

Watson Lake Area Gravity Survey Logistics Report

60° 2' N 129° 0' W, NTS 105A/02,03

Yukon, Canada

WORK PERFORMED:

March 9 – March 18, 2021

May 11 – May 28, 2021

November 9 – November 23, 2021

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February 11, 2022

Prepared for:

Yukon Geological Survey

Prepared by:



LOGISTICS REPORT
Watson Lake Area Gravity Survey Logistics Report

Prepared for:

Yukon Geological Survey

H.S. Bostock Core Library

91807 Alaska Highway
Whitehorse, YT, Y1A 0R3

Prepared by:

Aurora Geosciences Ltd.

34A Laberge Road, Whitehorse, Yukon, Y1A5Y9

Phone: (867) 668.7672 Fax: (867) 393.3577

www.aurorageosciences.com

Dave Hildes, P.Ge, Ph. D.

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1 SUMMARY

This geophysical report describes a gravity survey conducted for the Yukon Geological Survey to assist in locating the large faults within the survey area. The goal of the program is to assess the geothermal potential of the survey area. The survey was conducted in a 23 km X 4.5 km area located within NTS map sheets 105A/02 and 105A/03 with a station separation of 500 m and a line separation of 500 m. In total 414 gravity stations were collected across three phases from March 9 to March 18, May 11 to May 28 and from November 9 to November 23, 2021. Additionally, 56 NRCAN gravity points were extracted from the Canadian Geoscience Data Repository and processed with the collected gravity data.

The crew lodged at hotels in Watson Lake and commuted to and from the survey grid by truck and then skidoo or ATV depending on the proximity of the lines to the Alaska Highway. Travel between points was mostly on foot although some areas were amenable to use a vehicle to travel from point to point. A crew log describing daily operations and production is included with this report as Appendix II. Interpretation and modelling of the data are not within the scope of this project

2 CREW AND EQUIPMENT

The personnel who conducted the survey are shown in Table 1.

Table 1: Personnel list.

Andre Lebel	Geophysicist (Gravity Operator)	March 9–18, 2021
Morgan Henry	Field Assistant (GPS Operator)	March 9–18, 2021
Dave Hildes	Geophysicist (Gravity Operator)	May 11–18, 2021 November 9–23, 2021
Vince Van Delft	Field Assistant (GPS Operator)	May 11–28, 2021
Shawn Scott	Geophysical Tech (Gravity Operator)	May 18–28, 2021
Robert Chee	Field Assistant (GPS Operator)	November 9–23, 2021

The crew was equipped with instruments and equipment as detailed in Table 2. Further details of the instruments are in Appendix III.

Table 2: Instruments and equipment.

Gravity	Gravity meter - Scintrex CG-6 Gravimeter s/n: 18060099
	Gravity meter - Scintrex CG-5 Gravimeter s/n: 41368
	Gravity accessories

GNSS	Leica GS 14 s/n: 2804931 Leica GS 15 s/n: 1502747 Leica CS 15 controller s/n: 1575572 Pacific Crest PDL Radio & Repeater GPS accessories
Other	Laptops with Geosoft, Gravity & GPS processing software Repair tools Iridium satellite phone Garmin handheld GPSes Bear spray and bear bangers 1 - Truck 1 - Trailer 2 - Snowmobiles (phase 1) 2 - ATVs (phase 2 & phase 3)

3 SURVEY LOCATION

The target area encompasses 23 km WSW to ENE starting 2.5 km west of the terminus of the Stewart-Cassiar Highway and extending eastward to Watson Lake with the Liard River at the centre. The lines run 345° for 4.5 km with 500 m spacing between lines. Each line has 10 stations spaced 500 m apart. A section on the southern edge of the survey was not completed due to land access complication and budgetary constraints.

Phase 1 of the survey began on the far west of the grid but progress was slow due to the winter conditions and work relocated 10 km eastward near Upper Liard in hopes that the open terrain would be more productive. Ultimately the survey was postponed until better conditions were available in May; phase 2 of the survey addressed the gap between the two areas surveyed in March. Phase 3, in November, continued the survey from the Liard River to the townsite of Watson Lake.

NRCAN gravity points from the Canadian Geoscience Data Repository that are within or proximal to the survey area were downloaded and are included with the gravity data collected in 2021.

Figure 1 shows the locations of the gravity stations surveyed in 2021. All coordinates in this report are in the NAD83 (CSRS) datum using UTM Zone 9 projection, and the elevations are recorded as orthometric heights using the CGVD2013 datum.

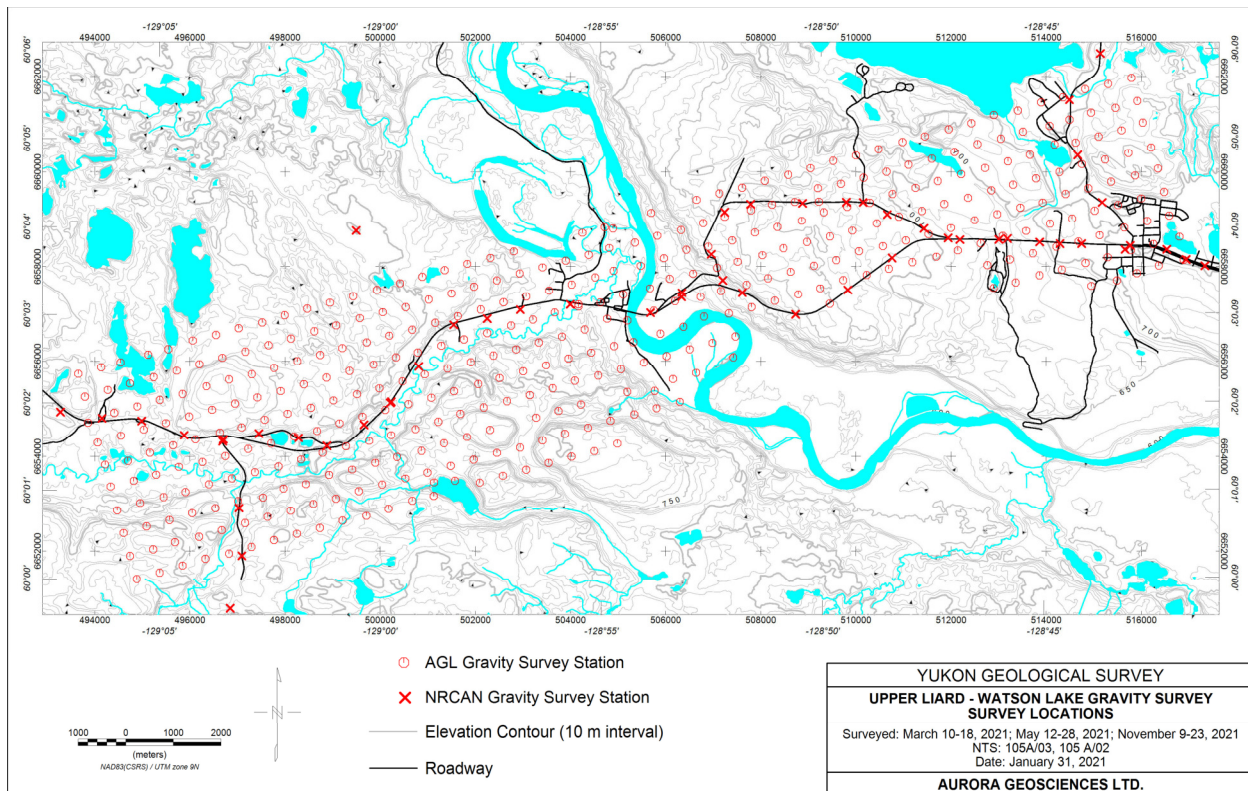


Figure 1: Gravity survey location map.

4 SURVEY SPECIFICATIONS

4.1 Pre-job Gravimeter Checks

Prior to mobilization for each phase, the gravimeter was warmed up for a minimum of 48 hours and kept level on a cement floor. The instrument was then cycled for 24+ hours taking 60 seconds readings continuously to determine the remnant instrument drift and to adjust the drift constant if required. An example of a drift test is shown in Figure 2; although a tidal correction has been applied to these data, a 10-15 μGal remnant tidal effect can be seen over the 30+ hour cycling. The gravimeter remained under power at all times throughout the survey operation.

Walk tests to simulate actual survey conditions were performed prior to mobilization for each phase. A walk test entails repeatedly picking up the gravimeter and walking with it to simulate the motion of walking from station to station. The instrument is returned to a precise location and either allowed to settle for a pre-determined time before taking a reading or a suite of short continuous readings were taken. The walk test for phase 3 is shown in Figure 3 where a settling time of 60 s is sufficient to limit the settling error to less than 10 μGal . Walk tests for phase 1 and 2 similarly showed that settling times of 30 or 60 seconds were sufficient. Practically it takes longer than this to prepare and level the gravimeter at each station in the field so this is not a significant issue for this survey.

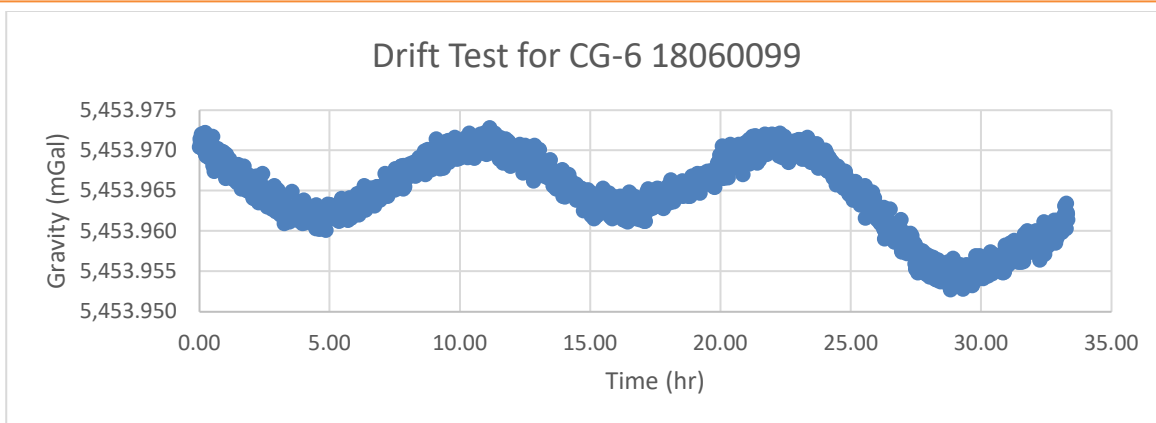


Figure 2: Drift test prior to phase 3 mobilization on November 07, 2021.

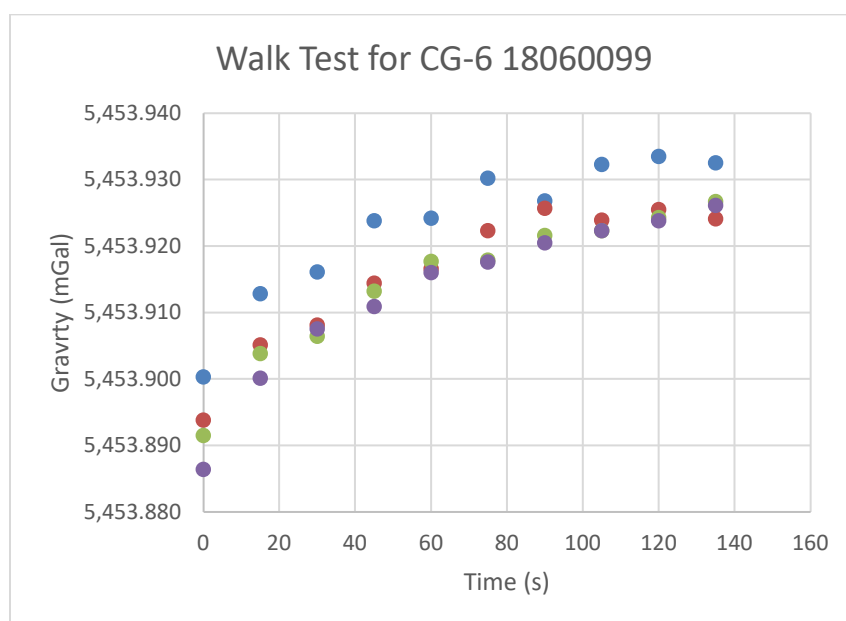


Figure 3: Walk test prior to phase 3 mobilization on November 7, 2021.

4.2 Gravity Survey Specifications & Method

Each gravity station is located using a handheld Garmin GPS. The site was cleared of snow, soft moss and organics or preferentially located on a low boulder if available. The station is usually marked by a flagged nail tagged with the station and line number as well as flagging on a nearby tree; these were omitted when working in populated areas.

During the survey, readings are stacked for a minimum of 60 s and when the standard deviation in individual 5 Hz readings (after seismic filtering) is greater than 0.05 mGal, repeat readings are taken. Repeats are also taken at any station at the discretion of the operator. Seismic filters were engaged to remove seismic noise and wind noise.

Prior and post daily surveying, readings are taken at a control station, established at locations as detailed in Section 5. A minimum of three readings are taken at the control with a maximum range of 0.02 mGal.

4.3 GNSS Survey Specifications & Method

Accompanying the gravity survey is a dual-frequency Global Navigation Satellite System (GNSS) survey to provide vertical control for the gravity reductions described in Section 6.3 using the GPS and Glonass constellations. GNSS readings are taken in the same locations as the gravity readings using a 1.8 m (phase 1) or 2.0 m (phase 2 & 3) rover antenna height. Real-Time Kinetic (RTK) phase-fixed solutions are achieved through the use of a base GNSS station and a radio link between the base and rover. Specification for the 3D Coordinate Quality (CQ3D) is 2.5 cm. If the 2.5 cm threshold is not met, up to 30 minutes of rover GNSS data are recorded at one second epochs for post-processing.

Base stations are established as detailed in Section 5 and log GNSS data at one second epochs, recording the data to disk as well as broadcasting over the radio link.

Achieving a good GNSS solution was challenging for many parts of the survey because of canopy cover. Actual point locations differed from the planned positions by up to 50 metres as the field crew would look for a hole in the canopy in to increase the quality of the GNSS solution.

The rover measurements are not always made on the exact gravity station. Long occupation times are sometimes required and to expedite the survey the GNSS measurement is initiated simultaneously with the gravimeter reading, but this requires the GNSS measurement to be made approximately 25 cm away from the gravity point. Every effort is made to ensure the GNSS measurement point is at the same elevation as the gravity measurement point. This is acceptable because an accurate vertical survey is very important for gravity reductions as described in Section 6.3 while the same accuracy for the horizontal survey is not required.

4.4 Remeasured Stations

Several stations were remeasured to assess the quality of the overall methodology.

These are separate from the “repeat” readings described above where the gravimeter was not moved from the tripod and were taken at the discretion of the operator because of non-ideal ground or noisy conditions. Line and station numbers are not changed for the repeats and typically it is only done for the gravity measurement and not for the GNSS measurement.

Remeasurements are surveyed on different days and therefore use a completely different constellation for the GNSS solution. They are assigned a unique line-station identifier by incrementing the station number by 1. An effort was always made to re-occupy the exact location however the station markings were inconsistently found, particularly for the phase 3 remeasurements when snow obscured visibility of the ground and mostly the remeasurement are in proximal but not identical locations.

5 Control Points

5.1 Gravity

Gravity control points, marked with a concrete pad, were established at two locations in 2021 as detailed in Table 3 and shown in Figure 4 and Figure 5. The concrete pad defines the gravity control station using a standard Scintrex CG-5 tripod with the legs at their minimum extension or a CG-6 tripod.

Control point 992 was destroyed by snow removal equipment in the time between phase 1 and phase 2. The monument was reestablished during phase 2 but was not used again, as it was unlikely to survive in future winters.

Table 3: Gravity control locations and dates used.

Location Description	UTM Easting (m)	UTM Northing (m)	Geoid Height (m)	Dates used (2021)	Absolute Gravity (mGal)
East of Hwy 37 (991)	497247.223	6654322.745	716.622	March 10 – 12 May 11 – 28	981690.346
Northwest of Liard River bridge (992)	505116.989	6657123.127	613.470	March 13 – 17	981691.357
CBC Radio Tower in Watson Lake (9157)	515600.279	6658855.647	700.549	November 9 – 23	981694.691



Figure 4: Control station east of Hwy 37 in May 2021 (991).



Figure 5: Control station NW of Liard River bridge (992).

The gravity reference station 9157-1990 at Watson Lake as shown in Figure 6 and described in Appendix I was surveyed at the beginning and end of each survey day from May 22 to May 28 and local check-in stations 991 and 992 were surveyed during these loops to create a series of ABA tie surveys. These data are processed separately and drift corrected using a datum of 981694.691 mGal equal to the stated value of the reference station. The results are averaged and used to create offsets for each of the local check-in station as shown in Table 4.

The reference station 9157-1990 was used directly as the daily control point during phase 3 of the survey.

Table 4: Local and absolute values of check-in stations.

Station	Local Values	Absolute Values
991	5331.891	981690.346
992	5332.902	981691.357



Figure 6: Watson Lake CGSN Station 9157-1990.

During the survey, drift measurements were made at a control point prior to and after each day's survey. Figure 7 (control station 991 – phase 1), Figure 8 (control station 992 – phase 1), Figure 9 (control station 991 – phase2) and Figure 10 (control station 9157 – phase 3) show the drift for the instrument. The gravity measurement is shown on the y-axis in mGal versus decimal date on the x-axis. A list of the control point locations and dates used is in Table 3. The discontinuity in Figure 10 on November 11 is due to a temporary power problem overnight and slight cooling of the gravimeter. The gravimeter was re-stabilized for several hours before surveying on November 11th. The scale of any error associated with the warming of the spring on November 11th is small, less than 10 μ Gal.

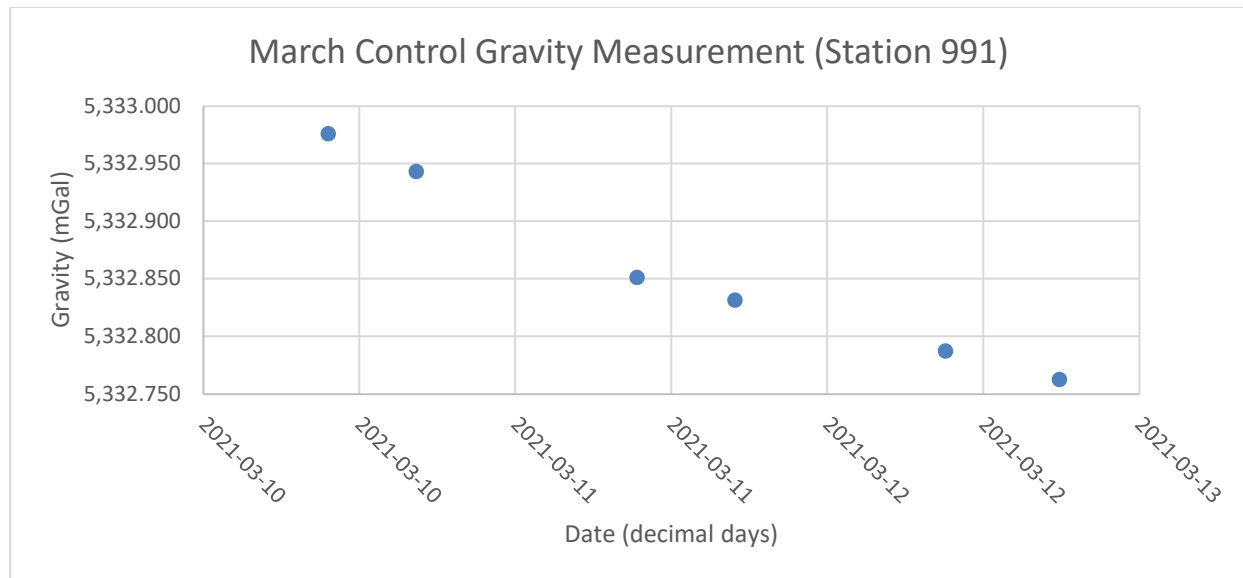


Figure 7: CG-6 check-in at control station 991 for phase 1 in March 2021.

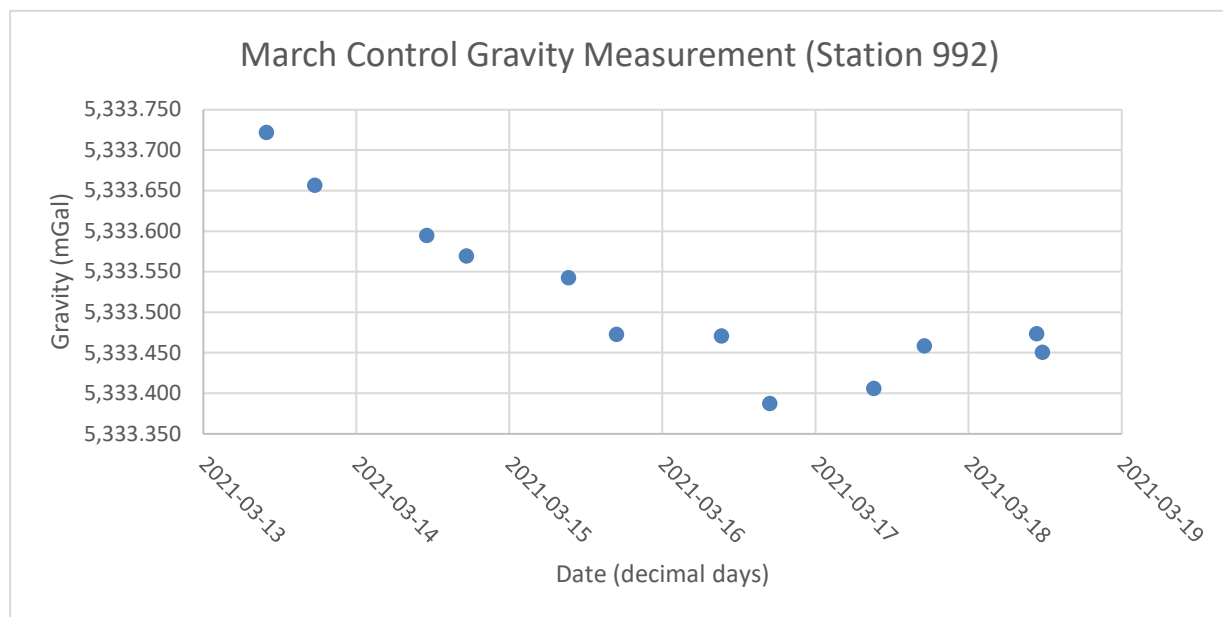


Figure 8: CG-6 check-in at control station 992 for phase 1 in March 2021.

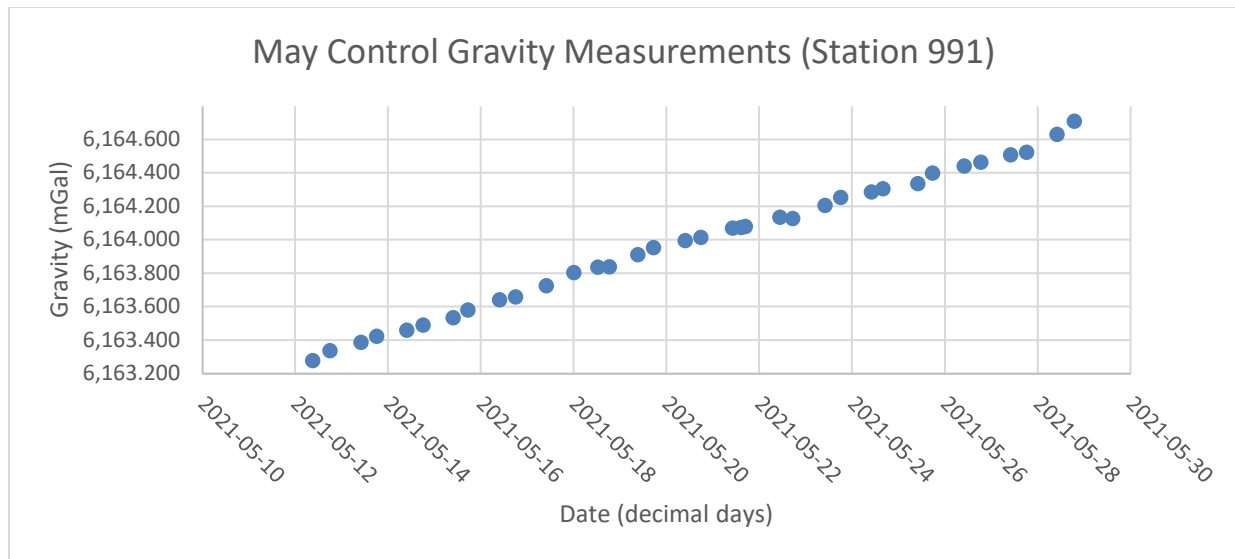
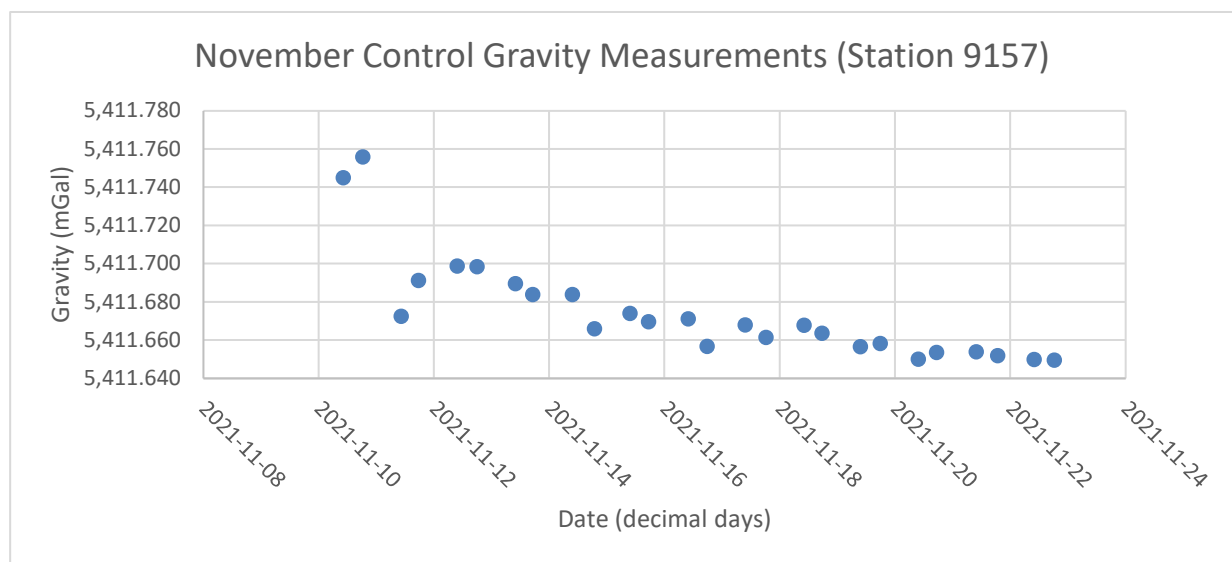


Figure 9: CG-5 check-in at control station 991 for phase 2 in May 2021.



A position for each GNSS control station is estimated when established and that same estimated position is consistently used every day that GNSS control station is occupied. The actual positions of the control stations are determined by Canadian Spatial Reference System Precise Point Positioning (CSRS-PPP). Submission of the base data to CSRS-PPP is delayed by at least two weeks after collection to ensure the most accurate ephemeris is available to produce the best possible position for the base. Several days of data are submitted and the results averaged; an adjustment is then made to the GNSS data to correct for the difference between the estimated position that was broadcast via radio and the averaged final position as determined by CSRS-PPP. The estimated position, final positions and adjustments made to the rover GNSS data are outlined in Table 5. The CSRS-PPP results are in Appendix 2.

Table 5: Estimated to final GNSS control adjustments.

Proximal to Gravity Control	991	992	991	None	None
Reference Name	YGS TIN 1	YGS TIN BASE2	GPSBASE1 051121	GPSBASE2 COR	Uncorrected 990
Dates Used	March 10 - 12	March 13 - 18	May 12 - 21	May 22 - 28	November 10 - 22
Broadcast NAD83 UTME	497247.2105	505117.2471	497248.2307	502699.0530	509448.1203
Broadcast NAD83 UTMN	6654321.8516	6657123.1720	6654322.4455	6657064.5228	6657214.9787
Broadcast Ellipsoid Height	712.7875	610.9166	714.8403	635.9602	750.2290
Measured Height in Leica Job	0.8571	0.9971	0.0521	1.1871	1.2350
Carrier Offset in Leica Job	0.3600	0.3600	0.3600	0.3600	0.0000
Antenna Height in Leica Job	1.2171	1.3571	0.4131	1.5471	1.2350
Mean PPP NAD83 UTME	497248.2297	505118.2110	497248.4070	502699.0568	509449.1680
Mean PPP NAD83 UTMN	6654322.4460	6657122.4560	6654322.5890	6657064.5188	6657212.9477
Mean PPP Ellipsoid Height	714.8357	611.2016	715.3570	635.9348	750.2831
ARP to Marker	0.8570	0.9970	0.0530	1.1870	1.2350
Actual ARP to Marker	1.2170	1.3570	0.8900	1.5470	1.2350

Easting Adjustment	1.0192	0.9639	0.1763	0.0038	1.0477
Northing Adjustment	0.5944	-0.7160	0.1435	-0.0040	-2.0310
Ellipsoid Adjustment	1.6881	-0.0751	0.1566	-0.3855	0.0542

All post-processing solutions use the estimated position and therefore the adjustments are universally applied.

All GNSS data use the NAD83 (CSRS) ellipsoid. The transformation to orthometric height is described in Section 6.1.

6 DATA PROCESSING

6.1 GNSS Processing

The real time GNSS solutions calculated at the rover through the radio link with the base GNSS station are examined to identify any points that did not achieve a full phase-fixed solution. Additionally, points that are labelled with an RTK phase-fixed position but that have 3D Coordinate Quality (CQ3D) values greater than 0.025 m are identified.

The identified points are post-processed using Leica Infinity software based on the estimated location of the base as broadcast via radio link to the rover during data collection. The post-processed solutions are compared to the RTK solutions and the following decision protocol is used:

- If a single phase-fixed solution is available, that solution is chosen. If two phase-fixed solutions are available, the one with the lower CQ3D is chosen.
- If the phase-fixed solution with the lowest CQ3D exceeds 0.025 m, that solution is flagged with a non-dummy entry in the GNSS_Flag column of the database.
- If no phase-fixed solution is available but a float, phase xRTK or widelane-fixed solution or solutions are available – which all indicate that the number of phase ambiguities remained a tolerance level – the solution with the lower CQ3D is chosen and this solution is flagged.
- If only code solutions are available or the lowest CQ3D solution is greater than 0.75, no solution is accepted.

Some exceptions are made to this decision protocol; for example, if the station is a remeasurement it is rejected instead of flagged if the best solution has a CQ3D that exceeds the 0.025 threshold.

Labels on all GNSS points are checked against the expected position to ensure there are no mislabelling errors.

All positions are adjusted to account for the difference between the initial estimated position of the GNSS base and the final CSRS-PPP determined position as described in Section 5.2 .

The NRCAN GPS-H tool is used to transform GNSS ellipsoid heights into orthometric (metres above sea level) heights using the Canadian Gravimetric Geoid model CGG2013a.

6.2 Digital Elevation Model (DEM)

An elevation model is required for the far-station terrain gravity correction (see Section 6.3.6); three zones of DEMs are used to balance high resolution close to the gravity station and reasonable file size and computing time.

Far-station_1 correction uses a dense inner DEM covering the survey area and 1 km beyond with a 5 m cell size. Far-station_2 correction uses an intermediate DEM that starts at the perimeter of the inner DEM and extends out to 9 km beyond the survey area using a 20 m cell size. Far-station_3 correction uses a coarse outer DEM that starts at the perimeter of the intermediate DEM and extends to approximately 110 km beyond the survey area using a 100 m cell size.

The primary product for the inner and intermediate DEMs is the Arctic DEM¹ which is produced for areas above 60° N from high resolution WorldView and GeoEye satellite imagery. It is constructed from ~0.5 m data and is generally available as a 2 m grid. This 2 m product is resampled to 5 m for the inner DEM and to 20 m for the intermediate DEM. The Canadian Digital Elevation Model (CDEM) is used to construct the outer 100 m DEM and is also used to supplement the inner and intermediate DEMs south of the BC-Yukon border where there is no ArcticDEM coverage.

The inner DEM is compared to GNSS measured data and have an usually poor match in the eastern part of the survey area where the difference between the two is as high as 100 m. The high differences are in a spatially coherent area where the GNSS solutions are of high quality and therefore the error can be confidently assigned to the ArcticDEM.

To incorporate the GNSS data from the survey to improve the inner DEM the following strategy is used: The inner DEM is sampled at each GNSS station and the difference is calculated between the sampled DEM and the GNSS data. A triangular irregular network (TIN) is made from these differences and then a 5 m cell size grid is created from the TIN that extends beyond the survey area by approximately 500 metres. This difference grid is then added to the inner DEM. This results in a final inner DEM that matches the GNSS data well at the stations and the changes made to the inner DEM are smooth throughout the survey area; this preserves the topographical features in the original inner DEM between the stations as best as possible while honouring the collected elevation data. It does create a noticeable “seam” at the extend of the gridded TIN where there is a discontinuity in the elevation. However, it is not an extreme discontinuity and is 500 metres from any survey point so does not significantly affect the far-station terrain correction described in Section 6.3.6.

Finally, LiDAR data are available over part of the survey area, which provides dense topographic information. A comparison between the GNSS data and the LiDAR-derived DEM show good agreement and no similar levelling as was done between the inner DEM and GNSS data is warranted. The outline of the LiDAR survey is removed from the inner DEM and then the two products mosaiced together to create the final 5 m DEM that is used for the far-station_1 terrain correction as described in Section 6.3.6.

The outline of the inner DEM is removed from the intermediate DEM so that this area does not provide double terrain corrections when the second round of far-station terrain correction is calculated. Similarly, the outline of the intermediate DEM is removed from the outer DEM.

¹ <https://www.pgc.umn.edu/data/arcticdem/>

6.3 Gravity Corrections

A suite of corrections is applied to the raw gravity to produce the Bouguer anomaly. Tilt and temperature corrections are performed on-board the CG-5 and CG-6 gravimeters. Tidal corrections are also normally part of the on-board suite of corrections although in phase 1 the internal GNSS of the gravimeter malfunctioned and the errant corrections based on incorrect positions are replaced with externally calculated tidal corrections.

The Bouguer anomaly is calculated by adding the Bouguer, Bullard-B, near-station terrain and far-station terrain corrections – which are all directly proportional to density – to the free-air anomaly. A suite of densities (2.4 g/cm³, 2.5 g/cm³, 2.6 g/cm³, 2.67 g/cm³ and 2.7 g/cm³) is used to create a Bouguer anomaly (BA) for each density.

6.3.1 Drift

The drift correction removes the linear drift of the gravimeter between readings at the control stations prior and post every survey day. The datum is originally set arbitrarily and then later adjusted to reflect absolute gravity as described in Section 5.1.

6.3.2 Latitude

The earth's gravitational field varies with latitude because of centrifugal force and equatorial distension of the terrestrial spheroid. Gravitational acceleration consequently increases from the equator towards the poles. Somigliana's equation is used to determine the expected strength of the gravitational field at the latitude of every gravity station through:

$$G_{\phi} = G_e \frac{1 + k \sin^2 \phi}{\sqrt{1 - e^2 \sin^2 \phi}}$$

Where G_{ϕ} is the expected gravitational field at latitude ϕ , G_e is the normal gravity at the equator (978932.67715 mGal), e is the eccentricity of the Earth ($6.69438002290 \times 10^{-3}$) and k is an ellipsoidal parameter ($1.931851353 \times 10^{-3}$).

6.3.3 Free-Air

The free-air correction corrects for the change in distance from the centre of the Earth through:

$$\Delta g_{FA} = H \left(2 \frac{G_{\phi}(1 + f + m - 2f \sin^2 \phi)}{a} - 3H \frac{G_{\phi}}{a^2} \right)$$

where Δg_{FA} is the free-air correction, H is the geoid elevation of the point, G_{ϕ} is the expected gravitational field at latitude ϕ , a is the semi-major axis of the earth (637817 m), f is the flattening of the earth ($3.35281068118 \times 10^{-3}$) and m is $3.44978600308 \times 10^{-3}$.

The free-air anomaly is calculated by subtracting G_{ϕ} from the observed gravity (which incorporates the on-board tilt and temperature corrections, tidal, drift and local datum corrections) and then adding Δg_{FA} .

The NRCAN data does not detail all these corrections and reports only the free-air anomaly.

6.3.4 Bouguer Slab and Bullard-B

The Bouguer slab correction compensates for the attraction of an infinite slab of material of density ρ located between mean sea level and the elevation H of the gravity station. The Bouguer slab correction (Δg_B) is:

$$\Delta g_B = -0.0419 * \rho * H$$

The Bullard-B correction accounts for the curvature of the earth and is applied to account for the finite nature of the crustal slab used in the Bouguer correction.

6.3.5 Near Terrain

The near-station terrain correction compensates for the effect of local differences in topography within 20 metres from a gravity station. DEMs are usually neither fine nor precise enough for this correction and instead gravity operators measure the average slope within six 60° sectors in a 20 m radius around the reading site. The slopes are converted to elevation differences which are used in the sector equation for the gravitational effect of a sector from a vertical cylinder:

$$\delta g_T = \gamma \rho \theta \left\{ (r_o - r_i) + \sqrt{r_i^2 + \Delta z^2} - \sqrt{r_o^2 + \Delta z^2} \right\}$$

where δg_T is the terrain correction required for a sector of angle θ with inner and outer radii equal to r_i and r_o , γ is the gravitational constant ($6.67430 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$), terrain density equals ρ , and $\Delta z = |z_s - z_a|$ where z_s is the station elevation and z_a is the average terrain elevation in the sector. The single slope measurement made by the field crew is interpolated to make a calculation for a suite of cylindrical sectors with $r_o - r_i = 0.5$.

The final near terrain correction (Δg_{NT}) is the sum of the contributions from all individual sectors:

$$\Delta g_{NT} = \sum_r \sum_\theta \delta g_T(r, \theta)$$

6.3.6 Far Terrain

The far-station terrain correction compensates for terrain effects from 20 m to 100+ km outside the survey area.

Three zones of DEMs as described in Section 6.2 are used with the following formula to evaluate the vertical component of the gravitational attraction of a flat top prism:

$$\delta g_{FT}(x, y, z) = -\gamma \rho \int_{x-u_1}^{x-u_2} \int_{y-v_1}^{y-v_2} \int_{z-w_1}^{z-w_2} \frac{w}{\sqrt{(u^2 + v^2 + w^2)^2}} du dv dw$$

Each DEM node becomes the centre of a prism reaching halfway to the adjacent nodes and is combined with each gravity station location. For every gravity station, the sum of the contribution of all individual DEM nodes yields the far terrain correction (Δg_{FT}).

The elevation used at the station for the far-station terrain correction is the sampled elevation from the DEM instead of the actual measured GNSS elevation. This prevents artifacts from any remaining mismatch between the measured elevation and the DEM.

6.3.7 QA/QC & Discussion

The gravity data are examined for outliers, high error or high tilt readings. These are masked from the database and an average calculated from the remaining readings. Checks for mislabelled point are done on the entire dataset by examining the time taken between readings and matching the sequence of measurements with the GNSS measurements.

Although no stations were measured on the waterbody of Watson Lake, it is proximal to several stations and no bathymetric corrections were applied. This will the lower Bouguer anomaly relative to that if the bathymetric correction had been done. The magnitude of the effect will depend on the depth of lake, particularly in the southern portion immediately adjacent to the grid.

6.4 Trend Removal

Trend removal is a common practice in gravity surveys to highlight features of interest that can be masked by large scale gravity trends – typically on a scale larger than the survey area. The data are gridded using a minimum curvature algorithm with a 125 m cell size and then several methods of trend removal are used.

For the first-order trend removal (FOTR), all points of the gridded data are used to calculate a best-fit plane which is then subtracted from the original grid.

For the second-order trend removal (SOTR), all points of the gridded data are used to calculate a best-fit second order polynomial which is then subtracted from the original grid.

The original gridded data are upward continued by 2500, 5000 and 10000 metres; this process is a natural long-wavelength filter that is well-suited to gravity (potential field) data. Each upward continued grid is subtracted from the Bouguer anomaly grid to produce a resultant grid with the long wavelengths removed; these are labelled up2500TR, up5000TR and up10000TR respectively.

7 CANADIAN GEOSCIENCE DATA REPOSITORY

Proximal gravity stations are extracted from NRCAN's Canadian Geoscience Data Repository and are integrated with the data collected for this project. These points are shown as separate symbols in Figure 1. The original station numbers are preserved but all these points are assigned a line number of 9999.

The free-air anomalies from the NRCAN data are consistent with the free-air anomaly described in Section 6.3.3; no details are provided for the processing (e.g. tilt, temperature, tidal or drift corrections) prior to the free-air anomaly.

Bouguer slab, Bullard-B and far-station terrain corrections are applied to the NRCAN data in an identical methodology as survey described in Sections 6.3.4 and 6.3.6. Near-station terrain corrections described in Section 6.3.5 require local slope measurements by the field crew and therefore cannot be calculated for the NRCAN data. Instead, the near-station terrain corrections for these data are estimated by gridding the near-station terrain corrections from the 2021 survey and then sampling the grid for at the missing locations.

8 RESULTS AND DISCUSSION

Details of all the remeasurements are shown in Table 1. As can be seen by the *Distance* column which is the (maximum) distance between the remeasurements, only three stations – (0,2000), (500,4000) and (11500,500) – were measured with the gravimeter in the exact same location. This table indicates that the overall error associated with the survey is on the order of 63 μ Gal.

Table 6: Results of all re-measurements.

Line	Station	Easting	Northing	Distance (m)	Date	BA_267	Range	Mean
0	2000	494328.195	6653360.949	0.095	2021-03-10	-83.106	0.072	-83.070
0	2001	494328.127	6653360.882		2021-03-12	-83.034		
500	3500	494406.918	6654920.648	3.218	2021-03-11	-82.903	0.098	-82.854
500	3501	494403.749	6654920.089		2021-05-13	-82.805		
500	4000	494269.507	6655405.125	0.109	2021-03-11	-82.996	0.069	-82.962
500	4001	494269.458	6655405.028		2021-05-13	-82.927		
2500	0	497290.838	6652086.950	1.118	2021-05-12	-88.084	0.024	-88.096
2500	1	497289.837	6652086.451		2021-05-16	-88.108		
10000	3500	503546.544	6657492.927	28.724	2021-05-23	-109.237	0.040	-109.217
10000	3501	503557.515	6657519.473		2021-11-22	-109.197		
10500	4000	503898.669	6658124.220	9.515	2021-05-23	-109.236	0.029	-109.251
10500	4001	503906.981	6658119.590		2021-11-22	-109.265		
11000	2500	504766.924	6656897.087	10.654	2021-03-14	-110.748	0.073	-110.703
11000	2501	504766.016	6656897.779		2021-05-26	-110.685		
11000	2502	504772.048	6656905.869		2021-11-12	-110.675		
11000	3000	504623.802	6657236.257	2.641	2021-03-14	-110.231	0.091	-110.173
11000	3001	504622.873	6657236.923		2021-05-26	-110.148		
11000	3002	504621.912	6657238.102		2021-11-12	-110.140		
11500	500	505805.745	6655018.330	0.281	2021-03-14	-112.602	0.014	-112.609
11500	501	505805.714	6655018.051		2021-03-16	-112.616		
11500	2000	505320.895	6656863.729	0.934	2021-03-14	-110.866	0.046	-110.843
11500	2002	505320.443	6656864.546		2021-11-12	-110.820		
11500	2500	505192.421	6656863.729	1.245	2021-03-14	-110.516	0.098	-110.467
11500	2502	505193.361	6656864.546		2021-11-12	-110.418		
11500	3000	505104.970	6657407.021	9.410	2021-03-13	-109.884	0.110	-109.814

Line	Station	Easting	Northing	Distance (m)	Date	BA_267	Range	Mean
11500	3001	505104.052	6657407.667		2021-05-26	-109.783		
11500	3002	505105.626	6657416.298		2021-11-12	-109.774		
12000	1000	506151.228	6655632.745	0.077	2021-03-14	-110.778	0.048	-110.802
12000	1001	506151.261	6655632.815		2021-03-15	-110.826		
12000	2500	505748.809	6657067.756	14.963	2021-03-16	-109.819	0.006	-109.822
12000	2501	505736.888	6657058.712		2021-11-12	-109.825		
12500	2500	506193.199	6657267.434	11.655	2021-03-16	-108.610	0.121	-108.550
12500	2501	506203.156	6657261.376		2021-11-12	-108.489		
Mean							0.063	
Maximum							0.121	

Two of the NRCAN points, stations 13001 and 13002, are flagged with a non-dummy QAQC code. Although they have distinct coordinates, they have identical geoid heights and observed gravimeter readings. Additionally, one of them appears to be in, on or near the bridge over the Liard River. For these reasons they are deemed suspicious points are therefore excluded through the QAQC code.

The usefulness of the NRCAN data should be examined. The NRCAN reported error in most of the free-air anomalies range from 140 μGal to 310 μGal which exceeds the estimated error in the surveyed data of 63 μGal from Table 6. When the Bouguer anomaly data is gridded without the NRCAN data and then the NRCAN data compared to the sampled grid, the standard deviation between these two is 0.28 mGal. It is not clear that the NRCAN data are of sufficient quality or are consistent enough with the surveyed data to be in a combined dataset.

The spatial distribution of the NRCAN points also do not significantly improve on the coverage of the survey other than along linear trends along the highway.

Figure 11 shows the Bouguer anomaly for a density of 2.67 g/cm^3 and Figure 12 shows the same data but with an upward continued grid of 2500 m removed.

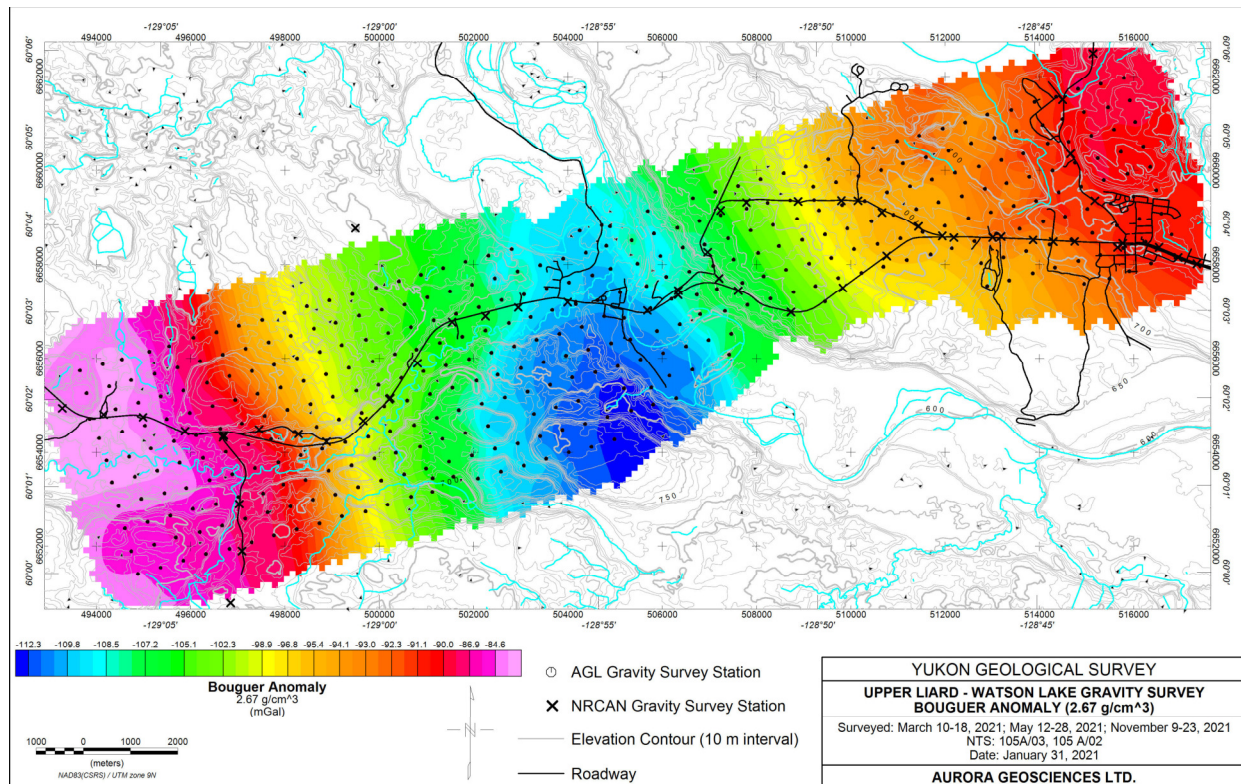


Figure 11: Bouguer anomaly for density of 2.67 g/cm³.

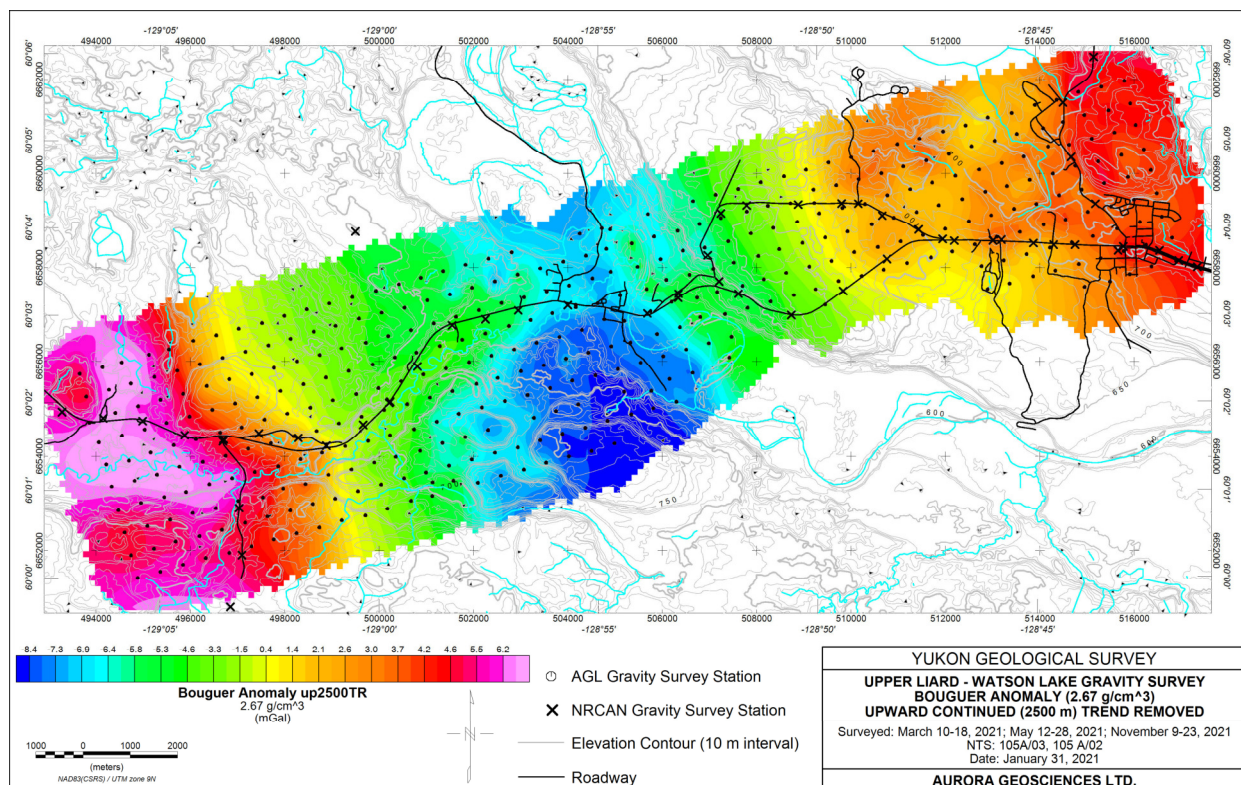


Figure 12: Bouguer anomaly for density of 2.67 g/cm³ with upward continued 2500 m trend removed.

9 PRODUCTS

The channels in the databases are described in Table 7

Table 7: Database channel descriptions.

Channel	Description
Line	Local X coordinate (m)
Station	Local Y coordinate (m)
SD	Standard deviation of 5 Hz gravity measurement (mGal)
Time	HHMMSS of data collection
Date	Date of data collection
Final_UTME	Corrected easting in NAD83 UTM Zone 9 (m)
Final_UTMN	Corrected northing in NAD83 UTM Zone 9 (m)
Final_Geoid	Corrected orthometric elevation relative to the CGG2013 Geoid (m)
Longitude	NAD83 (CSRS) longitude (decimal degrees)
Latitude	NAD83 (CSRS) latitude (decimal degrees)
Final_Ellipsoid	Corrected ellipsoid elevation (m)
GravRaw	Raw gravimeter reading with tilt, temperature, (+/- tidal) corrections (mGal)
Tide_Cor	Tidal correction if not included in GravRaw (mGal)
Local_Datum_Cor	Correction between local gravity check-ins (mGal)
Drift_Cor	Drift correction from daily pre and post survey gravity control point measurements (mGal)
Grav_obs	Grav Raw with tidal, local datum and drift corrections (mGal)
QAQC	Quality control for gravity readings (applied to BA channels)
Flag_GNSS	Flag for sub-optimal GNSS solution
QAQC_GNSS	Quality control for GNSS readings (applied to BA channels)
Grav_Lat	Expected gravity at latitude of reading (mGal)
FreeAir_Cor	Free air correction (mGal)
FreeAir_Anomaly	Grav_obs - Grav_Lat + FreeAir_Cor (mGal)
Bouguer_267_Cor	Bouguer slab correction for density of 2.67 (mGal)
Bull_B_267 Cor	Bullard-B correction for density of 2.67 (mGal)
NearStn_5i_267_Cor	Near station terrain correction for density of 2.67 (mGal)

FarStn_1_267_Cor	Far station terrain correction for density of 2.67 using the inner DEM (mGal)
FarStn_2_267_Cor	Far station terrain correction for density of 2.67 using the intermediate DEM (mGal)
FarStn_3_267_Cor	Far station terrain correction for density of 2.67 using the outer DEM (mGal)
BA_267	Bouguer anomaly for density of 2.67 (mGal)
BA_267_avg	Averaged repeats for Bouguer anomaly for density of 2.67 (mGal)
BA_267_RepAvg	Re-measured points averaged for Bouguer anomaly for density of 2.67 (mGal)
BA_240	Re-measured points averaged for Bouguer anomaly for density of 2.40 (mGal)
BA_250	Re-measured points averaged for Bouguer anomaly for density of 2.50 (mGal)
BA_260	Re-measured points averaged for Bouguer anomaly for density of 2.60 (mGal)
BA_270	Re-measured points averaged for Bouguer anomaly for density of 2.70 (mGal)
COORD_ERR	Coordinate error for NRCAN data (mGal)
DAY	Day of collection for NRCAN data
ELEV_ERR	Elevation error for NRCAN data (mGal)
FA_ERR	Free air error for NRCAN data (mGal)
G_ERR	Gravity reading error for NRCAN data (mGal)
PROJ	Project number for NRCAN data

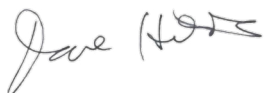
Table 8 describes the products attached to the digital version of this report.

Table 8: Product.

<u>Folder \ File</u>	<u>Description of Contents</u>
YGS-20220209-Watson Lake Gravity Report.pdf	This report in PDF format.
Data*.gdb, *.xyz, *.csv	Processed gravity databases in Geosoft format and ASCII format. GNSS data in csv format.

Figures\Geosoft Packed Maps\ YGS-20220210-Watson Lake Grav.map	Figures in Geosoft packed map format. Not all of the grids are displayed on the packed map.
Figures\Grids\NRCAN_excluded*.grd	Full suite of Bouguer anomaly grids in Geosoft *.grd format at 125 m cell size. Suite of densities = 2.40 g/cm ³ , 2.50 g/cm ³ , 2.60 g/cm ³ , 2.67 g/cm ³ and 2.70 g/cm ³ . Trend removal using FOTR, SOTR, up2500TR, up5000TR and up10000TR. NRCAN data are excluded.
Figures\Grids\NRCAN_included*.grd	Full suite of Bouguer anomaly grids in Geosoft *.grd format at 125 m cell size. Suite of densities = 2.40 g/cm ³ , 2.50 g/cm ³ , 2.60 g/cm ³ , 2.67 g/cm ³ and 2.70 g/cm ³ . Trend removal using FOTR, SOTR, up2500TR, up5000TR and up10000TR. NRCAN data are included.
Figures\Geotiffs\NRCAN_excluded*.tif	A selection of Bouguer anomaly grids in Geotiff *.tif format. Suite of densities = 2.40 g/cm ³ , 2.50 g/cm ³ , 2.60 g/cm ³ , 2.67 g/cm ³ and 2.70 g/cm ³ . Trend removal using FOTR, SOTR and up2500TR. NRCAN data are excluded.
Raw\	Daily archive of instrument and gps dump files.

Respectfully submitted,



Dave Hildes, Ph.D., P.Geo
Aurora Geosciences Ltd

Appendix I

CGSN Watson Lake Gravity Reference Station

Gravity (CGSN) - 9157-1990

Station 1 of 1

Site Identification

Name	Province	Unique Number	Classification	Status	Last Inspection
WATSON LAKE	YT	9157-1990	Excentre	Active	07/2004

Station Coordinates (Scaled)

Latitude	Longitude	Elevation	Description
N60° 3' 59" ± 20.0 m	W128° 43' 4" ± 20.0 m	700.82 ± .01 m	CBC RADIO TOWER

Gravimetric Information

Adjustment Number	Gravity	Instrument Height	Gradient	Velocity	Epoch
1991603	981694.6909 ± .0110 mGal	0.15 m	0.308 mGal/m		

Station Description

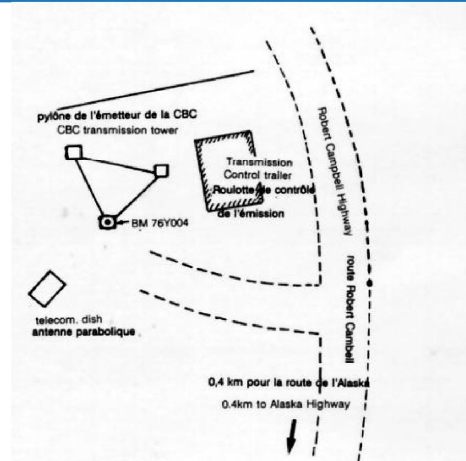
The station is located on the most southerly concrete support pier of the CBC (Watson Lake) Broadcasting tower, 40 cm above BM 76Y004. The station is monumented with a plastic disc.

Stations with same name

9360-195	9807-195	9907-195	9804-196	9318-197	9058-197	9156-199	9003-199
0	3	3	9	8	9	0	2



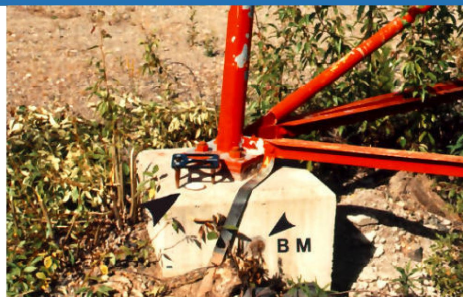
Sketch



Distant View



Close View



Report Date 09-Mar-21 Prepared on 14-Mar-21 Prepared By Andre Lebel

Weather Sunny -20C to -5C

Camp Mobbed in from Whitehorse to Waston Lake

Comments

Production

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	2
Total:	2	2

Report Date 10-Mar-21 Prepared on 14-Mar-21 Prepared By Andre Lebel

Weather Sunny -25C to -5C

Camp Tried out skiidooing to the first point and couldn't make because the skidoos got bogged down in the deep snow, traveled on foot after that

Comments

Production Read L0 from 3500 to 2000

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	4
Total:	2	4

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	4	4
Total:	4	4

Report Date 11-Mar-21 Prepared on 14-Mar-21 Prepared By Andre Lebel

Weather Cloudy in the morning and Sunny in the afternoon -10C to 5C

Camp

Comments

Production Read North of the Hyw on L0 from 4000 to 4500 and L500 from 4500 to 2000

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	6
Total:	2	6

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	8	4
Total:	8	4

Report Date 12-Mar-21 Prepared on 14-Mar-21 Prepared By Andre Lebel

Weather Sunny -25C to -5C

Camp

Comments

Production Read the End of Lines 0 and 500 from 1500 to 0.

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	8
Total:	2	8

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	16	8
Total:	16	8

Report Date 13-Mar-21 Prepared on 14-Mar-21 Prepared By Andre Lebel

Weather Snowing , high winds, blowing snow

Camp Truck was overheating on the drive out.

Comments

Production Read points around Upper Liard north of the hwy on L11000, L11500 and L12000

Comments

Personnel		
Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	10
Total:	2	10

Geophysics Production		
Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	27	11
Total:	27	11

Report Date 14-Mar-21 Prepared on 14-Mar-21 Prepared By Andre Lebel

Weather Sunny -30C to -10C

Camp Liam Hotshotted a truck from Whitehorse. The GMC truck went in for repairs and Liam drove Morgan's car back

Comments

Production Read points around Upper Liard south of the Hyw

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	12
Total:	2	12

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	35	8
Total:	35	8

Report Date 15-Mar-21 Prepared on 15-Mar-21 Prepared By Andre Lebel

Weather -26C in the morning and overcast, warming up to -10C in afternoon

Camp

Comments

Production read L12000 stn 1500 , 12500, 13000 and L13500 stn 1500 and 1000

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	14
Total:	2	14

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	42	7
Total:	42	7

Report Date 16-Mar-21 Prepared on 16-Mar-21 Prepared By Andre Lebel

Weather Sunny -10C to 0C

Camp

Comments

Production Read L11000 from 500 to 2000, L11500 stn 1000, L12000 stn 2500, L12500 stn 2500

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	16
Total:	2	16

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
	7	
Tinitina	47	7
Total:	54	7

Report Date 17-Mar-21 Prepared on 25-Mar-21 Prepared By Andre Lebel

Weather Sunny -10C to -5C

Camp

Comments

Production Read L12500 from 4500 to 3000, L14000 - L13000 stn 4500, L12000 Stn 3000

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	18
Total:	2	18

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	62	8
Total:	62	8

Report Date 18-Mar-21 Prepared on 25-Mar-21 Prepared By Andre Lebel

Weather -10C to 0C Sunny

Camp Demobed back to whitehorse

Comments

Production

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	20
Total:	2	20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	62	
Total:	62	

Report Date 11-May-21 Prepared on 11-May-21 Prepared By Dave Hildes

Weather Sun and cloud with some rain in the afternoon. +9C

Camp Mobbed from Whitehorse to Watson Lake. Set up tripods on old check in point.

Comments

Production

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	62	
Total:	62	

Report Date 12-May-21 Prepared on 12-May-21 Prepared By Dave Hildes

Weather Sun and cloud, +13C

Camp
Comments

Production Read L1000 from S2000 to 0, L1500 from S1500 to 0, L2000 from S1500 to 0, and L2500 S0.
Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	76	14
Total:	76	14

Report Date 13-May-21 Prepared on 13-May-21 Prepared By Dave Hildes

Weather Overcast +11C

Camp

Comments

Production Read north of the Alaska Hwy. Repeated L0 from 4500 to 4000, and L500 from 4500 to 3500. Read L1000

Comments from 4500 to 3500, L1500 from 4500 to 3500, and L2000 from 4500 to 3000.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	91	15
Total:	91	15

Report Date 14-May-21 Prepared on 14-May-21 Prepared By Dave Hildes

Weather Rain and overcast in the morning to sun and cloud in the afternoon. +10C

Camp

Comments

Production Read north of the Alaska Highway from L2500 S3000 up to S4500. Moved westward from L2500 to 6000.

Comments Read back along S4000 from L6000 to 3000. Then read south from L3000 S4000 to 2500.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	112	21
Total:	112	21

Report Date 15-May-21 Prepared on 15-May-21 Prepared By Dave Hildes

Weather Overcast and rain. +9C

 Camp
Comments

 Production
Comments Made an exploratory mission out of Upper Leard heading southwest to find trail access by quad to lines south of Albert creek, as well as a new high place for the RTK repeater. One trail leading to a plateau proved to be too difficult to continue with both being too ingrown as well as there being too much snow to find traction. An alternate trail allowed us to gain access to a lake and a spot for the repeater. We were able to survey L7000 S500 and 0, L6500 S500 and 0, and L6000 S500.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	117	5
Total:	117	5

Report Date 16-May-21 Prepared on 18-May-21 Prepared By Dave Hildes

Weather Sun and cloud, +11C

Camp

Comments

Production Read south of the Alaska Highway, and west of the Stewart Cassiar highway. Read S0 from L2500 to 6500,
Comments and read back east on S500 from L5500 to 2500. Grabbed L2500 S1000 on the way back to the truck.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	133	16
Total:	133	16

Report Date 17-May-21 Prepared on 18-May-21 Prepared By Dave Hildes

Weather Sun and cloud +10C

Camp
Comments

Production
Comments Read west of the Stewart cassiar, and south of the Alaska Highway. Reading went smoothly until the end of the day when in order to reach the quads, Albert creek had to be crossed. This was anticipated, and a plan had already been discussed during the morning meeting. The creek proved very difficult to cross, with the plan to mitigate damage to equipment failing. It was decided that attempting to take the CG6 and RTK across was too risky for equipment damage, and were stationed at L7000 S2500 for later retrieval. The crew rode back to the pickup, and drove to town to dry off and eat before heading down the access trail earlier explored. Equipment was retrieved after a ride and 2k walk, and returned to the hotel at 12:30am.

Personnel		
Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production		
Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	147	14
Total:	147	14

Report Date 18-May-21 Prepared on 19-May-21 Prepared By Shawn Scott

Weather Sun and cloud with rain in the afternoon.+13C

Camp

Comments

Production Read around the Nugget City property and Junction 37 services. A crew change was made mid day with Dave

Comments Hildes rotating out with Shawn Scott replacing as field Crew Chief.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	156	9
Total:	156	9

Report Date 19-May-21 Prepared on 19-May-21 Prepared By Shawn Scott

Weather Sun and cloud with some slight showers at the end of the day. +12C

Camp
Comments

Production Read north of the Alaska Highway up L3500 from S2500 to 3500, then east along S3500 from L3500 to 6000,
Comments then back along S3000 from L6000 to 4000. The crew then continued south reading L4000 S3000, 2500, 2000, and L4500 S2500 and 2000, finishing with L3500 S2000 next to the road.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	174	18
Total:	174	18

Report Date 20-May-21 Prepared on 20-May-21 Prepared By Shawn Scott

Weather Sunny, +14C

Camp
Comments

Production
Comments Read north of the Alaska Highway. Started reading west on S2000 from L6000 to 5000, then east on S2500 from L5000 to 6000, before moving northeast to L6500 S3000. Read north on 6500 from S3000 to 4500, then south on L7000 from S4500 to 3000 before walking back to the road.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	188	14
Total:	188	14

Report Date 21-May-21 Prepared on 21-May-21 Prepared By Shawn Scott

Weather Cloudy, +10C

 Camp
Comments

Production
Comments

Read along the Alaska highway to clean up leftover points before relocation of the base. L3000 S2000 and L6500 S2500 along with S1500 from L3500 to 5000 were read, but seismic activity slowed down readings. The crew then went to locate the Monuments for the National Gravity Network. The monument at the Upper Liard bridge could not be located, as it's possible the point was covered with the installation of the footbridge. Readings were taken over the assumed spot of the monument. The monument at the CBC radio tower was intact and readings were taken, although seismic activity again hampered the readings. The tower monument was tied in with the assumed bridge monument, the old gravity check in outside of junction 37, as well as the new base location a couple kilometers outside of Upper Liard.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	194	6
Total:	194	6

Report Date 22-May-21 Prepared on 22-May-21 Prepared By Shawn Scott

Weather Sun and cloud. +12C

Camp

Comments

Production Checked in at the CBC radio tower monument and the Base1 point near junction 37. Surveyed L7500 from S3000 to 4500, L8000 S3000 to 4500, finishing with L9000 S3000.

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	203	9
Total:	203	9

Report Date 23-May-21 Prepared on 23-May-21 Prepared By Shawn Scott

Weather Sun and cloud, +14C

Camp
Comments

Production Comments Checked in at the CBC radio tower, and the point near junction 37. Read north of the Alaska Highway on L8500 from S4500 to 3500, L9000 from S4500 to 3500, L9500 from S4500 to 3000, L10000 from S4500 to 3000, and L10500 from S4000 to 3000. The old check in at the Upper Liard bridge established by the march crew was restored and read.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	219	16
Total:	219	16

Report Date 24-May-21 Prepared on 24-May-21 Prepared By Shawn Scott

Weather Overcast with wind and rain. +6C

 Camp
 Comments

 Production
 Comments Checked in at the CBC radio tower, Upper Liard bridge, and the junction 37 point. The crew rode quads down the access trail to the grid south of Albert Creek. Attempts were made to explore trails that would lead to higher ground to place the repeater with good connection to the new base location. One spot was located near L8000 S0, but the trail had to be cleared of fallen logs and hanging willows. Read L8000 S500 and L8500 S500 on the way out.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	221	2
Total:	221	2

Report Date 25-May-21 Prepared on 25-May-21 Prepared By Shawn Scott

Weather Overcast, +10C

Camp
Comments

Production Comments Checked in at the CBC radio tower, bridge, and Junction 37 point. Rode in through the access trail and put up the repeater in the previously established spot. Read 12 stations through the day, (10 new and 2 repeats)
Read S0 from L7500 to 9500, S500 from L7500 to 9000, and L9500 S2500 and 2000.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	231	10
Total:	231	10

Report Date 26-May-21 Prepared on 26-May-21 Prepared By Shawn Scott

Weather Overcast and raining until noon when the sun came out. +6C

Camp

Comments

Production Checked in at the CBC radio tower, bridge, and junction 37 point. Repeated a few points that were easily accessible in Upper Liard that were completed by the march crew. S3000 L11000 and 11500, and L11000 2500. The crew then rode in along the access trail to points south of Albert Creek. Read S2500 from L7500 to 9000, S2000 from L7500 to 9000, and L8500 S3000.

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	240	9
Total:	240	9

Report Date 27-May-21 Prepared on 27-May-21 Prepared By Shawn Scott

Weather Mostly sunny with some cloudbursts through the day. +13C

Camp

Comments

Production Checked in at the cbc tower, bridge, and Junction 37 point. Several stations were reread with the RTK for

Comments GPS quality control. Rode in on the quad access trail south of Albert Creek. Read S1000 from L7000 to 9500, and S1500 from L7000 to 9500.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	252	12
Total:	252	12

Report Date 28-May-21 Prepared on 28-May-21 Prepared By Shawn Scott

Weather Sun and cloud, +12C

Camp
Comments

Production Comments Checked in at the cbc radio tower, bridge, and Junction 37 point. Rode in on the access trail to south of Albert Creek. Read L10000 from S0 to 2500, and L10500 from S0 to 2500. Point was taken at the old Junction 37 point to level with the new base location.

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel		20
Total:		20

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	264	12
Total:	264	12

Report Date 09-Nov-21 Prepared on 11-Nov-21 Prepared By Dave Hildes

Weather Windy, snowing, -10C

Camp Drive from Whitehorse to Watson Lake. Poor driving conditions, significant amount of snow in Watson Lake

Comments has fallen in past 24 hours.

Production
Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	22
Total:	2	22

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	264	
Total:	264	

Report Date 10-Nov-21 Prepared on 11-Nov-21 Prepared By Dave Hildes

Weather Snowing in the morning, clearing in the aft. Light winds, -10C all day.

Camp

Comments

Production Located monument, established GPS base, read lines 14500 to 16000, station 2000 and lines 14000 to 16000, station 2500. Quite a lot of snow ...

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	24
Total:	2	24

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	273	9
Total:	273	9

Report Date 11-Nov-21 Prepared on 12-Nov-21 Prepared By Dave Hildes

Weather -12 to -15C, light winds

Camp

Comments

Production Surveyed lines 16500 to 18500, stations 2000 and 2500.

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	26
Total:	2	26

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	283	10
Total:	283	10

Report Date 12-Nov-21 Prepared on 13-Nov-21 Prepared By Dave Hildes

Weather -8C all day, light snow some of the day

Camp

Comments

Production Lines 12000 to 14000, station 2000 and lines 12000 to 13500, station 2500. Line 12500, station 2500 was a repeat from March. Did an additional 5 repeats from March & May surveys.

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	67
Total:	2	67

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	291	8
Total:	291	8

Report Date 13-Nov-21 Prepared on 15-Nov-21 Prepared By Dave Hildes

Weather -5C, sunny

Camp
Comments

Production Lines 21500, 22000, 22500 and 23000 - stations 2000, 2500 and 3000

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	69
Total:	2	69

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	303	12
Total:	303	12

Report Date 14-Nov-21 Prepared on 15-Nov-21 Prepared By Dave Hildes

Weather -12C to -15C, calm & no precipitation.

Camp

Comments

Production Went to check out road to campground and broke in a trail. Surveyed lines 13000 and 13500, stations 3000-4000 and line 14000, stations 3000 & 3500.

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	71
Total:	2	71

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	311	8
Total:	311	8

Report Date 15-Nov-21 Prepared on 16-Nov-21 Prepared By Dave Hildes

Weather -10 to -12C, light snow

Camp

Comments

Production Nine point off the campground road - line 14000 station 4000, lines 14500 and 15000 stations 3000 to 4000, line 15500 station 4000 and line 16000 station 4000. Both line 15500 and 16000 station 4000 were moved to the campground road for quick surveying - line 16000 station 4000 is a significant distance from the planned position.

Comments Six point around the townsite of Watson Lake: lines 23000, 22500 and 22000 stations 1000 and 1500

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	73
Total:	2	73

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	326	15
Total:	326	15

Report Date 16-Nov-21 Prepared on 17-Nov-21 Prepared By Dave Hildes

Weather -10C mix of light snow and rain

Camp
Comments

Production Lines 15500 to 17500 - station 3000
Comments Lines 15500 to 17000 - station 3500
Line 19000 - stations 1000 to 2000
Line 19500, station 100 and 1500

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	75
Total:	2	75

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	340	14
Total:	340	14

Report Date 17-Nov-21 Prepared on 18-Nov-21 Prepared By Dave Hildes

Weather -10C to -5C, mostly sunny

Camp
Comments

Production Line 19000, station 2500 to 4000

Comments Line 18500, station 3000 to 4000

Line 18000, station 3000 to 4500

Line 17500, station 3500 to 4000

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	77
Total:	2	77

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	353	13
Total:	353	13

Report Date 18-Nov-21 Prepared on 19-Nov-21 Prepared By Dave Hildes

Weather -10C, mix of sun and cloud and flurries

Camp

Comments

Production Lines 18500 to 21500, station 4500

Comments Lines 19500 to 21000, station 4000
Line 21000, station 3500

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	79
Total:	2	79

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	365	12
Total:	365	12

Report Date 19-Nov-21 Prepared on 19-Nov-21 Prepared By Dave Hildes

Weather -15, snowing in the morning, clear in the afternoon

Camp
Comments

Production Line 19500, stations 3000 & 3500
Comments Line 20000, stations 3000 & 3500
Line 20500, stations 2000 - 3500
Line 20000, stations 1500 - 3000
Line 20500, station 1500

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	81
Total:	2	81

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	378	13
Total:	378	13

Report Date 20-Nov-21 Prepared on 21-Nov-21 Prepared By Dave Hildes

Weather -23C to -33C, mostly sunny & light to no wind

Camp
Comments

Production Comments Completed northern points around the campground. One point (L16000,S4000) is extra as previously taken along road, 250 metres away from planned station. Previous point will be renamed.
Lines 14500 to 17500, station 4500
Lines 16000 to 17000, station 4000

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	83
Total:	2	83

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	388	10
Total:	388	10

Report Date 21-Nov-21 Prepared on 22-Nov-21 Prepared By Dave Hildes

Weather -15C to -20C, light snow.

Camp
Comments

Production Line 21500 - stations 500, 3500 & 4000.
Comments Line 22000 - stations 500, 3000 to 4000.
Line 22500 - stations 500, 3000 to 4000.
Line 23000 - stations 500, 3000 to 4000.
GPS quality is questionable at L22000, 4500

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	85
Total:	2	85

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	403	15
Total:	403	15

Report Date 22-Nov-21 Prepared on 23-Nov-21 Prepared By Dave Hildes

Weather -15C to -20C. Windy (20-40 km/hr) in the morning and snowing all day

Camp

Comments

Production Line 19500, stations 2000 & 2500

Comments Line 20000, stations 1000 to 2500
Line 20500, stations 1000 & 1500
Line 21000, stations 500 & 1000
Line 21500, stations 1000
Line 15500, station 1500 - not at planned position. Took point at GPS base and labelled as closest grid point.
Repeats at Line 10000, station 3500 and Line 10500 stations 3000 and 4000. Were unable to find original locations and two of the repeats might be 10-20 metres from originals.

Personnel		
Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	87
Total:	2	87

Geophysics Production		
Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	414	11
Total:	414	11

Report Date 23-Nov-21 Prepared on 23-Nov-21 Prepared By Dave Hildes

Weather Cloudy, some blwoing and drifting snow.

Camp Pack up and drive from Watson Lake to Whitehorse.

Comments

Production

Comments

Personnel

Type of Personnel	Qty in Camp Today	Total Person Days
Geophysics Personnel	2	89
Total:	2	89

Geophysics Production

Grid Name	Total Production	Todays Production
Gravity Survey	Stations	Stations
Tinitina	414	
Total:	414	

CG-6 SPECIFICATIONS

SENSOR TYPE	Fused quartz using electrostatic nulling
READING RESOLUTION	0.1 microGal
STANDARD DEVIATION	< 5 microGal
OPERATING RANGE	World-wide (8,000 mGal without resetting)
RESIDUAL DRIFT	< 20 microGal/day
UNCOMPENSATED DRIFT	< 200 microGal/day
RANGE OF AUTOMATIC TILT COMPENSATION	±200 arcseconds
TARES	Typically < 5 microGal for shocks up to 20 g
AUTOMATED CORRECTIONS	Tide, instrument tilt, temperature, noisy sample filter, seismic noise filter, drift
DATA OUTPUT RATE	User selectable up to 10 Hz
GPS ACCURACY	Standard < 3 m
TOUCH-FREE OPERATION	Handheld Tablet with Bluetooth
BATTERY CAPACITY	2 X 6.8 Ah (10.8 V) rechargeable lithium smart batteries. Full day operation at 25 °C (77 °F)
POWER CONSUMPTION	5.2 Watts at 25 °C (77 °F)
OPERATING TEMPERATURE	-40 °C to + 45 °C (-40 °F to 113 °F); Optional high temperature version to +55 °C (131 °F)
DIGITAL DATA OUTPUT	USB and Bluetooth
DIMENSIONS	21.5 cm(H) x 21 cm x 24 cm (8.5 in x 8.2 in x 9.4 in)
WEIGHT	5.2 kg (11.5 lbs) including batteries
STANDARD SYSTEM CONTAINS	<ul style="list-style-type: none"> • CG-6 Autograv™ Gravity Meter • CG-6 Tripod • 2 Rechargeable Smart Batteries • Battery Charger • Tablet Computer w/GPS + accessories • Lynx LG Land Gravity Software • Power Supply and USB Cable • Transit Case • Shoulder Strap • User Manual • Spare Parts Kit • Carry Bag
AVAILABLE OPTIONS AND ACCESSORIES	<ul style="list-style-type: none"> • High-Temperature (HT) Meter Option • Cold Weather Survey Accessories • Surveyor's Backpack • Spare Meter Batteries • Spare Tablet Batteries • Trident Gradient Tripod • Spare Battery Caps

* Tablet and CG-6 specifications are subject to change without notice.

SCINTREX
A DIVISION OF LRS
Setting the Standards

222 Snidercroft Road
Concord, L4K 2K1
Ontario, Canada
PHONE +1 905 669 2280 FAX +1 905 669 6403
EMAIL scintrex@scintrexltd.com
WWW.SCINTREXLTD.COM



700-370-001 REV B

SCINTREX CG-5 AUTOGRAV SPECIFICATIONS

Sensor Type:	Fused quartz using electrostatic nulling
Reading Resolution:	0.001 milligal
Minimum Operating Range:	8000 milligals, without resetting
Residual Long-term Drift:	Less than 0.02 milligal/day
Standard Deviation:	less than 0.005 mGal
Range of Automatic Tilt Correction:	±200 arc sec.
Automated Corrections:	Tide, instrument tilt, temperature, noisy sample, seismic noise filter
Tares:	Typically less than 0.005 mgals
Dimensions:	30cm (H) x 21cm x 22cm
Weight:	8 kg, including standard battery
Battery Capacity:	2 x 6Ah (10.8V) rechargeable lithium smart batteries
Power Consumption:	4.5W at +25°C
Operating Temperature Range:	-40°C to +45°C.
Standard Memory:	1 MByte.
Noise Rejection:	Samples of more than 4 standard deviations from the average are rejected, if this feature is selected upon initialization of the instrument.
Displayed & Recorded Data:	Corrected Gravity, Standard Deviation, Tilt about the X-axis, Tilt about the Y-axis, Gravity Sensor Temperature, Tidal Correction, Duration of Measurement, Time at start of measurement and Header information (including date and initialization constants).
Digital Display:	1/4 VGA 320X240
Keypad Input:	27 key alpha/numeric for entering all commands, co-ordinates, header and ancillary information
Real Time Clock:	Day, month, year, hour, minute and second. Continuous lithium battery backup.
Digital Data Output:	RS-232 C and USB interface
Digital Data Formats:	Scintrex, text, CG-3, xyz

Leica Viva GS14

GNSS PERFORMANCE

GNSS technology	Leica SmartTrack	Advanced four constellation tracking
Leica SmartCheck	Continuous check of RTK solution	Reliability 99.99%
Signal tracking		GPS (L1, L2, L2C), Glonass (L1, L2), BeiDou (B1, B2), Galileo (E1, E5b), SBAS (WAAS, EGNOS, MSAS, GAGAN)
Number of channels		120 (up to 60 satellites simultaneously on two frequencies)

MEASUREMENT PERFORMANCE & ACCURACY¹

Time for initialisation		Typically 4 s
Real-time kinematic	Single baseline Network RTK	Hz 8 mm + 1 ppm / V 15 mm + 1 ppm Hz 8 mm + 0.5 ppm / V 15 mm + 0.5 ppm
Post processing	Static (phase) with long observations Static and rapid static (phase)	Hz 3 mm + 0.1 ppm / V 3.5 mm + 0.4 ppm Hz 3 mm + 0.5 ppm / V 5 mm + 0.5 ppm
Code differential	DGPS / RTCM	Typically 25 cm

COMMUNICATIONS

Communication ports	Lemo Bluetooth®	USB and RS232 serial Bluetooth® v2.00 + EDR, class 2
Communication protocols	RTK data protocols NMEA output Network RTK	Leica, Leica 4G, CMR, CMR+, RTCM 2.2, 2.3, 3.0, 3.1, 3.2 MSM NMEA 0183 V 4.00 and Leica proprietary VRS, FKP, iMAX, MAC (RTCM SC 104)
Built-in data links	3.75 G GSM / UMTS / CDMA phone modem Radio modem	Fully integrated, internal antenna Fully integrated, receive and transmit, external antenna 403 - 470 MHz, 1 W output power
External data links		GSM / GPRS / UMTS / CDMA and UHF / VHF modem

GENERAL

Field controller and software	Leica SmartWorx Viva software	Leica CS10 and CS15 field controller
User interface	Buttons and LEDs Web server	On / Off and Function button, 7 status LEDs Full status information and configuration options
Data recording	Storage Data type and recording rate	Removable microSD card, 8 GB Leica GNSS raw data and RINEX data at up to 20 Hz
Power management	Internal power supply External power supply Operation time ²	Exchangeable Li-Ion battery (2.6 Ah / 7.4 V) Nominal 12 V DC, range 10.5 - 28 V DC 7 h receiving (Rx) data with internal radio, 5 h transmitting (Tx) data with internal radio, 6 h Rx/Tx data with internal modem
Weight and Dimensions	Weight Diameter x Height	0.93 kg (GS14) / 2.90 kg standard RTK rover setup on pole 190 mm x 90 mm
Environmental	Temperature Drop Proof against water, sand and dust Vibration Humidity Functional shock	-40 to 65°C operating, -40 to 80°C storage Withstands topple over from a 2 m survey pole onto hard surfaces IP68 (IEC60529 / MIL STD 810G 506.5 I / MIL STD 810G 510.5 I / MIL STD 810G 512.5 I) Withstands strong vibration (ISO9022-36-08 / MIL STD 810G 514.6 Cat.24) 100% (ISO9022-13-06 / ISO9022-12-04 / MIL STD 810G 507.5 I) 40 g / 15 to 23 msec (MIL STD 810G 516.6 I)

LEICA VIVA GS14 - GNSS SMART ANTENNA	Performance	Professional
SUPPORTED GNSS SYSTEMS		
Dual frequency	✓	✓
GPS / GLONASS / Galileo / BeiDou	✓ / • / • / •	✓ / ✓ / ✓ / ✓
RTK PERFORMANCE		
DGPS/RTCM. RTK Unlimited, Network RTK	✓	✓
POSITION UPDATE & DATA RECORDING		
5 Hz / 20 Hz positioning	✓ / ✓	✓ / ✓
Raw data / RINEX data logging	✓ / •	✓ / ✓
NMEA out	•	✓
ADDITIONAL FEATURES		
RTK reference station functionality	✓	✓
3.75G or CDMA Phone / UHF Radio (receive & transmit) modem	✓ / •	✓ / •

✓ Standard

• Optional

¹ Measurement precision, accuracy, reliability and time for initialisation are dependent upon various factors including number of satellites, observation time, atmospheric conditions, multipath etc. Figures quoted assume normal to favourable conditions. A full BeiDou and Galileo constellation will further increase measurement performance and accuracy.

² Might vary with temperature, age of battery, transmit power of data link device.

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Leica Geosystems AG

www.leica-geosystems.com



- when it has to be **right**

Leica
Geosystems

Leica Viva GS15

GNSS TECHNOLOGY

Self-learning GNSS	Leica RTKplus SmartLink (worldwide correction service) SmartLink fill (worldwide correction service)	Adaptive on-the-fly satellite selection Remote precise point positioning (3 cm 2D) ¹ Initial convergence to full accuracy 20 - 40 min, Re-convergence < 1 min Bridging of RTK outages up to 10 min (3 cm 2D) ¹
Leica SmartCheck	Continuous check of RTK solution	Reliability 99.99%
Signal tracking		GPS (L1, L2, L2C, L5), Glonass (L1, L2, L2C, L3 ²), BeiDou (B1, B2, B3 ²), Galileo (E1, E5a, E5b, Alt-BOC, E6 ²), QZSS (L1, L2C, L5, L6 ²), NavIC L5 ³ , SBAS (WAAS, EGNOS, MSAS, GAGAN), L-band
Number of channels		555 (more signals, fast acquisition, high sensitivity)

MEASUREMENT PERFORMANCE & ACCURACY¹

Time for initialisation		Typically 4 s
Real-time kinematic (Compliant to ISO17123-8 standard)	Single baseline Network RTK	Hx 8 mm + 1 ppm / V 15 mm + 1 ppm Hz 8 mm + 0.5 ppm / V 15 mm + 0.5 ppm
Post processing	Static (phase) with long observations Static and rapid static (phase)	Hx 3 mm + 0.1 ppm / V 3.5 mm + 0.4 ppm Hz 3 mm + 0.5 ppm / V 5 mm + 0.5 ppm
Code differential	DGPS / RTCM	Typically 25 cm

COMMUNICATIONS

Communication ports	Lemo Bluetooth®	USB and RS232 serial Bluetooth® v2.00 + EDR, class 2
Communication protocols	RTK data protocols NMEA output Network RTK	Leica, Leica 4G, CMR, CMR+, RTCM 2.2, 2.3, 3.0, 3.1, 3.2 MSM NMEA 0183 V 4.00 and Leica proprietary VRS, FKP, iMAX, MAC (RTCM SC 104)
Built-in data links	3.5G phone modem Radio modem	Fully integrated, internal or external antenna Fully integrated, receive and transmit, internal or external antenna 403 - 470 MHz, 1 W output power, up to 28800 bps over air
External data links		GSM / GPRS / UMTS / CDMA and UHF / VHF modem

GENERAL

Field controller and software	Leica Captivate software Leica SmartWorx Viva software	Leica CS20 field controller, Leica CS35 tablet Leica CS10 and CS15 field controller
User interface	Buttons and LEDs Web server	On / Off and Function button, 8 status LEDs Full status information and configuration options
Data recording	Storage Data type and recording rate	Removable SD card, 8 GB Leica GNSS raw data and RINEX data up to 20 Hz
Power management	Internal power supply External power supply Operation time ⁴	2 exchangeable Li-Ion batteries (2.6 Ah / 7.4 V) Nominal 12 V DC, range 10.5 - 28 V DC 10 h receiving (Rx) data with internal radio, 9 h transmitting (Tx) data with internal radio, 7.5 h Rx / Tx data with internal phone modem
Weight and Dimensions	Weight Diameter x Height	1.34 kg (GS15) / 3.30 kg standard RTK rover setup on pole 196 mm x 198 mm
Environmental	Temperature Drop Proof against water, sand and dust Vibration Humidity Functional shock	-40 to 65°C operating, -40 to 80°C storage Withstands topple over from a 2m survey pole onto hard surfaces IP68 (IEC60529 / MIL STD 810G 506.5 I / MIL STD 810G 510.5 I / MIL STD 810G 512.5 I) Withstands strong vibration (ISO9022-36-08 / MIL STD 810G 514.6 Cat.24) 100% (ISO9022-13-06 / ISO9022-12-04 / MIL STD 810G 507.5 I) 40 g / 15 to 23 msec (MIL STD 810G 516.6 I)

LEICA VIVA GS15 - GNSS SMARTANTENNA	Performance	Unlimited
SUPPORTED GNSS SYSTEMS		
Multi-frequency	✓	✓
GPS / GLONASS / Galileo / BeiDou / QZSS	✓ / • / • / • / •	✓ / ✓ / ✓ / ✓ / ✓
RTK PERFORMANCE		
DGPS/RTCM. RTK Unlimited, Network RTK	✓	✓
SmartLink fill / SmartLink	• / •	✓ / •
POSITION UPDATE & DATA RECORDING		
5 Hz / 20 Hz positioning	✓ / ✓	✓ / ✓
Raw data / RINEX data logging / NMEA out	✓ / • / •	✓ / ✓ / ✓
ADDITIONAL FEATURES		
RTK reference station functionality	✓	✓

✓ Standard

• Optional

¹ Measurement precision, accuracy, reliability and time for initialisation are dependent upon various factors including number of satellites, observation time, atmospheric conditions, multipath etc. Figures quoted assume normal to favourable conditions. A full BeiDou and Galileo constellation will further increase measurement performance and accuracy.

² Believe to comply, but subject to availability of BeiDou ICD and Galileo commercial service definition. Glonass L3, BeiDou B3, QZSS L6 and Galileo E6 will be provided through future firmware upgrade.

³ Support of NavIC L5 is incorporated and will be provided through future firmware upgrade.

⁴ Might vary with temperature, age of battery, transmit power of data link device.

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