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HELISTINGER

REPORT ON A HELICOPTER-BORNE AEROMAGNETIC GEOPHYSICAL SURVEY

PROJECT:	WEST MADSEN A, WEST MADSEN B AND DIXIE LAKE
LOCATION:	RED LAKE, ONTARIO
FOR:	GREAT BEAR RESOURCES
SURVEY FLOWN:	SEPTEMBER 2017
PROJECT:	GL170338

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GEOTECH
AIRBORNE GEOPHYSICAL SURVEYS

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EXECUTIVE SUMMARY

VALLARD PROJECT
FERMONT, QUEBEC

During September 18th, to October 3th 2017 Geotech Ltd. carried out a helicopter-borne geophysical survey over the West Madsen A, West Madsen B and Dixie Lake projects situated near Red Lake, Ontario.

The principal geophysical sensor was a caesium magnetometer. Ancillary equipment included a GPS navigation system, radar altimeter. A total of 2842 line-kilometres of geophysical data were acquired during the survey.

In-field data quality assurance and preliminary processing were carried out on a daily basis during the acquisition phase. Preliminary and final data processing, including generation of final digital data and map products were undertaken from the office of Geotech Ltd. in Aurora, Ontario.

The processed survey results are presented as the following maps:

- Total Magnetic Intensity (TMI) Reduced to the Pole (RTP),
- First Vertical Derivative (1VD) of the Total Magnetic Intensity Reduced to the Pole,
- Digital Terrain Model (DEM)

The survey report describes the procedures for data acquisition, processing, final image presentation and the specifications for the digital data set.

1. INTRODUCTION

1.1 GENERAL CONSIDERATIONS

Geotech Ltd. performed a helicopter-borne geophysical survey over the West Madsen A, West Madsen B and Dixie Lake projects situated near Red Lake, Ontario (Figure 1 & Figure 2).

Bob Singh represented Great Bear Resources during the data acquisition and data processing phases of this project.

The geophysical survey consisted of helicopter-borne aeromagnetics using a caesium magnetometer system. A total of 2842 line-km of geophysical data were acquired during the survey.

The crew was based out of Red Lake in Ontario, for the acquisition phase of the survey. Survey flying started on September 18th, 2017 and was completed on October 3th, 2017.

Data quality control and quality assurance, and preliminary data processing were carried out on a daily basis during the acquisition phase of the project. Final data processing followed immediately after the end of the survey. Final reporting, data presentation and archiving were completed from the Aurora office of Geotech Ltd. in October, 2017.

Figure 1: Survey location.

1.2 SURVEY AND SYSTEM SPECIFICATIONS

The survey areas were located south of Red Lake, Ontario (Figure 2).

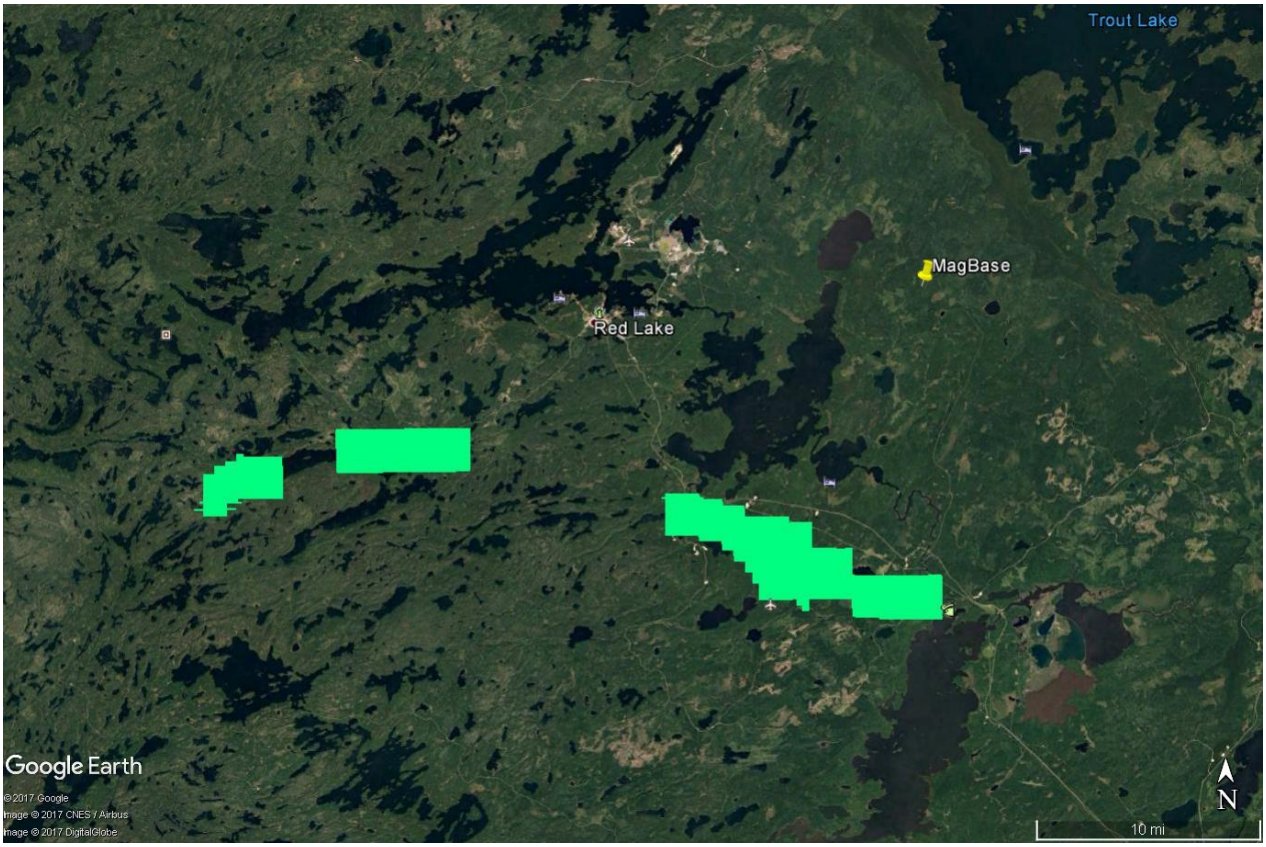


Figure 2: Survey area locations on Google Earth.

The survey areas was flown in a south to north (N 0° E azimuth) direction, with traverse line spacing of 50 metres as depicted in Figure 3. Tie lines were flown perpendicular to the traverse lines. For more detailed information on the flight spacing and direction see Table 1.

1.3 TOPOGRAPHIC RELIEF AND CULTURAL FEATURES

Topographically, the survey area exhibits a moderate relief with an elevation ranging from 360 to 462 metres for West Madsen A (A1), 366 to 436 metres for West Madsen B (A2) and 336 to 457 metres for Dixie Lake (A3) above mean sea level over an area of 121 square kilometres.

There are various rivers and streams running through the survey area which connect various lakes and wetlands. There are visible signs of culture such as roads, trails or buildings located in the survey area (Figure 3,4 and 5).

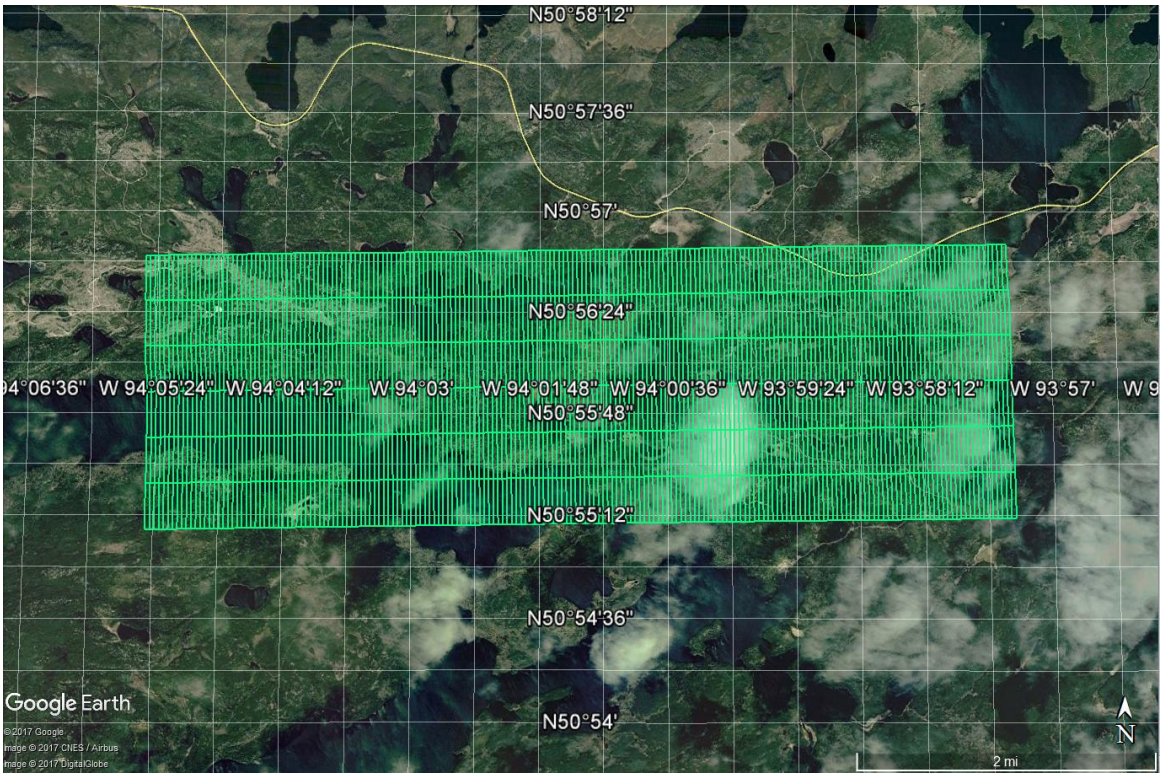


Figure 3: West Madsen A Flight path over a Google Earth Image

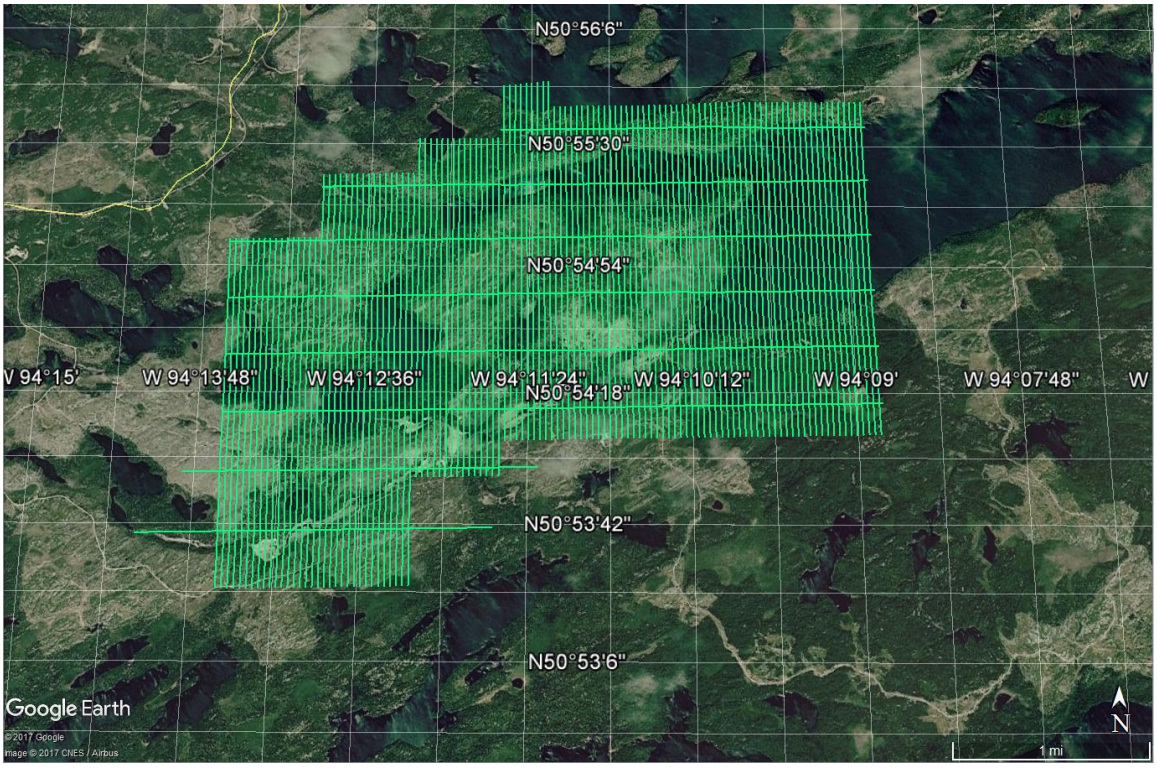


Figure 4: Flight path over a Google Earth Image

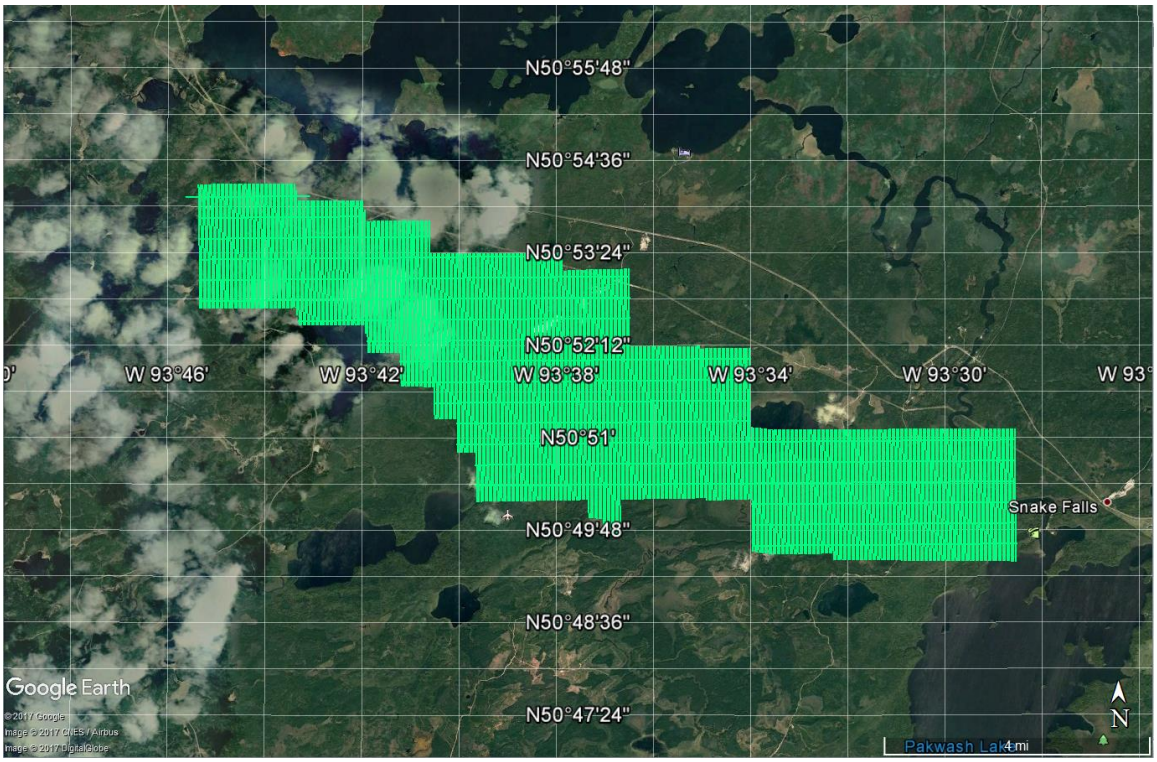


Figure 5: Flight path over a Google Earth Image

2. DATA ACQUISITION

2.1 SURVEY AREA

The survey area (see Figure 3, 4, 5 and Appendix A) and general flight specifications are as follows:

Table 1: Survey Specifications

Survey block	Line spacing (m)	Area (Km^2)	Planned[1] Line-km	Actual Line-km	Flight direction	Line numbers
West Madsen A	Traverse: 50	29	640	699	N 0° E / N 180° E	L1000 – L2900
	Tie: 500				N 90° E / N 270° E	T3000 – T3060
West Madsen B	Traverse: 50	17	388	412	N 0° E / N 180° E	L4000 – L5120
	Tie: 500				N 90° E / N 270° E	T6000 – T6070
Dixie Lake	Traverse: 50	75	1648	1731	N 0° E / N 180° E	L7000 – L10930
	Tie: 500				N 90° E / N 270° E	T11000 – T11170
TOTAL		121	2676	2842		

Survey area boundaries co-ordinates are provided in Appendix B.

2.2 SURVEY OPERATIONS

Survey operations were based out of Red Lake, Ontario from September 18th until October 6th 2017. The following table shows the timing of the flying.

Table 2: Survey schedule

Date	Flight #	Flown KM	Block	Crew location	Comments
18-Sep-17				Red Lake, Ontario	Mobilization
19-Sep-17				Red Lake, Ontario	Testing
20-Sep-17				Red Lake, Ontario	Testing
21-Sep-17				Red Lake, Ontario	Testing
22-Sep-17				Red Lake, Ontario	Testing
23-Sep-17				Red Lake, Ontario	Testing
24-Sep-17				Red Lake, Ontario	Testing
25-Sep-17				Red Lake, Ontario	Testing
26-Sep-17				Red Lake, Ontario	Testing
27-Sep-17	1	327	A2	Red Lake, Ontario	Operational
28-Sep-17	2.3	393.65	A2, A1	Red Lake, Ontario	Operational
29-Sep-17				Red Lake, Ontario	Troubleshooting
30-Sep-17	4	336.50	A1	Red Lake, Ontario	Operational
1-Oct-17	5,6	475.37	A3	Red Lake, Ontario	Operational
2-Oct-17	7,8	214.47	A3	Red Lake, Ontario	Operational
3-Oct-17	9,10	534	A3	Red Lake, Ontario	Operational
4-Oct-17	11,12	407.88	A3	Red Lake, Ontario	Operational
5-Oct-17				Red Lake, Ontario	Demobilization
6-Oct-17				Red Lake, Ontario	Demobilization

[1] Note: Actual Line kilometres represent the total line kilometres in the final database. These line-km normally exceed the Planned Line-km, as indicated in the survey NAV files.

2.3 FLIGHT SPECIFICATIONS

During the survey the helicopter was maintained at a mean altitude of 31 metres above the ground with a nominal survey speed of 140 km/hour.

The on-board operator was responsible for monitoring the system integrity. The operator also maintained detailed flight logs during the survey, tracking the times of the flight as well as any unusual geophysical or topographic features.

On return of the aircrew to the base camp the survey data was transferred from a compact flash card (PCMCIA) to the data processing computer. The data were then uploaded via ftp to the Geotech office in Aurora for daily quality assurance and quality control by qualified personnel.

2.4 AIRCRAFT AND EQUIPMENT

2.4.1 SURVEY AIRCRAFT

The survey was flown using an Aerospatiale A-Star 350 B3, registration KOI. The helicopter is owned and operated by Geotech Aviation. Installation of the geophysical and ancillary equipment was carried out by a Geotech Ltd crew.

2.4.2 AIRBORNE MAGNETOMETER

The magnetic sensor utilized for the survey was Geometrics optically pumped cesium vapour magnetic field sensor was installed inside the stinger. The sensitivity of the magnetic sensor is 0.01 nanoTesla (nT) at a sampling interval of 0.025 seconds or at sampling frequency of 40Hz.

2.4.3 MAGNETIC COMPENSATION SYSTEM

The magnetic data were compensated in real-time using an RMS Instruments AARC510 Compensator, utilizing a three-axis (XYZ) Fluxgate magnetometer to measure roll, pitch and yaw movements of the survey aircraft. A 26-term model of the aircraft magnetic noise was determined during a pre-survey test flight, removing permanent, induced, and eddy current fields from the airborne magnetic measurements.

2.4.4 ALTIMETER

A Terra TRA 3000/TRI 40 radar altimeter was used to record terrain clearance.

Figure 6: System Configuration.

2.4.5 GPS NAVIGATION SYSTEM

The navigation system used was a Geotech PC104 based navigation system utilizing a NovAtel's WAAS (Wide Area Augmentation System) enabled GPS receiver, Geotech navigation software, a full screen display with controls in front of the pilot to direct the flight and a NovAtel GPS antenna mounted on the helicopter tail (Figure 6). As many as 11 GPS and two WAAS satellites may be monitored at any one time. The positional accuracy or circular error probability (CEP) is 1.8 m; with WAAS active, it is 1.0 m. The co-ordinates of the block were set-up prior to the survey and the information was fed into the airborne navigation system.

2.4.6 DIGITAL ACQUISITION SYSTEM

A Geotech data acquisition system recorded the digital survey data on an internal compact flash card. Data is displayed on an LCD screen as traces to allow the operator to monitor the integrity of the system. The data type and sampling interval as provided in Table 3.

Table 3: Acquisition Sampling Rates

Data Type	Sampling
Magnetometer	0.025 sec
GPS Position	0.2 sec
Pressure and Temperature	1 sec
Radar Altimeter	0.2 sec

2.5 BASE STATION MAGNETOMETER

A dedicated computer including a high sensitivity base station cesium magnetometer and a GPS system to record the GPS time together with the magnetic data was employed to record diurnal magnetic activity. A Geometrics G822B high-sensitivity caesium vapour magnetometer and integrated GPS unit for accurate time synchronization was used with 10Hz data output. Digital recordings of the ground magnetometer were recorded at all times during the survey. The digital data include the date, an absolute value of the magnetic field, and GPS time with accurate synchronization to the aircraft data acquisition system.

The base station magnetometer sensor was installed near the landing site, away from electric transmission lines and moving ferrous objects such as motor vehicles. The base station data were backed-up to the data processing computer at the end of each survey day.

2.6 GPS GROUND BASE STATION

A dedicated Novatel PROPAK-V3_TR20 GPS receiver and a dedicated ground based GPS antenna was used with a 10Hz Raw GPS data recording. Post-flight differential GPS data processing utilizing Novatel GrafNav 8.3 software was used to produce sub-meter accuracy of the airborne system location at 10Hz sampling interval.

3. PERSONNEL

The following Geotech Ltd. personnel were involved in the project.

FIELD:

Project Manager:	Darren Tuck (Office)
Data QC:	Thomas Wade (Office)
Crew chief:	Colin Lennox
Operator:	n/a

The survey pilot and the mechanical engineer were employed directly by the helicopter operator – Geotech Aviation.

Pilot:	Wally Zek
Mechanical Engineer:	n/a

OFFICE:

Preliminary Data Processing:	Thomas Wade
Final Data Processing:	Adam Schubert
Data QA/QC:	Geoffrey Plastow, P.Geo and Data Processing Manager Zihao Han
Reporting/Mapping:	Joseli Soares

Processing phases were carried out under the supervision of Alexander Prikhodko, P.Geo, PhD, and Director of Geophysics. The customer relations were looked after by David Hitz.

4. DATA PROCESSING AND PRESENTATION

Data compilation and processing were carried out by the application of Geosoft Oasis Montaj and programs proprietary to Geotech Ltd.

4.1 FLIGHT PATH

The flight path, recorded by the acquisition program as WGS 84 latitude/longitude, was converted into the WGS84 Datum, UTM Zone 15 North coordinate system in Oasis Montaj.

The flight path was drawn using linear interpolation between x, y positions from the navigation system. Positions are updated every second and expressed as UTM easting's (x) and UTM northing's (y).

4.2 MAGNETIC DATA

The processing of the magnetic data involved a correction for diurnal variations by using the digitally recorded ground base station magnetic values. The base station magnetometer data was edited and merged into the Geosoft GDB database on a daily basis. The aeromagnetic data was corrected for diurnal variations by subtracting the observed magnetic base station deviations.

Tie line levelling was carried out by adjusting intersection points along traverse lines. A micro-levelling procedure was applied to remove persistent low-amplitude components of flight-line noise remaining in the data.

The corrected magnetic data was interpolated between survey lines using a random point gridding method to yield x-y grid values for a standard grid cell size of 10 metres at the mapping scale. The Bi Directional gridding algorithm was used to interpolate values onto a rectangular regular spaced grid.

5. DELIVERABLES

5.1 SURVEY REPORT

The survey report describes the data acquisition, processing, and final presentation of the survey results. The survey report is provided in two paper copies and digitally in PDF format.

5.2 MAPS

Final maps were produced at scale of 1:50,000 for best representation of the survey size and line spacing. The coordinate/projection system used was WGS84 Datum, UTM Zone 15 North. All maps show the flight path trace and topographic data; latitude and longitude are also noted on maps.

The preliminary and final results of the survey are presented as a colour TMI contour map and vertical derivative colour maps.

- Maps at 1:50,000 in Geosoft MAP format, as follows:

  GL170338_50k_TMI_RTP: Total Magnetic Intensity (TMI) Reduced to the Pole (RTP)
  GL170338_50k_DEM: Digital Elevation Model (DEM)
  GL170338_50k_TMI_RTP_1VD: 1VD Total Magnetic Intensity Reduced to the Pole

- Maps are also presented in PDF format.

- The topographic data base was derived from 1:50,000 Natural Resources Canada NTDB data www.geogratis.ca

- A Google Earth file *GL170338_GreatBearResources.kml* showing the flight path of the block is included. Free versions of Google Earth software from: http://earth.google.com/download-earth.html

5.3 DIGITAL DATA

Two copies of the data on DVD were prepared to accompany the report. Each DVD contains a digital file of the line data in GDB Geosoft Montaj format as well as the maps in Geosoft Montaj Map and PDF format.

- DVD structure.
  Data contains databases, grids and maps, as described below.
  Report contains a copy of the report and appendices in PDF format.

Databases in Geosoft GDB format, containing the channels listed in Table 4.

Table 4: Geosoft GDB Data Format

Channel Name	Description
X	X Easting Positional data (meters)
Y	Y Northing Positional data (meters)
Z	GPS antenna elevation (meters – ASL)
Lines	Flight Line Number
Longitude	WGS84 GPS longitude (decimal degrees)
Latitude	WGS84 GPS latitude (decimal degrees)
gtime	UTC time, second of the day
Radar	Aircraft Terrain Clearance from Radar altimeter (metres)
DEM	Digital elevation model derived from Radar altimeter (metres)
Mag1	De-spiked and compensated Total Magnetic field (nT)
Basemag	Magnetic diurnal variation (nT)
Mag2	Parallax & diurnal corrected Total Magnetic field (nT)
TMI	Levelled Total Magnetic field (nT)
TMI_IGRF	Total Magnetic intensity IGRF removed (nT)
Fiducial	Fiducial
Flux_X	Fluxgate magneticometer x component
Flux_Y	Fluxgate magneticometer y component
Flux_Z	Fluxgate magneticometer z component
IGRF	International Geomagnetic Reference Field (nT)

- Grids in Geosoft GRD and GeoTIFF format, as follows:

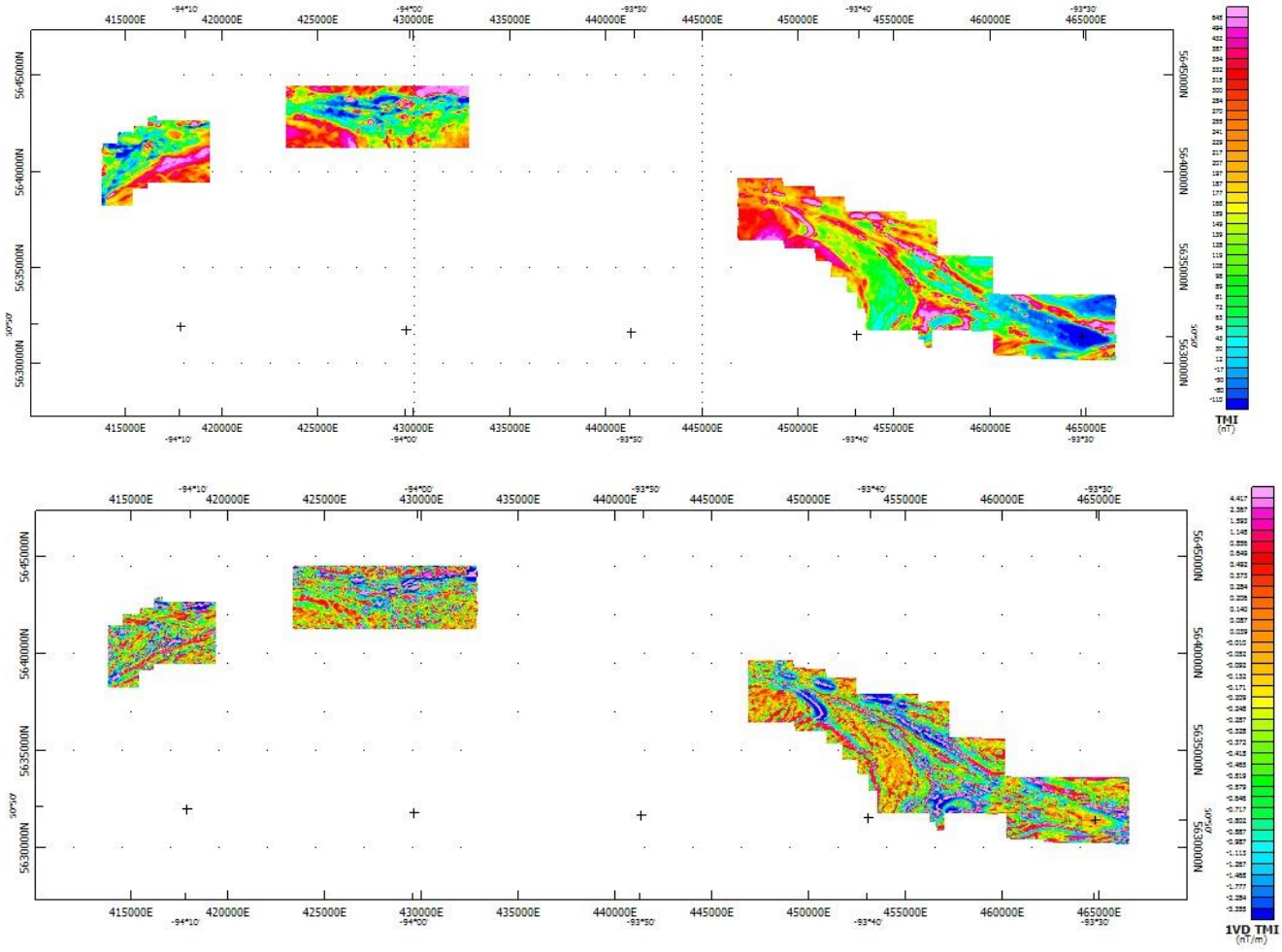
  TMI: Total magnetic intensity (nT)
  TMI_RTP: Total magnetic intensity reduced to the pole (nT)
  TMI_RTP_1VD: First Vertical Derivative of the Reduced to Pole TMI (nT)
  DEM: Digital Elevation Model (metres)

  A Geosoft .GRD file has a .GI metadata file associated with it, containing grid projection information. A grid cell size of 10 metres was used.

6. CONCLUSIONS AND RECOMMENDATIONS

A helicopter-borne geophysical survey has been completed over the West Madsen A, West Madsen B and Dixie Lake projects situated near Red Lake, Ontario.

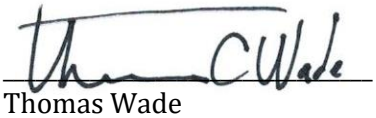
The total area coverage is 121 km^2. Total survey line coverage 2842 line kilometres. The principal sensor was a high-sensitivity caesium magnetometer. Results have been presented as contour colour images at a scale of 1:50,000.



Based on the geophysical results obtained a formal magnetic interpretation is recommended and can be completed by Geotech. This includes the definition of magnetic units, structural interpretation and 3D magnetic vector inversion of the acquired magnetic data. Further analysis of the data is recommended through supervised classification with other geoscientific datasets, geology and combined analysis with Landsat imagery.

Respectfully submitted[2],

Respectfully submitted[3],



Thomas Wade
Geotech Ltd.

Adam Schubert
Geotech Ltd.

_____

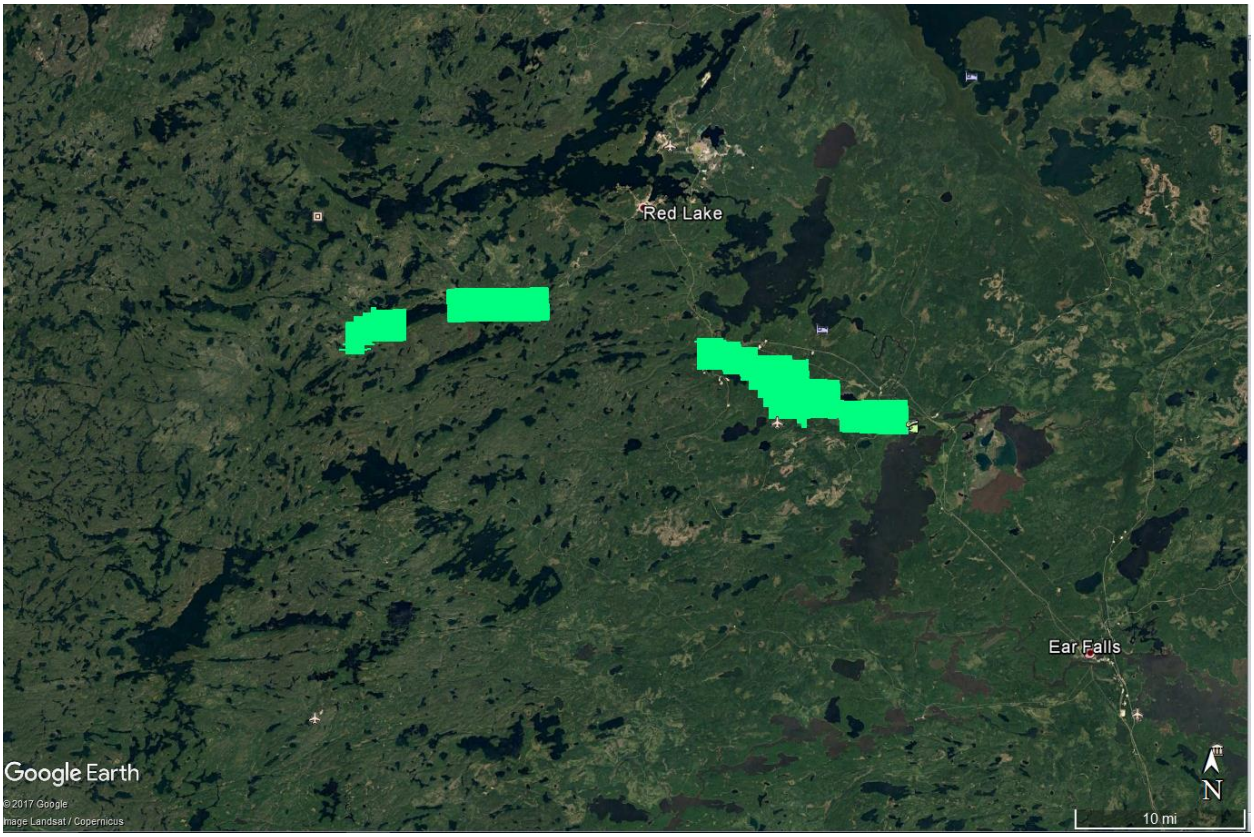
Geoffrey Plastow, P. Geo.
Data Processing Manager
Geotech Ltd.

October, 2017

[2] Final data processing of the magnetic data were carried out by Adam Schubert, from the office of Geotech Ltd. in Aurora, Ontario, under the supervision of Geoffrey Plastow, P.Geo. Data Processing Manager and and Nasreddine Bournas, P. Geo (OGQ#1235).

APPENDIX A

SURVEY AREA LOCATION MAP



Overview of the Survey Area

APPENDIX B

SURVEY AREA COORDINATES

(WGS 84, UTM Zone 15 North)

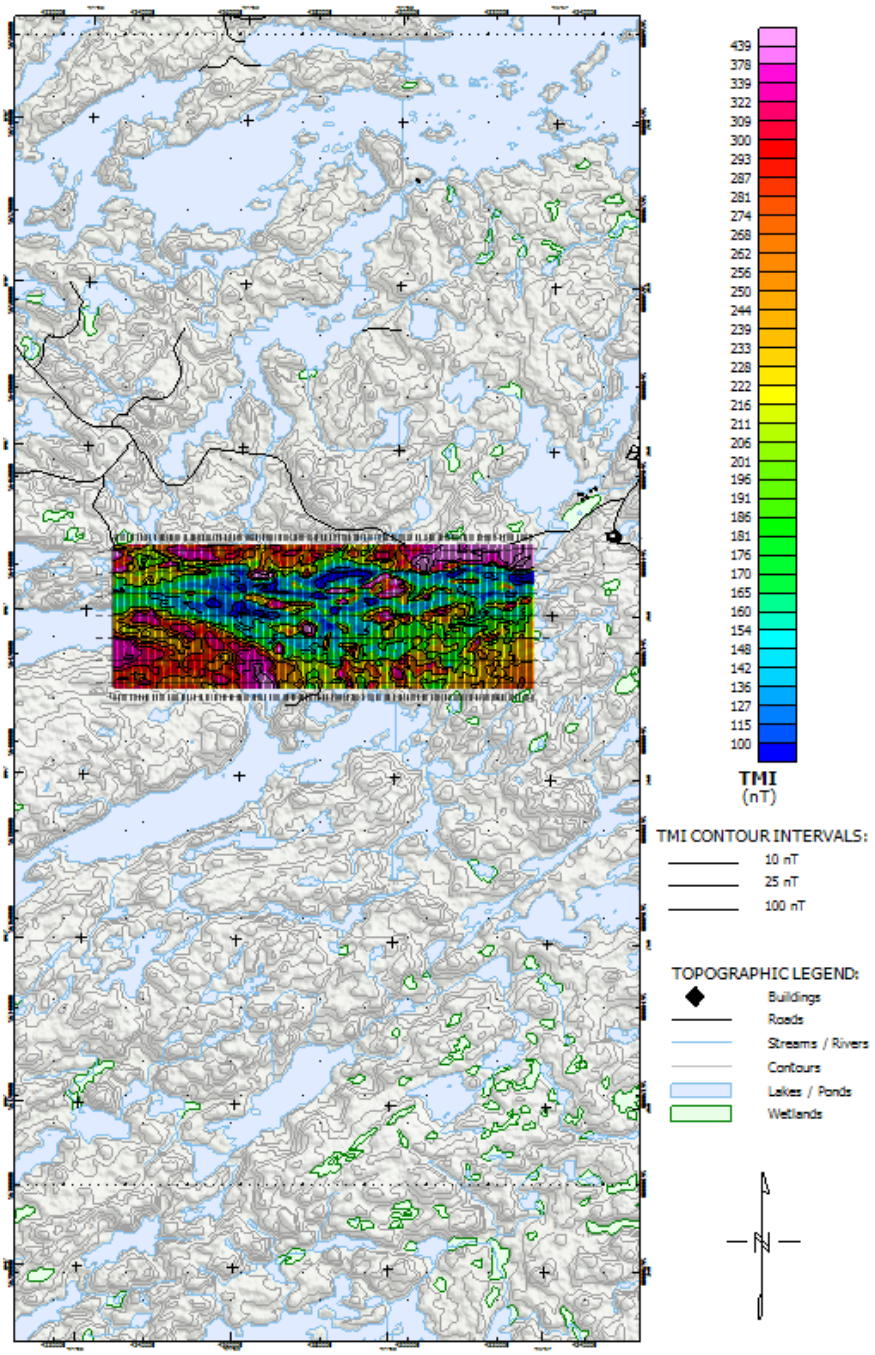
West Madsen A	
X	Y
423300	5644339
423300	5641339
432800	5641339
432800	5644339

West Madsen B	
X	Y
419361	5642528
416529	5642528
416528	5642771
416099	5642728
416096	5642227
415327	5642227
415329	5641910
414511	5641912
414510	5641333
413727	5641328
413727	5638328
415328	5638328
415327	5639227
416096	5639227
416085	5639527
419361	5639528

Dixie Lake	
X	Y
419361	5642528
416529	5642528
416528	5642771
416099	5642728
416096	5642227
415327	5642227
415329	5641910
414511	5641912
414510	5641333
413727	5641328
413727	5638328
415328	5638328
415327	5639227
416096	5639227
416085	5639527
419361	5639528

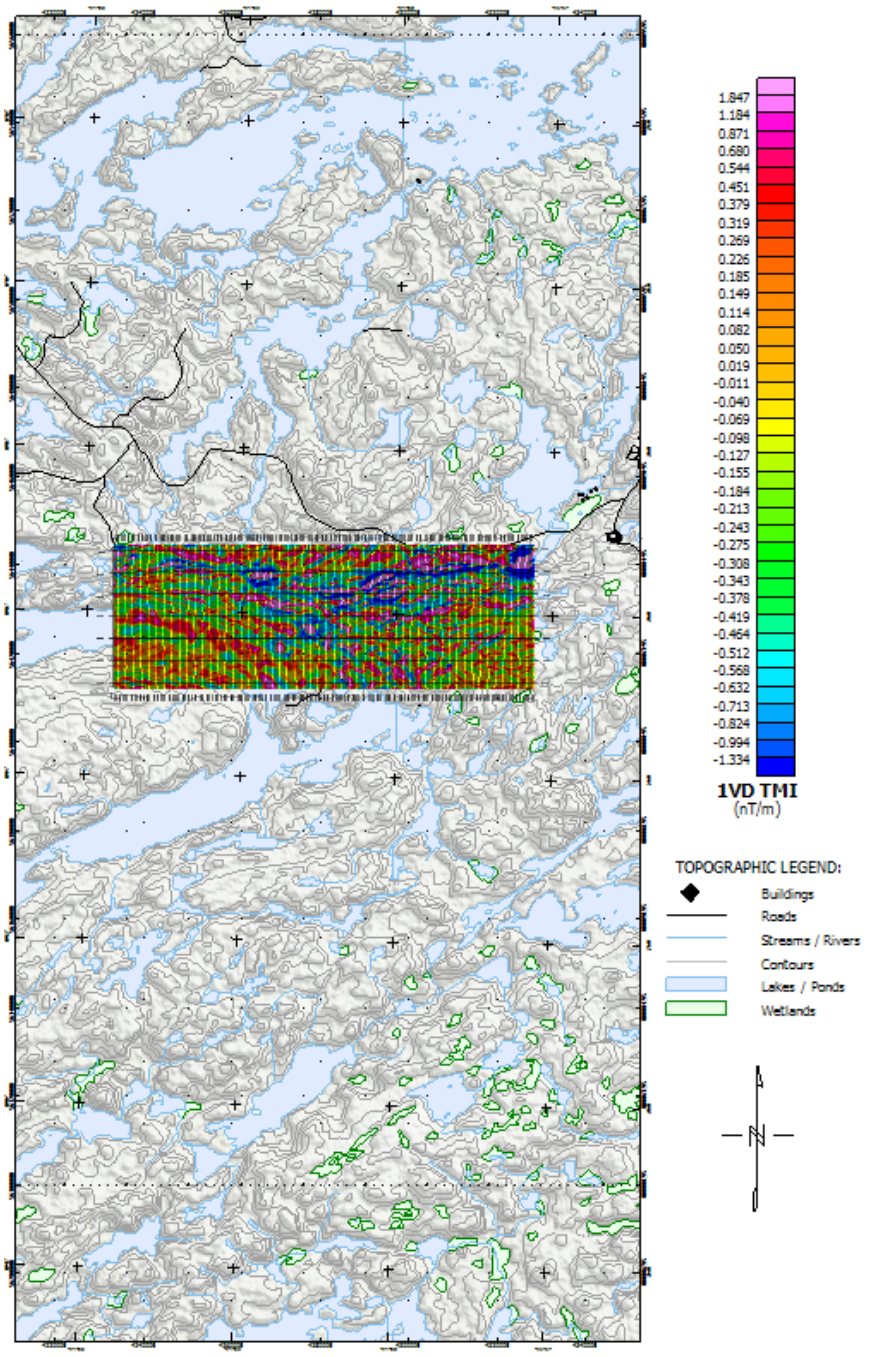
APPENDIX C

GEOPHYSICAL MAPS[1]

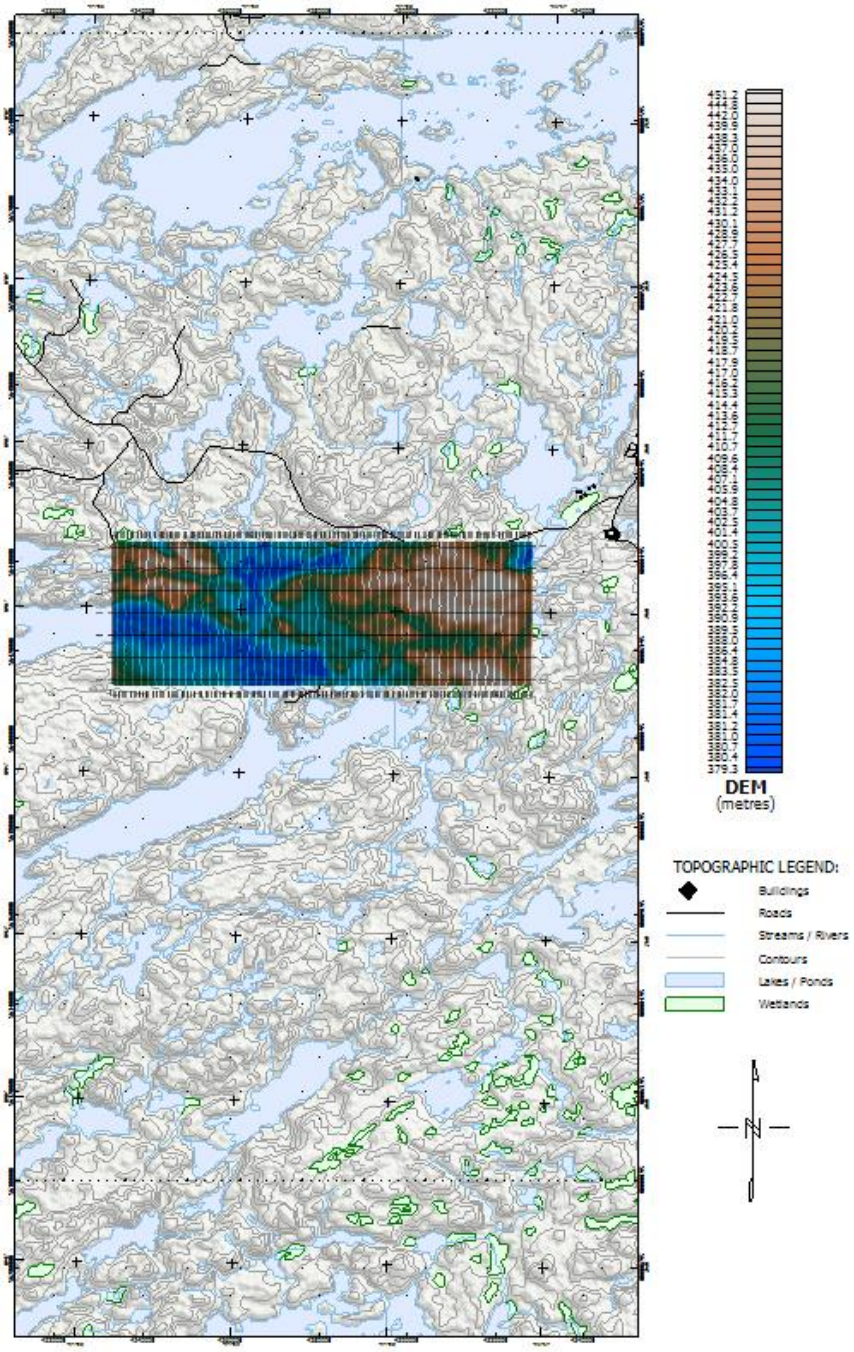


Total Magnetic Intensity (TMI) Reduced to the Pole (RTP) – West Madsen A (A1)

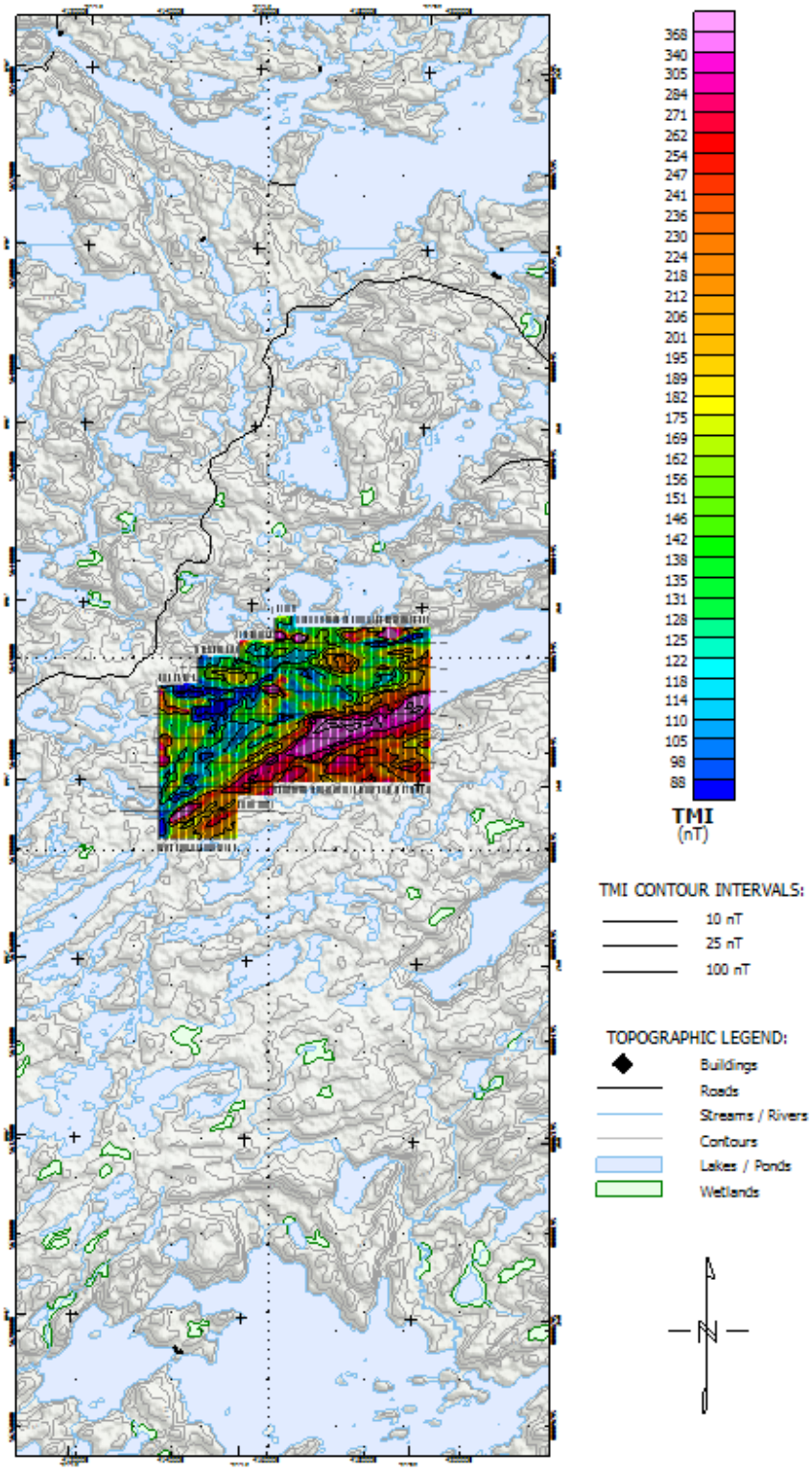
[1] Full size geophysical maps are also available in PDF format on the final DVD



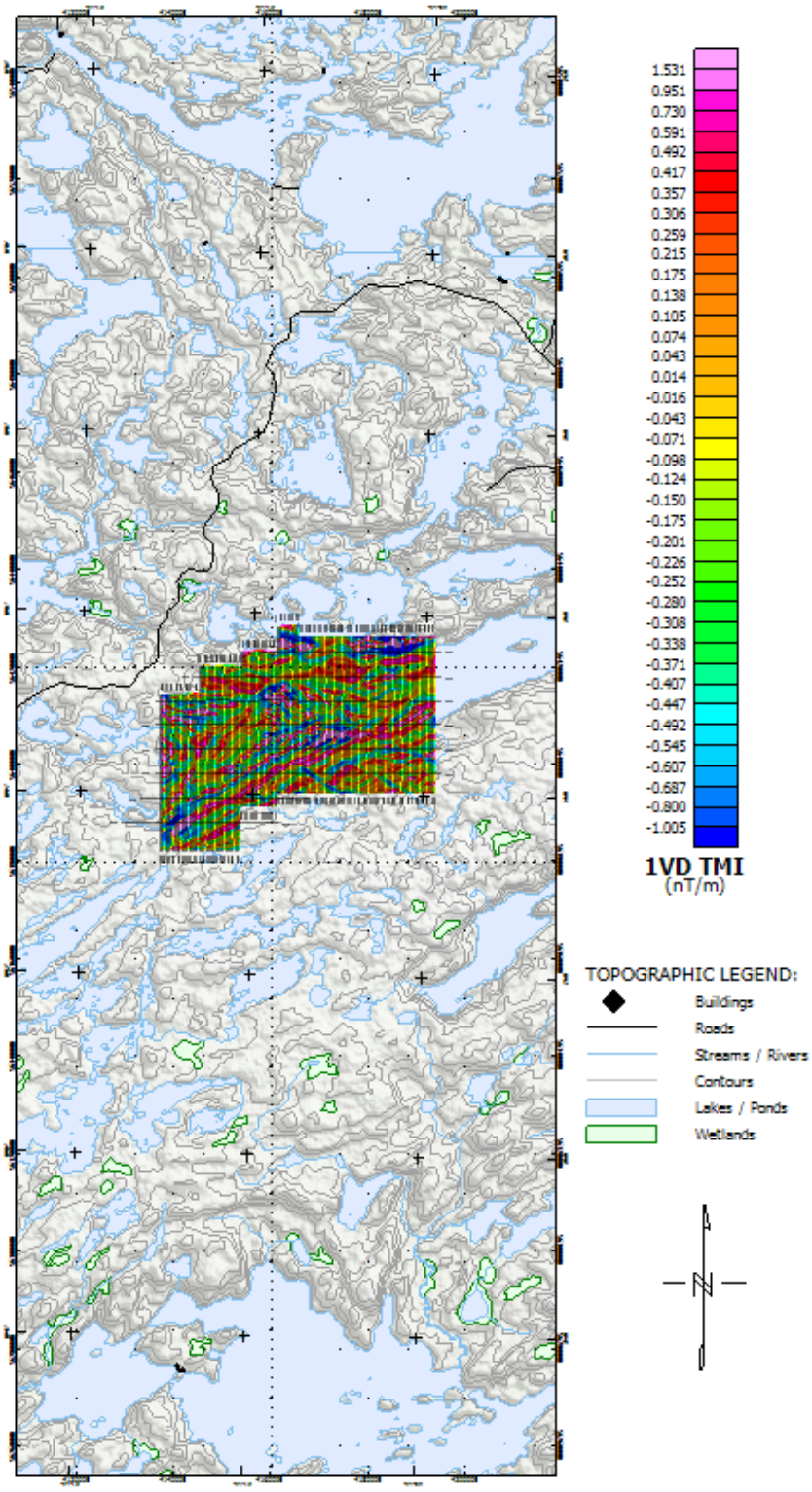
Total Magnetic Intensity (TMI) Reduced to the Pole (RTP) First Vertical Derivative (1VD) – West Madsen A (A1)



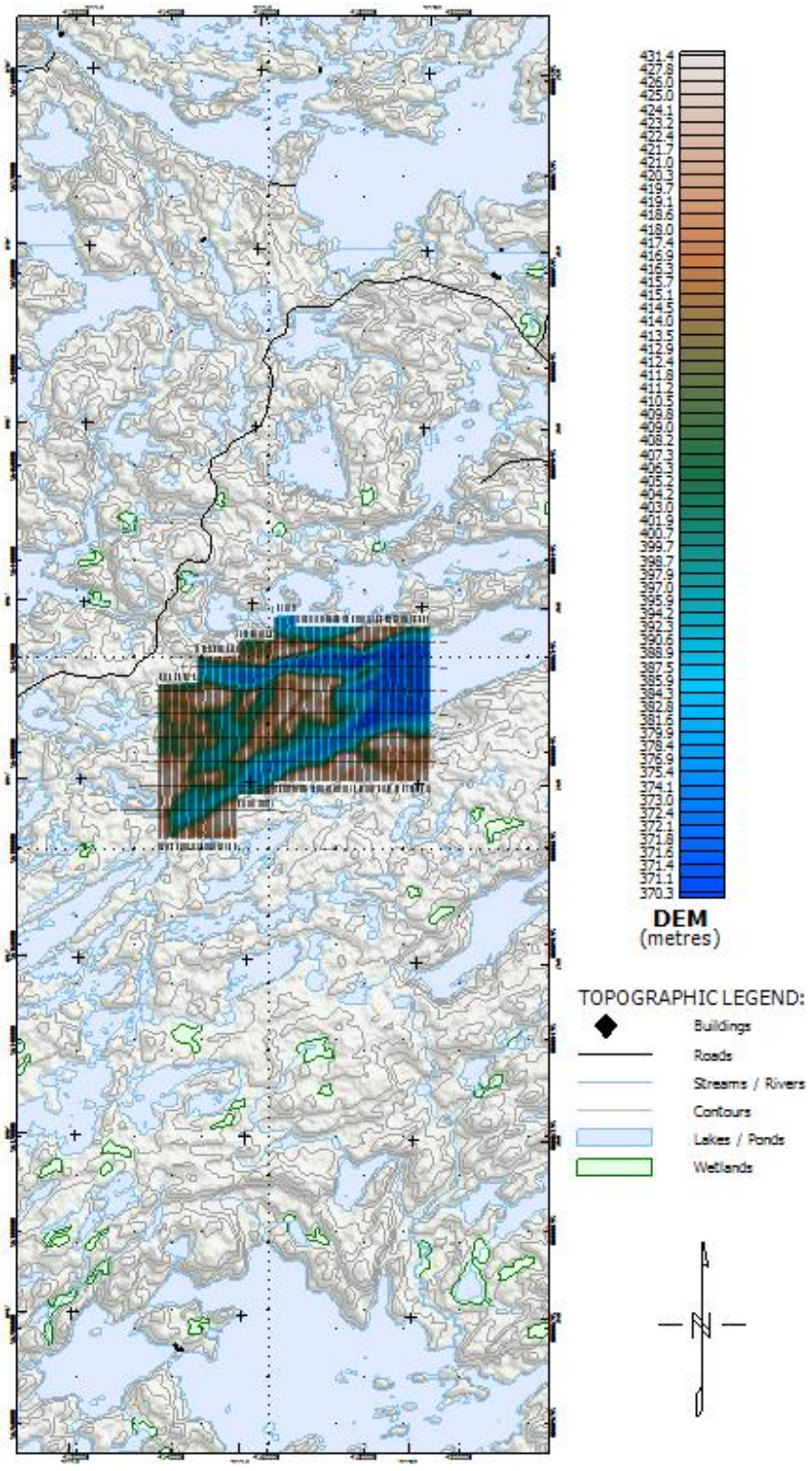
Digital Elevation Model (DEM) – West Madsen A (A1)



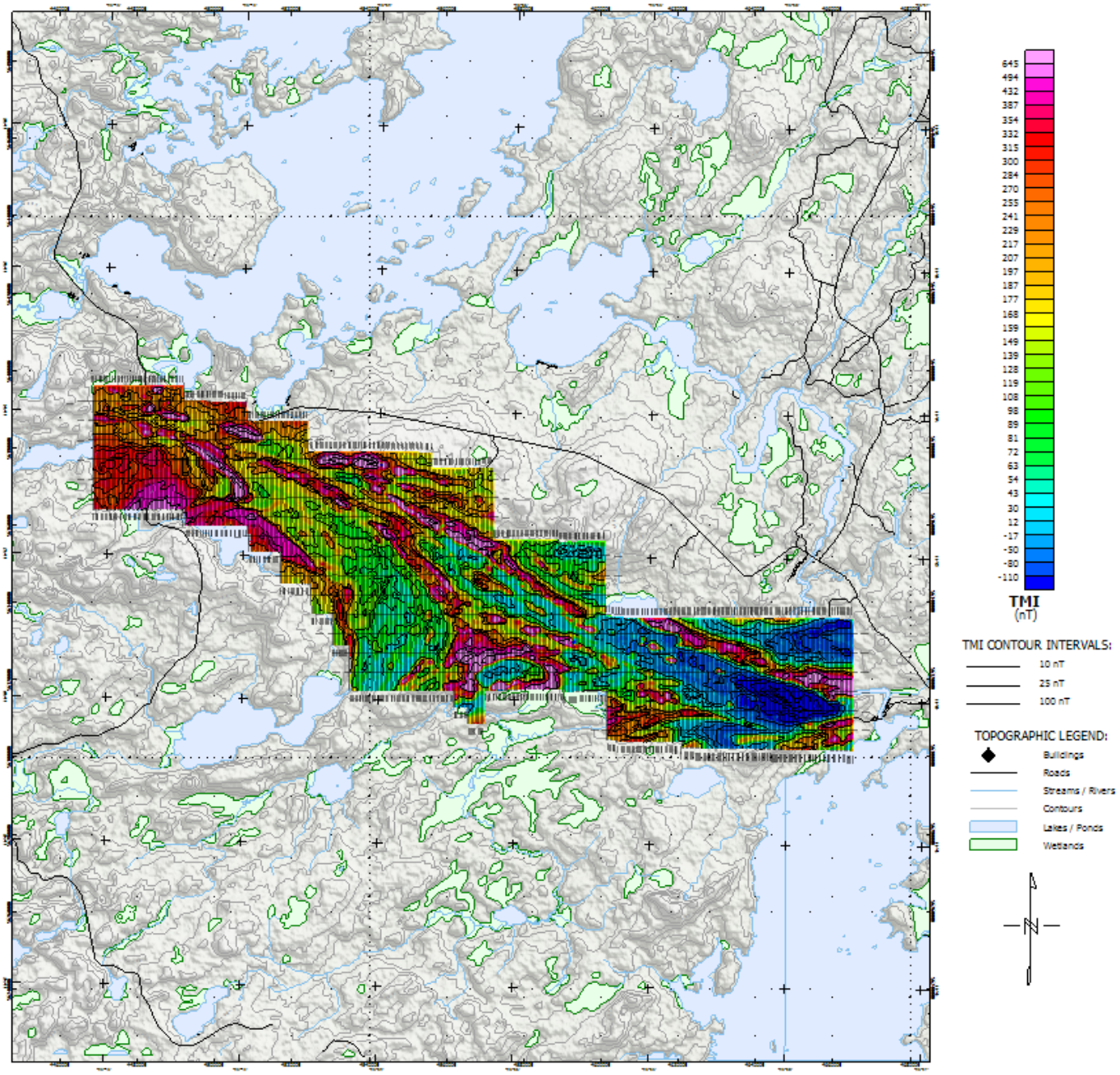
Total Magnetic Intensity (TMI) Reduced to the Pole (RTP) – West Madsen B (A2)



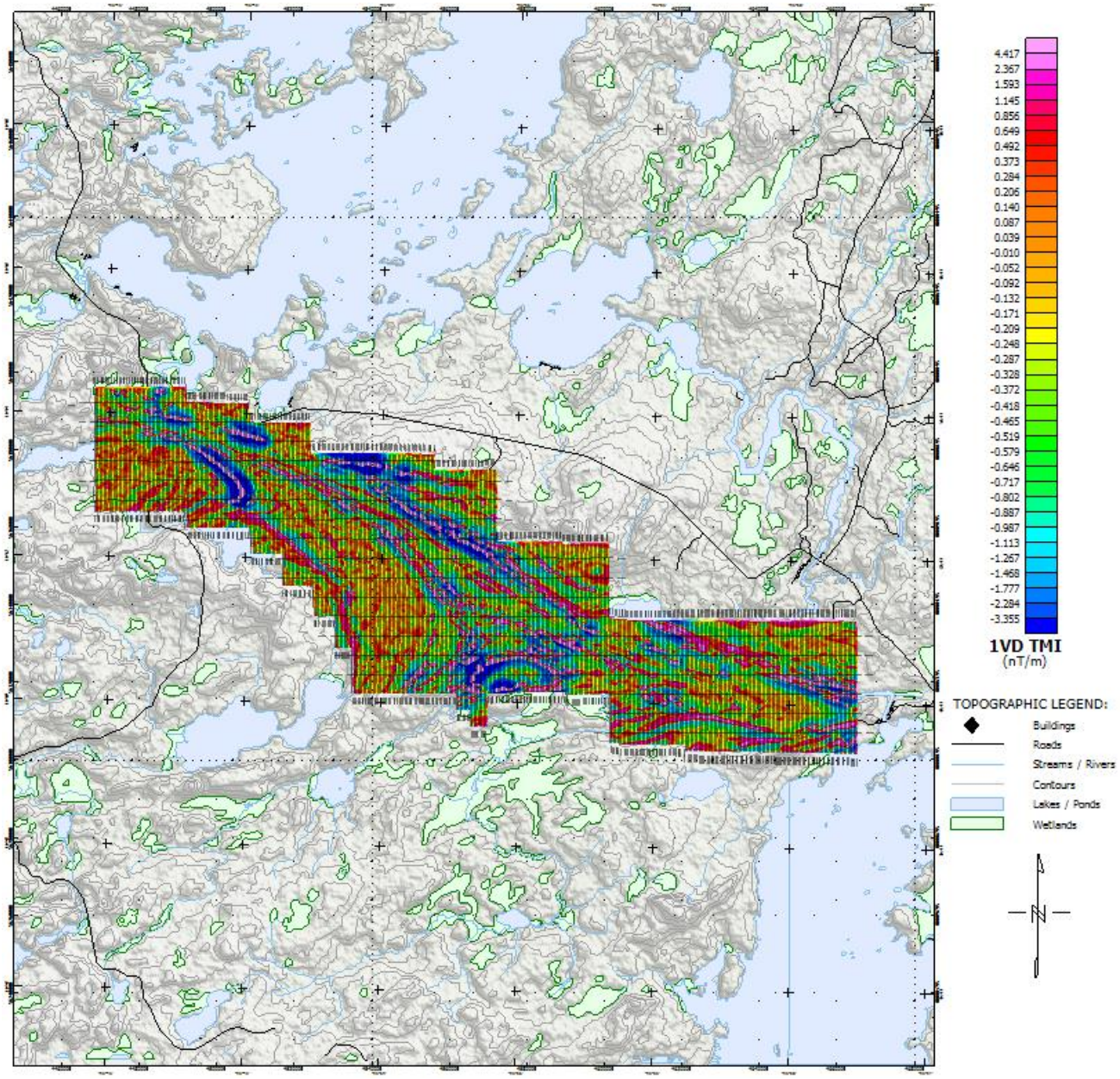
Total Magnetic Intensity (TMI) Reduced to the Pole (RTP) First Vertical Derivative (1VD) – West Madsen B (A2)



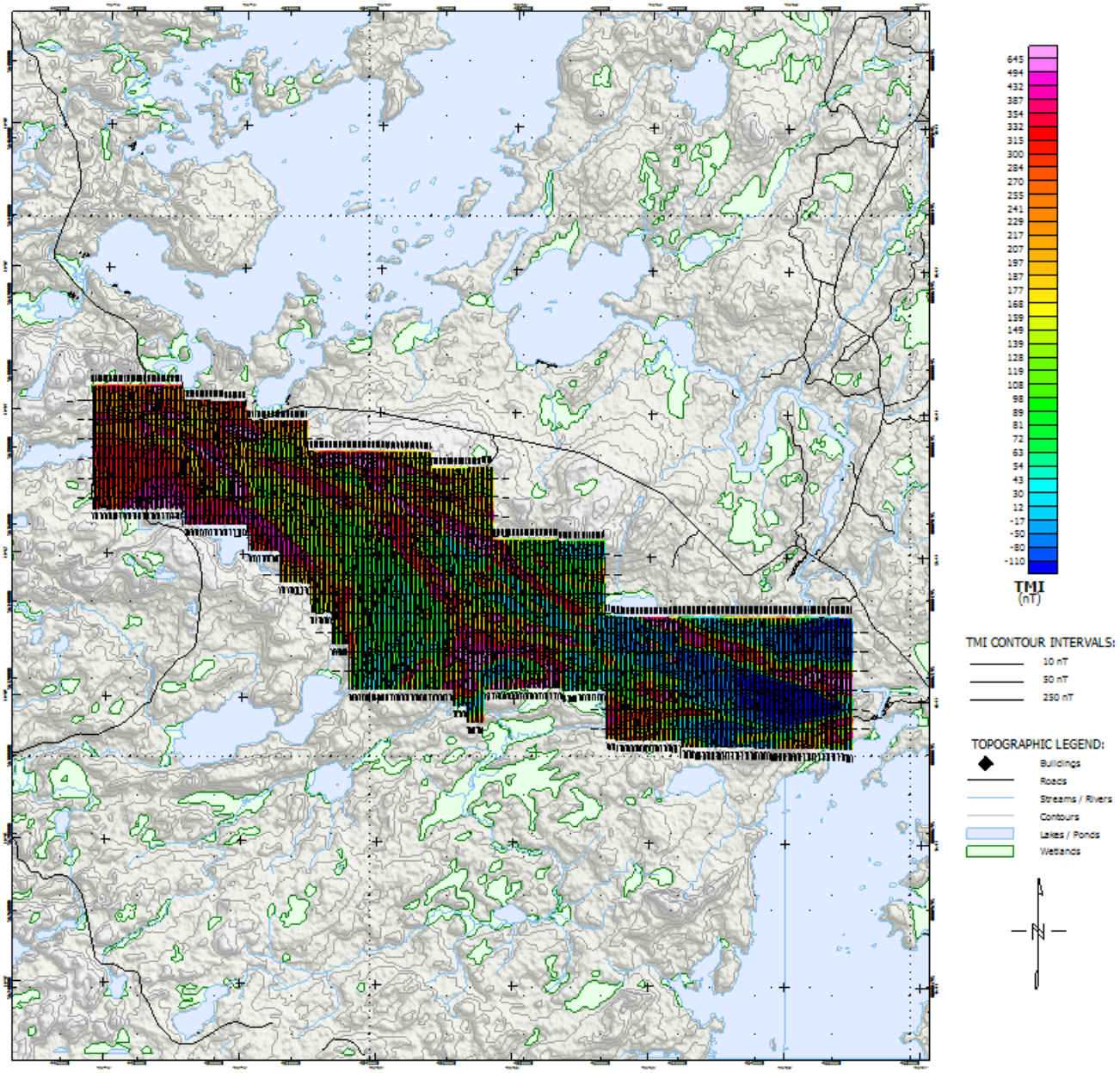
Digital Elevation Model (DEM) – West Madsen B (A2)



Total Magnetic Intensity (TMI) Reduced to the Pole (RTP) – Dixie Lake (A3)



Total Magnetic Intensity (TMI) Reduced to the Pole (RTP) First Vertical Derivative (1VD) – Dixie Lake (A3)



Digital Elevation Model (DEM) – Dixie Lake (A3)

445000 450000 455000 460000 465000 470000

5640000

5635000

5630000

Gullrock Lake

Dixie Lake

Pakwash Lake

N W E S

4284981 4284983 4284984 4284986 4284989 4284992
4284982 4284985 4284987 4284990 4284993 4284995
4284988 4284991 4284994 4284996
4284997 4284999 4284998
1209776 3001792 1244670 4282556 1209778 4282558 4282557 1143990 1185178
4285325 4285324 4285322 4285320
4285323 4285321 4285319

Legend

- Mining Claim Group
- Flight Lines
- Roads

0 1 2 4 6 8 Km

Great Bear Resources

Dixie Lake Block
Airborne Magnetic Survey
Claims / Flight Lines

Scale: 1-50,000	NAD 83 - Zone15N
2017 - 12 - 08	Drawn by: ICR

455000

460000

5635000

5630000

N

W

E

S

4284987

4284990

4284993

4284995

4284996

4284988

4284991

4284994

4284997

4284999

4284998

1184341

1023083

1023082

4282556

1209776

3001792

1244670

1023085

1023124

1023078

1023080

1209777

4267870

1209788

1209778

4282558

1023100

1023101

1184323

3001791

1144357

1023099

1023102

1023109

1023108

4282557

1023127

1023098

1023103

1023111

3001795

4285325

4285324

1143990

1056795

1056794

1056793

1056792

3001771

1056796

4282555

1056798

1185178

1056802

1056801

1056800

1056799

3001770

1209780

1056890

1056891

1056892

Dixie Lake

Legend

Mining Claim Group

Flight Lines

Roads

0 1 2 4 6 8 Km

Great Bear Resources

Dixie Lake Block
Airborne Magnetic Survey
Claims / Flight Lines

Scale: 1-20,000	NAD 83 - Zone15N
2017 - 12 - 08	Drawn by: ICR

445000 450000 455000 460000 465000 470000

5640000 5635000 5630000

Gullrock Lake

Dixie Lake

Pakwash Lake

N W E S

4284981 4284983 4284984 4284986 4284989 4284992 4284982 4284985 4284995 4284987 4284990 4284993 4284996 4284988 1209776 3001792 1244670 4284991 4284994 4282556 1209778 4282558 4284997 4284999 4282557 4285325 4285324 4285322 4285320 4284998 1143990 1185178 4285323 4285321 4285319

Legend

- Mining Claim Group
- Flight Lines
- Roads

0 1 2 4 6 8 Km

Great Bear Resources

Dixie Lake Block
Airborne Magnetic Survey
Claims / Flight Lines / TMI-RTP

Scale: 1-50,000	NAD 83 - Zone15N
2017 - 12 - 08	Drawn by: ICR

424000 426000 428000 430000 432000

5646000 5644000 5642000 5640000

4280680 4280678

4280682 4280681 4280679 4284972 4284973 4284975

4280683 4280677

N W E S

Legend

- Mining Claim Group
- Flight Lines
- Roads

0 0.5 1 2 3 4 Km

Great Bear Resources

Madsen 'A' Block
Airborne Magnetic Survey
Claims / Flight Lines

Scale: 1-20,000	NAD 83 - Zone15N
2017 - 12 - 08	Drawn by: ICR

424000 426000 428000 430000 432000

5646000 5644000 5642000 5640000

N W E S

4280680 4280678

4280682 4280681 4280679 4284972 4284973 4284975

4280683 4280677

Legend

Mining Claim Group

Flight Lines

Roads

0 0.5 1 2 3 4 Km

Great Bear Resources

Madsen 'A' Block
Airborne Magnetic Survey
Claims / Flight Lines/TMI

Scale: 1-20,000	NAD 83 - Zone15N
2017 - 12 - 08	Drawn by: ICR

412000 414000 416000 418000 420000

5644000 5642000 5640000 5638000

N W E S

4280684
4280691
4280689
4280690
4280687
4280688
4280686
4280685

Legend

- Mining Claim Group
- Flight Lines
- Roads

0 0.5 1 2 3 4 Km

Great Bear Resources

Madsen 'B' Block
Airborne Magnetic Survey
Claims / Flight Lines

Scale: 1-20,000	NAD 83 - Zone15N
2017 - 12 - 08	Drawn by: ICR

412000 414000 416000 418000 420000

5644000 5642000 5640000 5638000

N W E S

4280684
4280691
4280689
4280690
4280687
4280688
4280686
4280685

412000 414000 416000 418000 420000

5644000 5642000 5640000 5638000

Legend

- Mining Claim Group
- Flight Lines
- Roads

0 0.5 1 2 3 4 Km

Great Bear Resources

Madsen 'B' Block
Airborne Magnetic Survey
Claims / Flight Lines / TMI

Scale: 1-20,000	NAD 83 - Zone15N
2017 - 12 - 08	Drawn by: ICR

	Actual lkm	Actual cost per block	Area flown (km2)	Claim Units	Claim Block Area (km2)	% of coverage on GBR claims	Allow for 15% overflight coverage	Adjust for 100% of DL	Cost per block	Cut back lkm filed
Total line km	**2842**									
WMA	699	$50,008.05	29	98	15.68	0.540689655	0.621793103	0.62	**31005**	433
WMB	412	$29,475.42	17	72	11.52	0.677647059	0.779294118	0.78	**22991**	321
DL	1731	$123,839.69	75	452	72.32	0.964266667	1.108906667	1	**123840**	1,731
check sum	2842	$203,323.16		622					**177836**	2,486
								Rounded	**177892**	

Total cost	$203,323
cost per lkm	$71.54

1 unit claim 400x400m	
1 unit km2	0.16

Average cost per claim unit with 15% overflight
$285.91

***Cost per claim unit** **286.00**

*rounded to nearest dollar