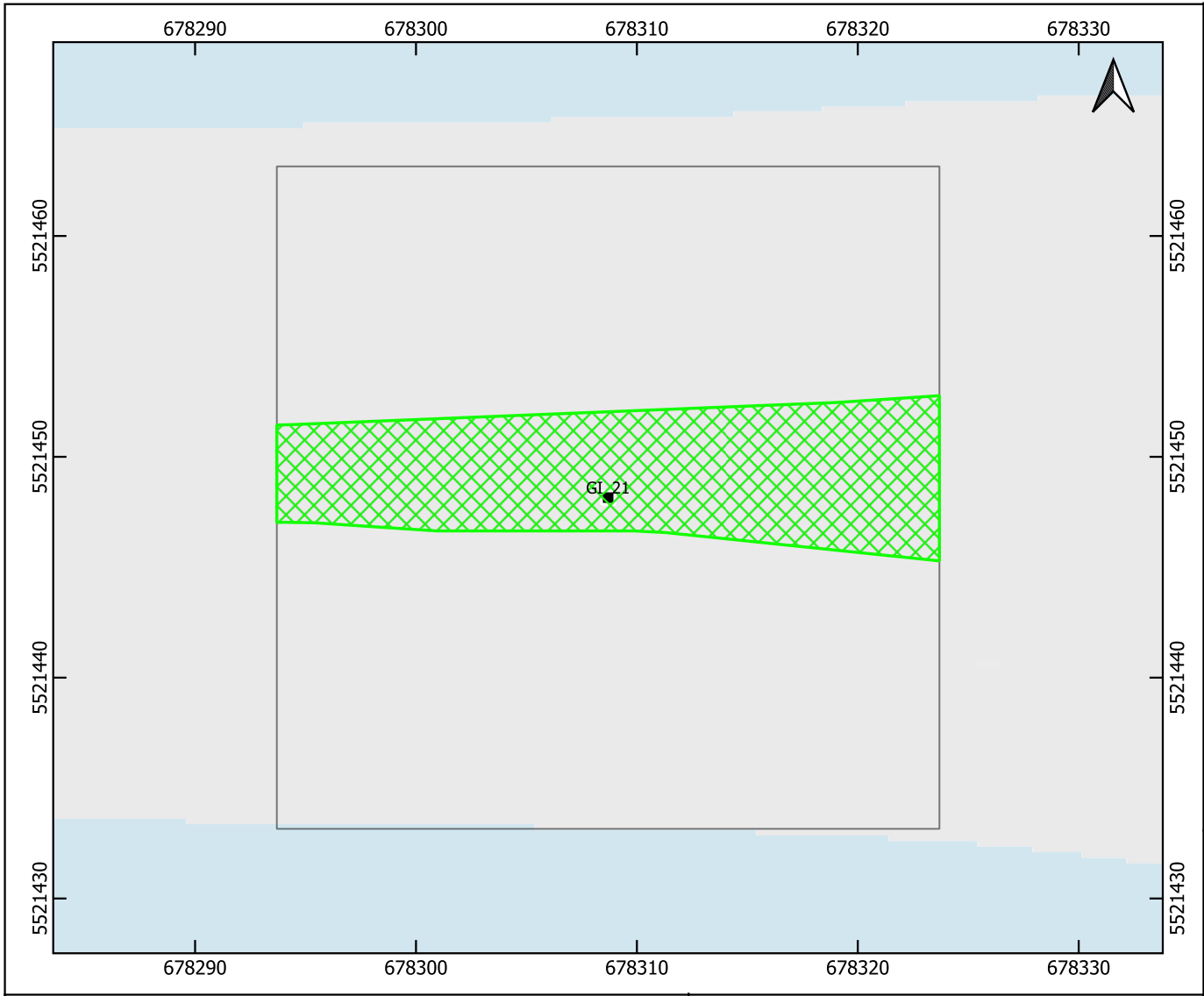
ORIGINAL LOCATION

ALARP Working area : 147 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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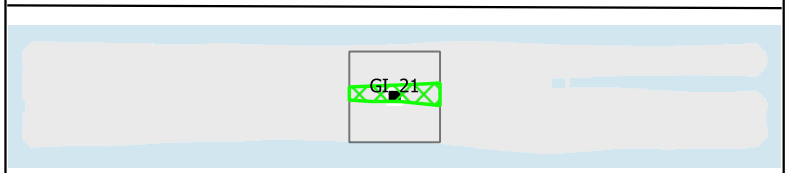
GEOQUIPMARINE

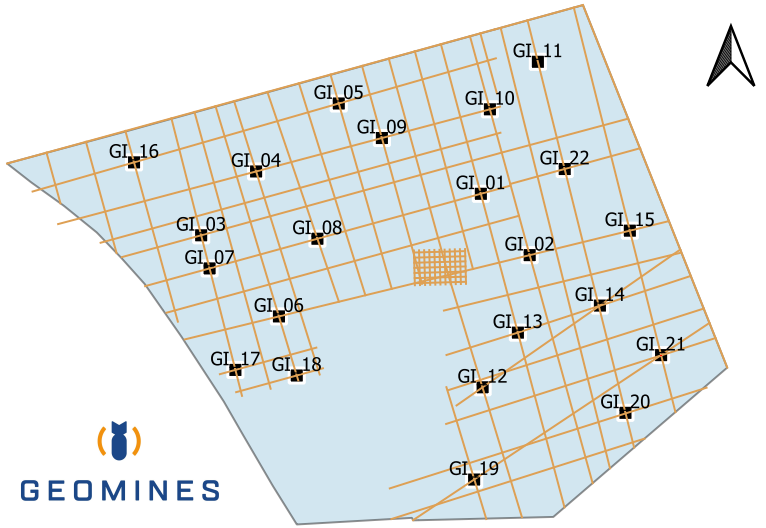
ANNEXE A: AO4 - GI_21
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

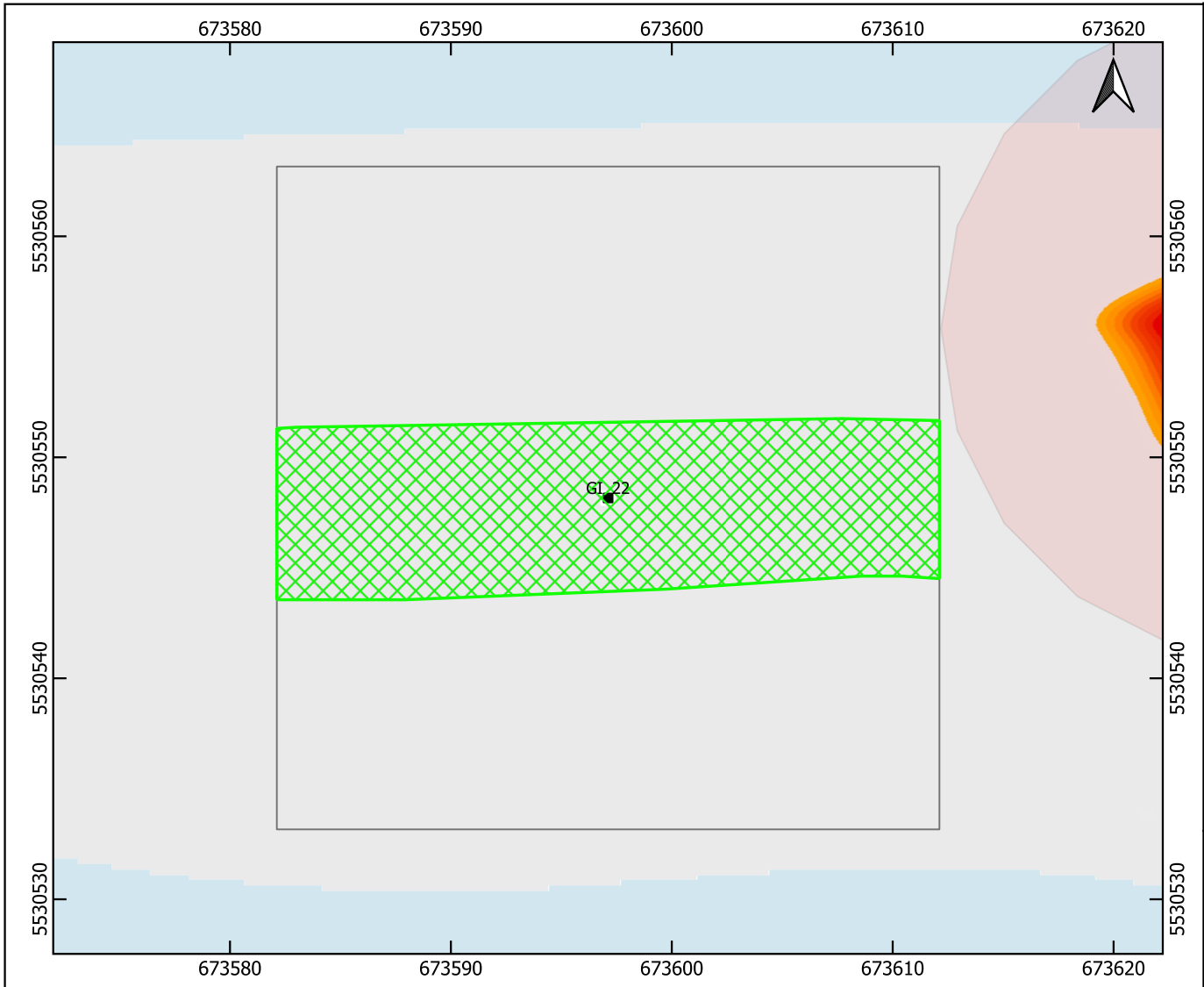
ORIGINAL LOCATION

ALARP Working area : 169 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)



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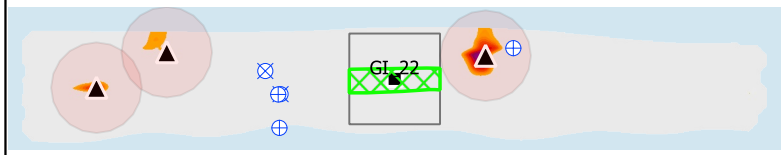
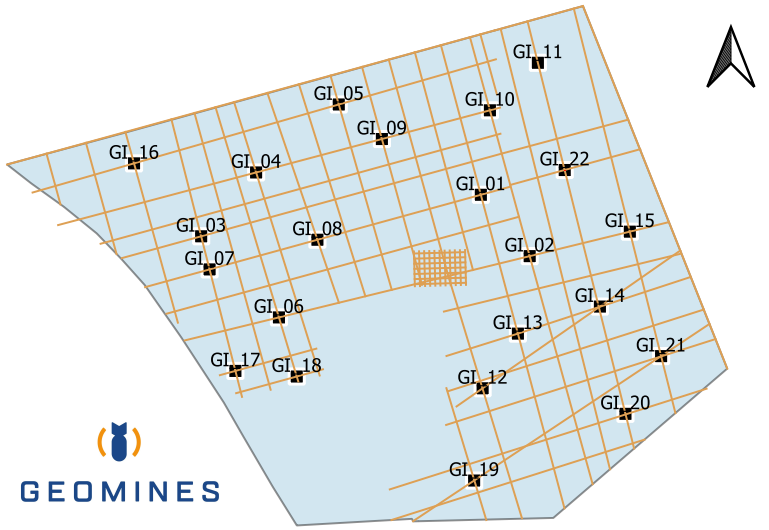
ANNEXE A: AO4 - GI_22
ALARP CERTIFICATE GIS

Scale: 1/300 Date: 2021-11-29

Geodesy : WGS 84 - UTM 30N Version: V0

0 5 10 15 20 m





GEOMINES

Concession

AO4_Concession area

Geotech locations

AO4_GI_Location_Box_30x30m

AO4_GI_Location_original

Seismic lines

A04_Planned UHR Lines

Targets

AO4_pUXO magnetic target

AO4_Mag_avoidance_area_buffer

AO4_MBES Contact

AO4_SSS Contact

ORIGINAL LOCATION

ALARP Working area : 227 square meters

ALARP_Working area

Residual Magnetic Field (nT)

Residual total magnetic field (nT)