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LOGISTICS, OPERATIONS AND PROCESSING REPORT ON A REGIONAL GRAVITY AND GPS SURVEY TENNANT INLIER NORTHERN TERRITORY ON BEHALF OF AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION (SCINTREX REF.: NT 062)

by

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SUMMARY

During the period from July 6 to 30 (2001), Scintrex executed a regional gravity and GPS survey in the Tennant Creek region, central Northern Territory. The survey was completed on behalf of the Australian Geological Survey Organisation in conjunction with the Northern Territory Geological Survey. Surveying involved the observation of gravity and GPS positioning data on a regular grid of 4 x 4km and at 2 x 2km within an area to the south west corner of the Tennant Creek 1:250 000 map sheet. A network of permanently monumented gravity and GPS base stations was also established throughout the survey area.

A total of 1605 new stations were observed during surveying with 139 repeat readings taken at 135 independent stations taken to demonstrate the accuracy and repeatability of the gravity and GPS data. The final standard deviation of all observed gravity repeat readings was 0.24μms^{-2} and for the AHD elevations was 0.04m.

Data was acquired using a combination of helicopter and vehicle supported operations. Gravity data was acquired using Scintrex CG-3 Autograv gravity meters and reduced to Bouguer and Free Air Anomaly values. Positioning information was established using GPS and final processed data was located using the World Geodetic System (WGS84). Elevation data was tied to the Australian Height Datum (1971) while gravity data was referenced to the Australian Fundamental Network Datum (Isogal84).

1.0 INTRODUCTION

On behalf of the Australian Geological Survey Organisation (AGSO) in conjunction with the Northern Territory Geological Survey (NTGS), Scintrex completed a regional gravity and GPS survey in the Tennant Creek region of the Northern Territory. The survey involved establishment of gravity stations on a regular grid of 4 x 4 km and at 2 x 2 km in selected areas. A network of permanently monumented gravity and GPS base stations was also established throughout the survey area.

Gravity readings were made using Scintrex CG-3 and CG-3M Autograv gravity meters while positioning information was obtained using Ashtec and NovAtel dual frequency geodetic receivers operating under the Global Positioning System (GPS). A combination of vehicle and helicopter supported operations were utilised to maximise survey efficiency and production rates.

The survey area covers the 1:250 000 map sheet of Tennant Creek and parts of the Green Swamp Well and Bonney Well sheets. Within the survey area and as specified by AGSO, selected areas were excluded where existing detailed gravity data was already available. The survey area terrain varied from major rock outcrops (Davenport Ranges) to thick spinifex and to black soil plains in the north. General vehicle access provided by 2 major highways and numerous outstation access tracks was good but off road access was poor given the density of the vegetation.

Field surveying was carried out by Scintrex Perth and Queensland personnel with the helicopter and pilots supplied by Rotor Work Australia, based in Bankstown, New South Wales. The survey was conducted by Peter Johnson (geophysicist – crewleader), Kenneth Elleray (senior operator) and Barrett Cameron (geophysicist – operator). The helicopter pilots were Peter Muddle and Barry D'Hoedt, both having several thousand flying hours and significant low level flying experience. Surveying commenced on July 6 (2001), and was completed on July 30.

2.0 SURVEY EQUIPMENT

During surveying, measurements of gravity were made using Scintrex CG-3 and CG-3M gravity meters while positioning information was obtained using GPS with both NovAtel and Ashtec geodetic receivers. A combination of helicopter and vehicle transportation was employed for surveying dependant upon station access and field conditions.

2.1 Gravity Meters

The Scintrex CG-3 Autograv is an automated gravity meter which makes relative measurements of gravity by sampling the gravity field at 1 second intervals in the range from 4 to 99999 seconds. The reading duration is selected depending on the field conditions and background noise levels. Each 1 second measurement is stacked and averaged with an auto rejection routine employed to ignore erroneous spikes. The average and standard deviation is calculated and displayed during the reading to indicate the reading stability and reliability.

The sensing element of the CG-3 (spring and proof mass) is situated between two capacitive plates within a temperature stabilised chamber. In the null position, the proof mass is balanced by the fused quartz spring and small electrostatic restoring force. A change in gravity causes a displacement of the proof mass, which is returned to the null position by an automatic feedback voltage applied to the plates. The feedback voltage is a measure of the relative gravity. The biggest advantage of this system is that there is no need for mechanical clamping between stations which often results in significant elastic hysteresis effects. Provided the operator maintains a basic level of care with the meter, settling times at field stations can be as little as 0 – 1 minutes to provide accuracy better than $0.3\mu ms^{-2}$.

The stability of quartz spring in the CG-3 enables the application of a real time software correction for long term instrument drift resulting in a typical drift of less than $0.2\mu ms^{-2}$/day. Internal digital tilt meters supply information on the off-vertical

tilt of the instrument and if selected, a real time correction is made to each 1 second sample eliminating errors in the reading particularly at sites where the ground is unstable or soft. A real time earth tide correction using the Longman Formula is applied at the completion of each reading based on the values of latitude, longitude, Greenwich Mean Time (GMT) Offset and time of the reading. The CG-3 has a reading resolution of $0.05\mu ms^{-2}$, while the CG-3M is $0.01\mu ms^{-2}$.

2.2 GPS Systems

The NovAtel GPS system used is based on the NovAtel Millenium GPS card which is a 24 channel (12-L1 and 12-L2) "all-in-view", dual frequency card. The Millenium makes measurements of both carrier phases (L1 and L2) as well as L1-C/A and L2 P-Code and employs narrow correlator technology for more accurate and reliable C/A data. The NovAtel units Scintrex uses have external palmtop computers for recording the satellite information during an observation. At the completion of each day, the palmtop computers have a removable PCMCIA card which can be easily downloaded onto a computer with PCMCIA card capabilities.

The Ashtec Z-Survey is also a 24 channel "all-in-view" receiver tracking both L1 and L2 carrier phases with multipath mitigation, dual frequency smoothing for improved code differential and Z-tracking for more reliable solutions. The Z-Surveyor is an extremely versatile receiver which is waterproof, compact and operates as a stand alone unit for post processing applications. Observations of the satellite frequencies are recorded directly onto a PCMCIA card within the receiver which is simply removed at the end of the day for downloading.

The two receiver types utilise a choke-ring type antenna (antenna is mounted in the centre of a large round metal ring to reduce multipath effects) at the base station and smaller aircraft type or round plastic 'mushroom' type antennas for the mobile units. The aircraft type are used on both vehicles and the helicopter as they are designed to operate in a high vibration environment.

Both receiver types are geodetic quality receivers capable of accuracies well within the contractual requirements. Regular field repeats demonstrate consistent and reliable operation of the receivers at all times.

2.3 Computing and Processing

During surveying, data was downloaded and processed on Toshiba laptop computers. All field data was regularly backed up onto compact disk (CD) and field plots of the data and text files for repeat station statistics were made on a colour Hewlett Packard DeskJet 340 printer.

2.4 Vehicles

Over the duration of the survey, several vehicles were utilised for field work as well as for transporting helicopter fuel and base camp duties. All vehicles used were Toyota Landcruiser Traybacks.

Field survey vehicles were fitted with UHF radios for communication with each other and with the helicopter, satellite telephones and vehicle recovery equipment. All vehicles carried 2 spare tyres as well as tyre repairing equipment. Regular survey vehicles also carry first aid kits and fire extinguishers.

The vehicles were hired from Queensland Four Wheel Drive and were all regularly maintained and had traveled less than 50 000km when initially hired.

2.5 Helicopter

All helicopter surveying was completed using a piston engine, Bell-47GA. The Bell-47 is ideal for gravity surveying with the ability to carry the pilot, an operator and all surveying equipment. If an additional two 20 litre fuel containers are carried, the helicopter has an endurance of between 5 – 5.5 hours. The pilot carries a personal emergency beacon (EPIRB) and the helicopter is fitted with both VHF and UHF radios for communication. The helicopter was on sub-contract from Rotor Work

Australia Pty Ltd, who provided all pilots and maintained the aircraft throughout the duration of the survey. Rotor Work also obtained all necessary flight licenses and permits for their pilots and were responsible for the insurance of the helicopter while surveying. During the survey, 2 pilots were employed to make maximum usage of the surveying day (approximately 10.5 hours flying).

3.0 LOGISTICAL SUMMARY

Scintrex field crews initially mobilised from Adelaide where all field equipment was being stored. The crew consisted of 3 personnel and 2 Toyota Landcruiser Traybacks. The crews departed Adelaide on July 3 (2001) and arrived in Tennant Creek on July 5.

Establishment of the gravity and GPS base station networks began on July 6 and was completed on July 8. Additional GPS base stations were established after this date during the course of surveying operations.

A combination of 1 and 2 vehicle operations began on July 8 and continued until July 10. At this time, almost all stations easily accessible on roads and tracks had been exhausted. Due to land entry and access restrictions, vehicle surveying was difficult with access being restricted entirely to established tracks only. Production rates for each vehicle were around 10 – 15 readings per day.

On July 11 and 12, Scintrex crews remained on standby as negotiations over land access and helicopter operations were held. These negotiations included a reconnaissance flight by the traditional owners in order to identify and obtain coordinates for any sensitive areas or sacred sites which were to be avoided during surveying. Negotiations took place between representatives of the Central Land Council (CLC), NTGS and Scintrex.

On July 13 after being granted the appropriate access permission, helicopter surveying operations commenced utilising 2 crews (each crew being 1 pilot and 1 operator) and a 10 – 11 hour flying day. Helicopter surveying continued in this manner until July 30, when survey operations were completed. Production rates varied from between 80 to 110 depending upon the station spacing, vegetation density and ferry to and from the working area.

From July 6 to 26, survey operations were based in Tennant Creek. After this time, operations were moved to Wauchope to finish the southern section of the survey area.

On July 31 the Scintrex and helicopter crews demobilised from Wauchope to Alice Springs.

4.0 CALIBRATION OF SURVEY EQUIPMENT

Prior to the commencement of, during and after field surveying, all field equipment was tested and periodically checked for correct operation. In addition to tests on calibrations ranges, regular repeats and loop ties between different instruments (gravity meters and GPS receivers) during surveying demonstrate the achievement of the contractual requirements for data precision and quality.

4.1 Gravity Meters

The gravity meters to be used on the survey were tested on a calibration range to demonstrate their satisfactory performance and to ensure the requirements for data quality and repeatability would be achieved. The same meters were then tested again at the completion of surveying.

Scintrex CG-3 gravity meters have only one worldwide operating range and do not require the use of a calibration table for varying reading ranges. The purpose of the pre- and post-survey calibration range tests are simply to verify that the differences measured are consistent with the data quality requirements for the survey. No adjustment is made to the instrument or constants provided the observed error is acceptable.

In order to test the correction functioning of the gravity meters prior to the survey, each was used to measure differences between the two accessible stations on the Adelaide Calibration Range. The primary base station used was Kensington Gardens (2001.9108) with differences measured at Nortin Summit (6091.0208) over one loop. The results of these tests demonstrate that all meters were operating correctly, within specification and consistently between each meter. CG-3M gravity meter number 9610353 gave an error of $0.29\mu ms^{-2}$ to the published value at Nortin Summit, CG-3M meter number 9711402 gave an error of $-0.02\mu ms^{-2}$, CG-3 meter number 9610358 gave an error of $0.02\mu ms^{-2}$ and CG-3 meter number 9403241 gave an error of $0.06\mu ms^{-2}$.

At the completion of surveying, the meters were tested on the Perth Calibration Range using Mount Gungin (7391.0271) as the primary base station. Differences were then measured at station 8090.0317 using each meter over two loops. The results again demonstrate that each gravity meter was operating correctly and within specification. CG-3M gravity meter number 9610353 gave an average (over the two loops) error of -0.10μms^{-2} to the published value at 8090.0317, CG-3M meter number 9711402 gave an average error of 0.41μms^{-2}, CG-3 meter number 9610358 gave an average error of 0.25μms^{-2} while CG-3 meter number 9403241 gave an average error of 0.43μms^{-2}.

Results of the pre-survey and post-survey calibration tests are contained within appendix one.

4.2 GPS Receivers

The simplicity and low sensitivity of the GPS receivers eliminates the need for regular calibration and testing with data quality and consistency being demonstrated during surveying.

Initially during establishment of the base station network, configuring the GPS receivers in a closed polygon structure allows the consistency and precision of each receiver to be demonstrated provided the loop closure errors are acceptable. A closed polygon configuration also provides multiple paths to each station utilising multiple GPS receivers and again demonstrates the correct functioning of each receiver provided the error between each solution at the station is acceptable.

In addition, during field surveying regular GPS repeats between loops, within loops and between different GPS receivers demonstrates their reliability, consistency and quality.

5.0 BASE STATION NETWORK

During the survey, a network of GPS and gravity base stations was established both for the purposes of the current survey and to provide permanent reference stations for any future surveying in the area. A total of 5 permanently monumented gravity/GPS base stations were established in a random distribution throughout the survey area while 18 intermediate GPS only base stations were established at intervals of approximately 30km.

Intermediate GPS only base stations were established in order to minimise baseline (base-rover GPS receiver seperation) lengths during surveying. These stations are marked with a fence dropper and small metal picket just above ground level (10cm). The stations have an aluminium identifier tag attached to the fence dropper with the station number (200181.80XX) and the word "AGSO". The small metal picket provides the assumed ground level and in its centre is the exact location of the GPS position for the station. The positioning accuracy of the GPS only stations is equivalent to that of the permanently monumented stations.

Permanently monumented combined gravity and GPS base stations are marked with a flat topped concrete block, approximately 30 x 30cm. Set in the centre of the concrete is a brass disc with the words "Precise Survey Mark" and the station number (200181.900X) stamped on. Immediate adjacent is a star picket with a diamond shaped white witness plate attached stating the distance and bearing of the monument from the witness marker. This plate has the words "Survey Mark" with a reference to AGSO under the words "Further Information Contact". Each concrete monument protrudes from the ground by approximately 10cm so that it does not become covered with sand or dirt. The monument has been set in the ground approximately 20 – 30cm. Attached to the star picket is an aluminium identifier tag with the station number (200181.900X) and the word "AGSO". The exact location of the GPS position for the station is at the top of the raised section, in the centre of the brass disc.

5.1 GPS Network

The GPS network consists of a series of closed geometrical figures and smaller internal network structures. The origin of the network is the Australian National Network (ANN) station NTS 233, situated just north of Tennant Creek, with 0 order ellipsoidal coordinates and a 3rd order AHD elevation. Only control stations with 3rd order AHD elevations were available in the survey area which is consistent with the contractual precision requirements. Several additional state geodetic control stations which were to be incorporated into the Scintrex network could not be located and as a result no additional control to station NTS 233 was observed. In addition, given the remoteness and lack of access to most parts of the area, state control was only available at limited locations generally along the major highways.

The closed polygon structure of the network ensures consistency and compatibility between all stations within the network and as demonstrated by the numerous closure errors, network accuracy was very high and within contractual requirements.

The GPS base station network was established using a combination of multiple GPS receivers logging concurrently, generating multiple network paths to each station and providing a real indication of the network error. Up to 4 GPS receivers were used placed in either a linear traverse or closed polygon configuration at separations of 25 – 30km, access and field conditions permitting. Once the first and last receivers had logged a minimum of 1.5 hours, the receivers were moved in succession. For convenience, base station sites were chosen along tracks and fence lines and generally situated at major features such as road junctions and gates. Base stations were also generally set off major roads and highways by 50 – 100m for security of the equipment when left unattended.

Because the network consists of a series of closed polygons, it is possible to determine the error at a station to which more than one path exists. In addition, it is also possible to determine the reliability of any stations along a path which end at a station of known precision (provided the closure error is acceptable). The network processing

package used on the current survey uses the shortest possible network path to derive coordinates at each station (i.e. minimal number of network legs) and then uses any additional paths as a check or error estimate. In the final adjustment however, all network paths to a station will have an effect on the final network adjusted coordinates for that station.

Table 5.1 is a listing of the closure errors for the various closed polygons of the GPS network. They are not network adjusted and demonstrate that all closure errors are within contractual requirements. The errors shown in table 5.1 are stations which have a minimum of 2 paths connecting them to the network and the errors are generated by differencing the coordinates derived from the shortest network path to all subsequent observations / paths at that station.

@STA	FROM	TYPE	DN (m)	DE (m)	DH (m)
8003	8001	Loop	-0.03	0.01	-0.05
8003	8001	Dup.	0.01	0.04	-0.01
8003	8002	Loop	0.00	0.05	0.00
8004	9005	Loop	-0.03	0.10	-0.05
8005	8002	Loop	0.19	-0.06	0.11
8005	8003	Loop	0.03	-0.03	0.05
8005	8007	Loop	-0.01	0.03	0.07
8007	8002	Loop	0.01	0.01	-0.01
8010	9004	Loop	0.03	0.11	-0.01
8010	8008	Loop	0.00	0.06	0.00
8010	8009	Loop	0.00	0.01	0.00
8011	8001	Loop	0.00	0.03	0.10
8012	8009	Loop	-0.04	-0.04	0.02
8013	9004	Loop	-0.03	0.00	-0.03
8014	9004	Loop	0.02	-0.02	0.01
8015	8002	Loop	0.12	0.04	0.09
8015	8003	Loop	0.02	-0.07	0.01
8016	8015	Loop	-0.03	0.08	-0.01
8017	8005	Loop	0.01	-0.03	-0.07
8019	9002	Loop	0.00	0.07	0.00

8019	9003	Loop	-0.04	0.01	-0.02
8020	9003	Loop	0.05	-0.07	-0.03
9001	8002	Loop	0.00	0.00	-0.01
9002	9001	Loop	0.01	0.01	0.01
9005	8001	Loop	0.03	-0.10	0.04
9005	8011	Loop	0.01	0.01	0.00
9005	9004	Loop	0.00	-0.02	0.00
		RMS Error	0.05	0.05	0.04

Table 5.1 GPS base station loop closure summary – Tennant Inlier NT Gravity Survey

In table 5.1: the '@ station' column indicates the station on which the closure is made; 'From' indicates the previous station from which the check path originates; 'DN', 'DE', 'DH' indicate the errors measure in the GDA94 easting, northing and elevation respectively; 'Type' indicates whether the closure is from a closed **loop** structure or a **dup**licate observation (2 observations of the same baseline). The 'RMS Error' is the root mean squared error measured over all loop closure errors.

A full listing of the base station information including network diagrams, station descriptions and positioning details can be found in appendix two.

5.2 Gravity Network

The gravity base station network established throughout the survey area was observed with 3 gravity meters using an A-B-A-B-A (3/2) loop structure. In most cases, 2 new stations were observed within the same loop for efficiency. The use of multiple meters in each gravity loop generated independent gravity values for each meter at each station giving a true error estimate and allowing for some redundancy. Each gravity loop was started and completed at the same established base station, with a minimum of 2 readings of 120 seconds duration taken at each station. If the repeat difference between the 2 readings was greater than $0.15\mu ms^{-2}$ then additional readings were made until a minimum of 2 were within $0.15\mu ms^{-2}$.

The gravity network (figure 5.1) originates from the AGSO Isogal station at the Tennant Creek Airport terminal building (6793.0134). All primary permanent base stations (200181.9001 to 200181.9005) are connected directly to station 6793.0134 while station 200181.8021 (intermediate station) is connected via station 200181.9002. In addition, stations 200181.9002 and 200181.9003 are connected by a second loop to station 200181.9001.

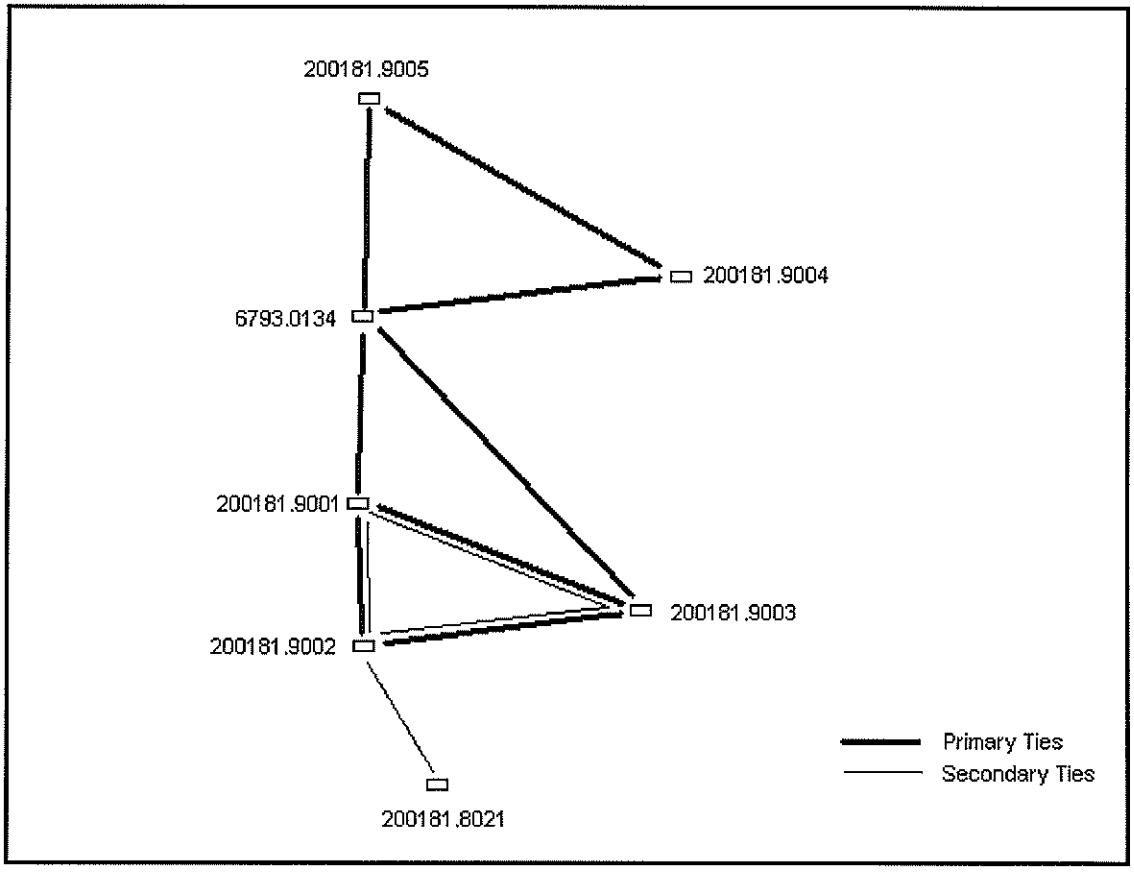


Figure 5.1 Gravity base station network – Tennant Inlier NT Gravity Survey

Station	Loop No	Error (μms^{-2})	No. Meters	Date
200181.9004	1 / 2	0.17	3	06/07/2001
200181.9005	1 / 2	0.11	3	06/07/2001
200181.9001	1	0.14	2	06/07/2001
200181.9001	1 / 2	0.18	3	07/07/2001
200181.9001	check	0.04	3	07/07/2001
200181.9002	1 / 2	0.23	3	07/07/2001
200181.9003	1 / 2	0.23	3	07/07/2001
200181.9002	1 / 2	0.25	3	11/07/2001
200181.9002	check	0.03	3	11/07/2001
200181.9003	1 / 2	0.29	3	11/07/2001
200181.9003	check	0.04	3	11/07/2001

Table 5.2 Summary of the gravity base station network errors – Tennant Inlier NT Gravity Survey

In table 5.2, stations with "1 / 2" in the loop number column indicate the maximum error observed at each newly established base station between all gravity meters (the number of meters used is indicated by "No. Meters"). The "1 / 2" denotes the fact that this error is generated from taking the average value determined from each of the 2 loops for each meter. The "check" in the loop number column is for stations which were re-observed in a second independent loop. The error values listed for these cases is the difference to the previously established observed gravity value at the station. These same observations also have internal error values associated with the present loop between all the meters, the values of which are shown within the same box (with loop number "1 / 2" shown).

As demonstrated by table 5.2, repeat errors from independent loops and within loops are well within contractual requirements and indicate the high accuracy and reliability of the gravity base station network. A full listing of the repeatability of the gravity network is contained within appendix three.

6.0 FIELD SURVEYING

The field survey procedures and methodology employed for both vehicle and helicopter modes of transport were for the most part very similar and varied only slightly for reading times and conditions.

6.1 Navigation

Surveying and setting out of gravity stations was conducted based on navigating to pre-determined reading locations. Navigation was accomplished using both the Garmin 12XL (vehicle) and GPS II+ (helicopter) handheld GPS receivers. Both receivers are 12 channel, operating in non-corrected or autonomous mode with an expected accuracy of better than 5m (in the absence of selective availability). Proposed gravity reading point information including station number, easting and northing, were loaded into the receiver (via the PC-GPS interface) as waypoints and then field readings taken as close as possible to these. Stations were generally taken within 100m of the proposed location and only moved outside of this limit when absolutely necessary. Because the proposed waypoints are loaded into the receiver, the exact distance from the proposed point is known (and displayed on the screen) and there is no possibility of errors in reading locations. Stations to be re-observed as repeats were marked in the GPS if the reading site did not coincide with the pre-planned point so that they could be easily relocated.

6.2 Gravity Operations

During surveying, all gravity meters had the constant tilt correction (correcting each 1 second sample for off vertical tilt), real time earth tide correction and auto rejection (rejecting any reading more than 4 standard deviations from the mean) features enabled. The time the reading was taken and the value of gravity at each site were recorded on a field sheet by the operator as was the station number and any additional comments on unusual field conditions. This was only done as a cross check to ensure there had been no errors in entering station number information into the gravity meter

and allowed any errors to be easily and accurately rectified. Data recorded by the gravity meter is stored digitally and recovered by downloading to a computer.

All gravity surveying consisted of measuring data in independent, closed loops which started and finished at base stations of known observed gravity. These stations form part of the base station network established during the survey or are part of the AGSO Australian Fundamental Gravity Network. Generally it was not practical to have loop durations of less than 10 hours due to either the helicopter crews changing over in the field (away from the base station) or vehicle operators working too far away to return to the base. In these cases, additional repeats and loop ties were made to ensure the data within in each loop was of acceptable quality and reliability. In addition, the gravity meters used for surveying generally exhibited very stable drifts, the values of which can be found in appendix four.

For both vehicle and helicopter supported gravity operations, at each station a minimum of 2 readings were taken to ensure repeatability and reliability. The difference between these 2 readings was required to be no more than $0.3\mu ms^{-2}$ unless there were extremely adverse reading conditions at the station (such as muddy or unstable ground). In the event that the difference exceeded this, additional readings were made until at least 2 were within $0.3\mu ms^{-2}$. The 2 readings made at each station are then averaged during the data processing.

6.2.1 Helicopter

For helicopter supported gravity surveying, gravity readings were averaged for a duration of 30 seconds with a minimum of 2 readings having a difference of less than $0.3\mu ms^{-2}$ taken at each site. When travelling between stations, the meter was placed on the seat between the operator and the pilot. Because transportation by helicopter has a minimal effect on the meter, it was not necessary to allow any settling time before reading in order to achieve the required repeatability.

Gravity readings were taken at an average offset of about 5m, directly out from the passenger side of the helicopter. This position was far enough from the helicopter that the gravity measurement was not affected by ground vibration (micro-seismic) and just outside the effect of down wash from the helicopter blades. At all times, the operator was still in the view of the pilot for safety purposes. The GPS antenna was located on the boom of the helicopter, approximately 5m behind the cabin, which meant the gravity reading was taken at an offset of less than 10m from the antenna. All reading sites were chosen to be flat (gradient of less than 10cm in 10m), clear and away from major terrain changes which minimised the possibility of breaching Bouguer assumptions.

When 2 additional fuel containers (20L each) were carried, the helicopter had an endurance of 5.5 hours including ferry time. This generally resulted in a reading time of 5 hours in the field yielding between 80 and 110 new readings depending upon station access and spacing. A typical day for helicopter surveying consisted of 2 shifts of 5 hours each, with a crew replacement (both pilot and operator) around 12:30pm. The helicopter lifted off in the mornings at around 7:00am and landed at 6:00pm with a break during crew change over for refueling.

6.2.2 Vehicle

Gravity surveying with vehicles used a sampling duration for the gravity field of 40 seconds at each site, again with a minimum of 2 readings having a difference of less than $0.3\mu ms^{-2}$. In almost all cases, the difference was less than $0.1\mu ms^{-2}$ due to the fact that the meter was allowed to settle for several minutes before the first reading was taken. The settling time was necessary because transportation by vehicle causes the greatest stress on the meter and allowing it to settle just after transportation helps the spring recover from any minor elastic hysteresis effects. During transport, the meter was placed in the transit case on the tray of the vehicle. The case is well padded to absorb shock and vibration and minimise the effect on the meter.

Gravity readings were taken immediately adjacent to the vehicle which is an offset of less than 2 metres from the position of the GPS sensor. Reading locations were chosen to be flat (gradient of less than 10cm in 10m), clear and away from major terrain changes which minimised the possibility of breaching Bouguer assumptions.

With the exception of the first few days of surveying, the vehicle operator was generally used only for helicopter support, setting out and retrieving the GPS base stations in advance of the helicopter. Working off the existing roads and tracks was made difficult by the vegetation density and it was considered more efficient to utilise the helicopter for the majority of the survey.

6.3 GPS Operations

The GPS field procedures varied depending upon the mode of transportation (vehicle or helicopter) and the GPS system used. The Ashtec GPS receivers recorded data directly to removable PCMCIA cards inserted into the receiver, while the NovAtel system recorded data to a palmtop computer using the program *LOGGPS*. For both the NovAtel and Ashtec GPS systems, the data recording interval was set to 5 seconds.

GPS base stations were set up over the station marks established during the base station surveying and occasionally on new marks established during a session. The use of optical plummets in the tri-brach allowed for accurate positioning of the phase centre of the antenna, to ensure no errors in positioning of field points.

In general, the Ashtec receivers were used at the base stations and in the helicopter while the NovAtel receivers were used as mobile units in the vehicles. A total of 3 Ashtec and 2 NovAtel receivers were employed during surveying.

6.3.1 Helicopter

Helicopter supported GPS surveying utilised the kinematic procedure with the rover continuously in motion. At the commencement of surveying for a particular session (generally when the helicopter was close to the base station GPS receiver), the receiver began logging a minimum of 10 – 15 minutes prior to observation of the first station. This allowed sufficient time to reliability and accurately resolve the satellite ambiguity values (number of cycles between the GPS satellite and GPS receiver) using the Kinematic Ambiguity Resolution (KAR) technique. Dual frequency measurements make KAR extremely reliable and very fast (sometimes as little as 1 – 2 minutes of time is used depending upon satellite geometry).

KAR (also known as 'on-the-fly' resolution) is a technique used by the post-processing software to fix the satellite ambiguity values to integer numbers when the rover GPS is continuously moving. Previously, GPS surveys were initiated by occupying a station with known position and then fixing the ambiguity values. This is no longer necessary as it is possible to do this simply while the helicopter is on the ground just before take off and while it is flying to the first station. The ambiguities are still fixed to integer values which is the highest accuracy solution possible. In the event that the lift off point is some distance from the GPS base, the helicopter would simply fly closer to the base before beginning to survey, or ensure that at some point within the session, it would fly over the GPS base. The processing would simply then be done in reverse from this point to the start and forward from this point to the end of the session. This technique is also particularly useful when using several GPS base stations during a session. The GPS post-processing can utilise all base stations by resolving 'on-the-fly' when switching between each one.

Once the ambiguity values are initially fixed, the session continues in kinematic mode provided a minimum of 4 satellites are maintained. Once the number of satellites drops below this, KAR is evoked and the values re-fixed. KAR uses an auto-reversal process which searches past times of loss of lock (less than 4 satellites), fixes the ambiguity values and then goes backwards until it reaches the last loss of lock. In this

way, there is little chance of losing large blocks of data while the program tries to find the best time for resolving.

Helicopter GPS data is often the cleanest and kinematic lock is generally maintained throughout each session. Under these conditions, only 5 seconds is required (1 epoch) at each station to get an accurate solution. Because the gravity reading takes 1 – 2 minutes however, there are usually at least 12 solutions per station which can be used to monitor solution stability and ensure there is little drift. Baseline lengths (base-rover separation) were generally kept below 30km when possible but were sometimes increased beyond this when there was no access for vehicles to set up GPS base stations in advance of the helicopters arrival.

The helicopter GPS antenna was mounted on tail boom, midway between the cabin and the tail rotor. In this manner, the sensor was located beneath the main rotor blades but this presented no problem for the GPS receiver or processing.

6.3.2 Vehicle

Vehicle surveying utilised a similar process to the helicopter kinematic procedure using KAR to resolve ambiguity values 'on-the-fly'. Most of the survey areas in which the vehicles were utilised had only minor tall vegetation resulting in longer periods of continuous satellite lock. This allowed operators to spend less time at each station in order to obtain an accurate and reliable solution. For stations in thicker vegetation where satellite lock may have been lost, operators simply waited a minimum of 5 minutes at each station (depending on distance from the base station) to acquire enough GPS data to resolve a solution. Vehicle baseline lengths where generally kept below 15 – 20km to ensure accurate and reliable solutions with minimal observation time.

The GPS antenna was mounted on the steel bars of the vehicle tray, immediate behind the passenger cabin. It was securely mounted to avoid movement during readings and between stations.

6.4 Repeat Stations

In order to demonstrate the repeatability and reliability of the data, it was necessary to repeat selected stations placed at easily accessible locations and distributed evenly in time within each gravity loop. Repeat stations are of 3 types: an internal loop repeat which involves re-observing a point surveyed within the same loop; an external loop tie which involves re-observing a point outside of the current loop; and an external base loop tie which involves re-observing a station that has been surveyed using another gravity and/or GPS base station. Internal repeats are an indication of the internal consistency of a loop by demonstrating the assumption of linear drift, for which a correction has been applied to all points within the loop. Loop ties ensure consistency between loops and indicate repeatability of measurements under different survey conditions which may vary from day to day. Base ties are used to ensure data acquired using different base stations is both consistent and comparable. Both types of loop ties are a way of relating the data from independent loops.

In order to return to repeat stations, each was clearly marked with survey flagging along with the location of the GPS antenna and gravity reading point to ensure repeatable data was obtained. In the case of the helicopter, paint marks were made along the skids and flagging placed to indicate the direction in which the helicopter faced. When re-occupying stations with the helicopter, it was generally possible to land within 1m of the original position depending on whether it was considered safe by the pilot.

For vehicle surveying, repeat stations were marked with flagging tape and paint marks were made for the position of the tyres (also indicating the direction of the vehicle) and that of the gravity meter.

6.5 Station Locations

As required by contractual obligation, stations were taken within a radius of 10% of the station spacing when possible and only moved outside of this limit when absolutely necessary. Causes for offsetting stations outside of this limit include lack of landing or vehicle access, sacred sites or interference from cultural features. Initially when surveying was conducted by vehicle and access was restricted by the CLC to roads and tracks only, some stations were taken at higher than usual offsets (up to 700m on the 4km grid) in order to continue working.

A total of 69.2% of all stations were taken within 100m of the pre-planned reading location, 30.2% were taken within 100 – 500m of it and 0.8% were taken at more than 500m.

6.6 Land Access Issues

Significant sections of the Tennant Inlier Gravity Survey covered Aboriginal Lands which required entry permits and negotiations with the CLC to access. In addition, sacred sites and sensitive areas had to be identified and marked onto maps in order to minimise disturbance and damage during survey operations.

After negotiations by personnel from the CLC, NTGS and Scintrex, it was decided the most appropriate method of providing land clearance was to fly selected traditional owners over the survey area in the helicopter prior to surveying in order to identify the sites of significance and to obtain GPS coordinates. Several of these reconnaissance flights were undertaken at various times during the survey as and when required. Each flight generally cleared enough area to continue surveying for several days during which time the next flight would be pre-arranged so it could be done quickly and with minimal disturbance to survey operations. It was necessary to conduct the land clearance by air given the size of the survey area and lack of vehicle access.

After initial negotiations by the NTGS, Scintrex was responsible for liasing directly with the CLC in order to effect the land clearance. Each traditional owner was paid by

the NTGS for the time they spent working on land clearance with their details and hours worked being documented and supplied to the payment agency for the NTGS in Tennant Creek by Scintrex.

7.0 HEALTH AND SAFETY

The health and safety of all employees and sub contractors on a survey is of major concern to Scintrex and as a routine practice, employees must adhere to all guidelines and procedures documented in the company Occupational Health and Safety Manual. These guidelines require specific tasks to be performed by field personnel in order to maintain a safe and productive work place. All Scintrex employees and sub contractors have been trained and are competent to perform the tasks required of them.

All vehicles used on the survey had the necessary recovery and remote operations equipment such as long range fuel tanks, kangaroo jack, fire extinguisher, first aid kit, drinking water, satellite phone and 2 spare tyres. Vehicle log books were kept and a weekly check of vehicle condition and damage was carried out.

All surveying crews were required to contact the main base at lunch time and at 6:00pm if they had not already returned from the field. In the event the base was not manned, crews arranged beforehand to contact one another in the field to advise other crews of their whereabouts, status and estimated time of return. Helicopter crews maintained contact with the base every 2 – 3 hours by satellite phone (carried in the helicopter) or UHF radio.

All permanent Scintrex staff (all staff on site for the surveys) have current first aid training and have also completed four wheel drive training.

8.0 DATA REDUCTION AND PROCESSING

Data editing, GPS processing and reduction to Bouguer gravity were conducted in the field on a daily basis in order to monitor data quality and instrument performance. Reduction of the raw data to final Bouguer gravity involves several steps utilising different processing procedures as detailed below.

8.1 Gravity Processing

Raw gravity data processing methods were independent of the method in which the data was acquired (vehicle or helicopter), due to the fact all meters used were the Scintrex CG-3. All gravity data collected in the field, inclusive of station and reading details, are digitally stored within the memory of the CG-3. At the completion of each survey day, the data from each meter was downloaded via the RS-232 output into separate files on a notebook computer. Individual meter survey files are named according to the last three digits of the meter serial number and an abbreviated version of the survey date (eg. 353jl02.dmp is meter number 9610353 on the 02/07/2001).

Once downloaded, the data was backed up and an edited copy made. The data was checked and corrected for any data entry errors made by the operator. When the gravity reading is taken in the field, the time, gravity reading and station number is recorded on the field sheet by the operator so that any errors made can be easily and accurately corrected. In addition, each station with the exception of repeats should have only 2 readings in the edited file. Multiple readings taken at noisier stations are removed leaving only 2 which are within the allowed tolerance of $0.3\mu ms^{-2}$.

8.2 GPS Processing

All GPS data recorded in the field either using the Ashtec or NovAtel receivers was stored on PCMCIA memory cards which were removed each day and downloaded to a notebook computer. For the base station GPS receivers, files are named according to the base station number they observed (eg. base 9002 is named *b9002.*) and for

mobile units, the first 3 digits of the gravity meter serial number and an abbreviated date are used (eg. *353jl02.* for meter number 9610353 on 02/07/2001). Each days data is stored in a directory named after the date (eg. ..\jl15\. for surveying on July 15) and separated depending on if the observations are part of field surveying or base station network set out.

Each observation file created by the Ashtec GPS receivers requires decoding and decompression from the raw Ashtec format. This results in the output of several files (binary GPS records, text ephemeris data and a text information file) which are then converted to the format required by the GPS processing software. Files made by the NovAtel GPS units are already recorded in the correct format and can be imported directly into the GPS processing software.

In order for the post processing software to recognise each reading location as a station, a station file has to be generated with the station number and observation time for that station. The station file is generated using in-house software and is based on reading the gravity meter dump file and using the reading times and the value for Greenwich Mean Time Offset (GMT). The times recorded in the dump file are in local time. From this the software generates station observation times in GPS seconds (since Midnight Sunday GMT) for each station which is required by the post processing software.

After the GPS processing is complete, an output file of station coordinates for each day is produced for subsequent reduction of the gravity data. Each gravity meter has an associated GPS file which contains stations observed only by that meter for a particular session. Station information (latitude, longitude and ellipsoidal elevation) are output based on the station file input (listing of GPS observation time for each station). A solution file is generated after processing for every 5 seconds of the session with the program simply extracting the closest solution point for each station.

8.2.1 Software

All of the GPS processing was completed using the post-processing software *GrafNav* (field surveying) and *GrafNet* (base network surveying), designed by Waypoint Consulting Incorporated. *GrafNav/GrafNet* is a post-processing program which runs under windows, capable of processing fixed or quick static and float type solutions. It can automatically switch between static and kinematic (pseudo-kinematic surveying) within the same session and provides both graphical and statistical analysis for all solutions. Graphical displays of DOP's (PDOP, GDOP, HDOP, VDOP), static session convergence, forward/reverse solution separation, satellite phase residuals and RMS values give an excellent indication of resulting solution reliability. Numerous statistical parameters also exist to access reliability including RMS, PDOP and covariance trace.

Specialised techniques are developed to exclude the use of poor quality and erroneous phase data in the Kalman filter in order to avoid contaminating the resulting solution. When processing fixed or quick static, the program searches the data for the periods of continuous satellite lock with the maximum number of satellites, omitting any noisy sections of data which may be present. If this process fails or there is insufficient consistent periods of lock, the standard processing techniques of utilising the best satellites over the entire observation are used. A similar process is used for KAR, when phase ambiguity values are fixed to integer values with the exception that the sensor is not stationary.

Through the windows based interactive menu system, many properties of the data can be modified to give more accurate and reliable solutions. Satellite geometry can be altered, the elevation mask changed, base satellites changed and noisy satellites removed. Solutions obtained from forward and reverse processing can be combined in order to identify any problems which may exist in the data.

8.3 Positioning Datums

As a contractual requirement, all horizontal coordinate data was referenced to the World Geodetic System (WGS84), equivalent for most practical purposes to the Geocentric Datum of Australia (GDA94). Vertical coordinate data was referenced to the Australian Height Datum (AHD71). The grid projection system used for generating rectangular coordinates from WGS84 latitude and longitude positions was the Universal Transverse Mercator / Map Grid of Australia (UTM / MGA94) with a zone number of 53.

8.3.1 Derivation of Orthometric Heights

Elevations for each station obtained from GPS observations are WGS84 ellipsoidal values and must be converted to orthometric heights based on the AHD71 by application of the N-value for that location. This was achieved using the latest geoid model produced by AUSLIG, AusGeoid98 and the interpolation software *Winter*.

Corrections for the geoid-ellipsoid separation (N-value) were performed in a differential or relative mode from each of the GPS base stations in order to minimise the error associated with the absolute N-value (0.3 – 0.5m). The resulting AHD values at each station have a 3rd order uncertainty (<0.1m). This error is consistent with the only available AHD control stations in each area which all have a 3rd order uncertainty.

8.4 Gravity Datums

All observed and processed Bouguer Gravity was referenced to the Australian Fundamental Gravity Network datum (based on the IGSN71 international datum). All primary control and subsequent field stations had Isogal 84 values of observed gravity.

8.5 Reduction to Bouguer Gravity

Final processed GPS files were combined with the edited gravity dump files using in-house windows based software. As a contractual requirement, all Bouguer gravity was processed using the formula and constants as specified in the Bureau Gravimetrique "Bulletin d'Information".

$$\Delta g_{BA}\ (1984) = g_{obs}\ (\text{Isogal } 1984) - g_n\ (1967) + 3.086h - 0.419\rho h\ (\mu ms^{-2})$$

where

$$g_n\ (1967) = 9780318.5\ (1 + 0.005278895\sin^2\phi - 0.000023462\ \sin^4\phi)\ (\mu ms^{-2})$$

Latitude (ϕ) corrections were made based on the WGS84 value, while elevation (h) was using the AHD71 elevation, with a density value (ρ) of 2.67gm/cc. Tidal corrections were obtained using the Longman formula based on the position (latitude, longitude and GMT difference) of the base station for the current gravity loop.

Output from the processing software was a file comprising the following fields:

1. station number
2. horizontal (WGS84/GDA94) information (both geographic and grid values)
3. vertical information (AHD)
4. time of reading
5. date of reading
6. drift corrected observed gravity (both corrected and non-corrected for instrument height) (Isogal 84)
7. tidal correction value
8. free air value (Isogal 84)
9. Bouguer (2.67gm/cc) value (Isogal 84)
10. gravity base station used to establish the station
11. GPS base station used to establish the station
12. gravity meter used to establish the station
13. offset from the pre-planned position

Once processed and checked for errors, data from each day was appended to the master file and then gridded and plotted to verify compatibility. Any erroneous stations can be identified and then re-processed or re-observed when necessary. In addition, repeat analysis is performed each time new data is appended giving a detailed listing of the repeat readings taken and the associated statistics.

9.0 DATA PRECISION AND REPEATABILITY

An analysis of all repeat data from the survey shows consistently high quality and excellent repeatability. Repeats made within each loop and ties to external loops demonstrate the achievement of the project requirements for data quality and precision. A complete listing of the repeat stations can be found in appendix five.

A total of 139 (8.7%) repeat readings were made at 135 independent stations distributed between vehicle and helicopter operations. A combination of internal, external and external-base loop repeat types were employed (table 9.1). Repeat stations were chosen in order to give an accurate reflection of the observed gravity and GPS positioning errors within and between each loop by distributing them appropriately within the loop. When practical, each gravity loop contained a minimum of 1 repeat for each 10 new stations and at least 1 external loop tie. For an average loop utilising helicopter transport, a total of 100 new readings were observed with 7 – 8 internal repeats and 1 – 2 external loop ties. An average loop utilising vehicle transport observed between 10 and 15 new stations with 1 – 2 internal repeats and when possible, 1 external loop tie. The high number of internal repeats were made due to the extended durations of the gravity loops (usually 10 hours).

Internal	External	External-Base	Total
65	21	53	139

Table 9.1 Summary of repeat reading types

Table 9.1 summarises the repeat reading types which include internal (repeats within the current gravity/GPS loop), external (ties to an existing loop outside the current loop) and external base (ties to a station established with another gravity and/or GPS base station) loop repeats. External base repeats are also a type of external repeat as they also observe stations outside of the current loop but they have the added benefit of ensuring that the gravity and/or GPS base stations involved are compatible to within project requirements.

The repeat table listings of appendix five display the maximum repeat errors for each of the parameters (easting, northing, elevation and observed gravity) observed at each repeat station. These values are only differences between the maximum and minimum values (i.e. always positive) for each parameter and do not account for the sign of the difference. In order to analyse the repeat data correctly, the error used to derive the statistics in the table 9.2 below is generated by differencing each repeat reading from the first observation at the station and retaining the sign of the difference. This method is also used to generate the frequency distribution graphs (appendix five) for the observed gravity and AHD elevation differences at each repeat station.

The frequency distribution graph of the AHD elevation repeat errors shows a mostly random spread with 100% of the data contained within the limits of –0.1m to +0.1m (1σ), centred at 0.01m. A plot of the frequency distribution of observed gravity repeat errors displays a mostly random spread with over 97% of the data contained within the limits of $-0.5\mu m^{-2}$ and $+0.5\mu m^{-2}$ (1σ). The population is centred at $0.02\mu m^{-2}$.

Parameter	Easting (m)	Northing (m)	Elevation (m)	Obs. Grav. (μm^{-2})
Max Error	0.86	1.59	0.09	0.46
Min Error	-1.27	-6.30	-0.10	-0.65
Median	-0.00	0.01	0.01	0.02
Mode	-0.04	0.01	0.08	0.08
Std Dev	0.10	0.14	0.04	0.24
Repeat Readings	139			
Repeat Stations	135			
% Repeats	8.7%			

Table 9.2 Summary of statistical analysis of all parameters

No detailed analysis of the horizontal coordinate errors at repeat stations was undertaken given the project precision requirements for these were only 10m (absolute). In general, the accuracy of the horizontal coordinates is 0.7 times the vertical and any large errors evidenced in the horizontal but not vertical coordinate

values simply reflect incorrect positioning of the GPS antenna on re-occupation of the station and not error in the GPS solution.

Of all repeat readings taken, no GPS positioning repeat errors were outside of the requirements for data precision (0.1m). A total of 4 observed gravity repeat readings exceeded project quality requirements by $0.03\mu m^{-2}$, $0.04\mu m^{-2}$, $0.08\mu m^{-2}$ and $0.15\mu m^{-2}$.

Stations which fall just outside the $0.5\mu m^{-2}$ repeat error limit can be explained by the presence of localised noise sources such as vibration from the helicopter, micro-seismic noise or unstable ground surfaces. In all cases where a repeat error was greater than $0.5\mu m^{-2}$, numerous additional internal and external repeat stations demonstrate that the error is not consistent across the loop and is isolated to that station only.

A complete listing of the repeat stations and the associated repeat data information can be found in appendix five. These repeat tables are a comprehensive listing of each repeat station including the values for easting, northing, elevation, gravity meter used, time, date as well as the gravity and GPS base station used to establish the station. The average value for each parameter (easting, northing, elevation and observed gravity) as well as the standard deviation and maximum difference measured for each station are shown as well as overall survey statistics. The Free Air and Bouguer values were not analysed for repeatability as they vary only with observed gravity, elevation and latitude differences all of which are shown.

10.0 CONCLUSION

Field surveying and acquisition of the data was completed quickly, effectively and to a high standard of precision and repeatability. Data quality was consistently high as demonstrated by 139 repeat readings made at 135 independent stations. The survey was completed within the time requirements with no incidents or accidents.

Access restrictions and difficulties proved to be significant initially but where minimised once negotiations took place and agreements were made with the CLC. At times, survey operations were adversely effected by the lack of access to parts of the area close to Tennant Creek resulting in significant ferrying with the helicopter over land not cleared for access.

A combination of vehicle and helicopter operations proved to be the most successful method of surveying given the variability of field conditions, density of vegetation and the station intervals. In addition, helicopter operations were the most environmentally sensitive for work off roads on Aboriginal Lands.

Appendix One

Results of Gravity Meter Calibration Tests

Pre– and Post– Survey

Scintrex Gravity Reduction Report: Calibration Range Data

Base station for current loop: 2001.9108
Observed gravity at base: 9796985.26μms^{-2}
Gravity Data units: GRAVITY UNITS
Survey date: 03/07/01
Current date: 22/08/01
Gravity meter serial number: 610353
Gravity meter operator(s): 1

STATION	OBSGRAV	TIME	DATE	GRAVREF	METERNO
6091.0208	9796301.29	12:51:54	030701	2001.9108	610353
Average Value:	9796301.29				
Max Repeat Error:	0.00				
Std Dev:	0.00				
**Published Value:	9796301.00				
Error:	0.29μms^{-2}				

Pre-survey gravity meter calibration results
METERNO: 9610353

Scintrex Gravity Reduction Report: Calibration Range Data

Base station for current loop: 2001.9108
Observed gravity at base: 9796985.26μms^{-2}
Gravity Data units: GRAVITY UNITS
Survey date: 03/07/01
Current date: 22/08/01
Gravity meter serial number: 610358
Gravity meter operator(s): 1

STATION	OBSGRAV	TIME	DATE	GRAVREF	METERNO
6091.0208	9796301.02	12:50:10	030701	2001.9108	610358
Average Value:	9796301.02				
Max Repeat Error:	0.00				
Std Dev:	0.00				
**Published Value:	9796301.00				
Error:	0.02μms^{-2}				

Pre-survey gravity meter calibration results
METERNO: 9610358

Scintrex Gravity Reduction Report: Calibration Range Data

Base station for current loop: 2001.9108
Observed gravity at base: 9796985.26μms^{-2}
Gravity Data units: GRAVITY UNITS
Survey date: 03/07/01
Current date: 22/08/01
Gravity meter serial number: 711402
Gravity meter operator(s): 1

STATION	OBSGRAV	TIME	DATE	GRAVREF	METERNO
6091.0208	9796300.98	12:58:03	030701	2001.9108	711402
Average Value:	9796300.98				
Max Repeat Error:	0.00				
Std Dev:	0.00				
**Published Value:	9796301.00				
Error:	-0.02μms^{-2}				

Pre-survey gravity meter calibration results
METERNO: 9711402

Scintrex Gravity Reduction Report: Calibration Range Data

Base station for current loop: 2001.9108
Observed gravity at base: 9796985.26μms^{-2}
Gravity Data units: GRAVITY UNITS
Survey date: 03/07/01
Current date: 22/08/01
Gravity meter serial number: 403241
Gravity meter operator(s): 1

STATION	OBSGRAV	TIME	DATE	GRAVREF	METERNO
6091.0208	9796301.06	12:55:10	030701	2001.9108	403241
Average Value:	9796301.06				
Max Repeat Error:	0.00				
Std Dev:	0.00				
**Published Value:	9796301.00				
Error:	0.06μms^{-2}				

Pre-survey gravity meter calibration results
METERNO: 9403241

Scintrex Gravity Reduction Report: Calibration Range Data

Base station for current loop: 7391.0217
Observed gravity at base: 9793989.28μms^{-2}
Gravity Data units: GRAVITY UNITS
Survey date: 20/08/01
Current date: 22/08/01
Gravity meter serial number: 610353
Gravity meter operator(s): 120

STATION	OBSGRAV	TIME	DATE	GRAVREF	METERNO
8090.0317	9794530.94	13:56:43	200801	7391.0217	610353
8090.0317	9794530.88	14:56:30	200801	7391.0217	610353
Average Value:	9794530.91				
Max Repeat Error:	0.06				
Std Dev:	0.03				
**Published Value:	9794531.01				
Error:	-0.10μms^{-2}				

Dataset Summary Statistics:

Observed Gravity Data:
Maximum difference: 0.06
Maximum standard deviation: 0.03

Overall Standard Deviations:
Observed Gravity Data:

Total number of input readings:	2
Total number of new readings:	1
Total number of invalid readings:	0
Total number of repeat stations:	1
Total number of repeat readings:	1
Percentage repeated readings:	100.00%

Post-survey gravity meter calibration results
METERNO: 9610353

Scintrex Gravity Reduction Report: Calibration Range Data

Base station for current loop: 7391.0217
Observed gravity at base: 9793989.28μms^{-2}
Gravity Data units: GRAVITY UNITS
Survey date: 20/08/01
Current date: 22/08/01
Gravity meter serial number: 610358
Gravity meter operator(s): 120

STATION	OBSGRAV	TIME	DATE	GRAVREF	METERNO
8090.0317	9794531.14	14:01:33	200801	7391.0217	610358
8090.0317	9794531.39	15:02:39	200801	7391.0217	610358
Average Value:	9794531.26				
Max Repeat Error:	0.24				
Std Dev:	0.12				
**Published Value:	9794531.01				
Error:	0.25μms^{-2}				

Dataset Summary Statistics:

Observed Gravity Data:
Maximum difference: 0.24
Maximum standard deviation: 0.12

Overall Standard Deviations:
Observed Gravity Data:

Total number of input readings:	2
Total number of new readings:	1
Total number of invalid readings:	0
Total number of repeat stations:	1
Total number of repeat readings:	1
Percentage repeated readings:	100.00%

Post-survey gravity meter calibration results
METERNO: 9610358

Scintrex Gravity Reduction Report: Calibration Range Data

Base station for current loop: 7391.0217
Observed gravity at base: 9793989.28μms^{-2}
Gravity Data units: GRAVITY UNITS
Survey date: 20/08/01
Current date: 22/08/01
Gravity meter serial number: 711402
Gravity meter operator(s): 120

STATION	OBSGRAV	TIME	DATE	GRAVREF	METERNO
8090.0317	9794531.41	13:59:53	200801	7391.0217	711402
8090.0317	9794531.43	14:53:31	200801	7391.0217	711402
Average Value:	9794531.42				
Max Repeat Error:	0.02				
Std Dev:	0.01				
**Published Value:	9794531.01				
Error:	0.41μms^{-2}				

Dataset Summary Statistics:

Observed Gravity Data:
Maximum difference: 0.02
Maximum standard deviation: 0.01

Overall Standard Deviations:
Observed Gravity Data:

Total number of input readings:	2
Total number of new readings:	1
Total number of invalid readings:	0
Total number of repeat stations:	1
Total number of repeat readings:	1
Percentage repeated readings:	100.00%

Post-survey gravity meter calibration results
METERNO: 9711402

Scintrex Gravity Reduction Report: Calibration Range Data

Base station for current loop: 7391.0217
Observed gravity at base: 9793989.28
Gravity Data units: GRAVITY UNITS
Survey date: 27/08/01
Current date: 28/08/01
Gravity meter serial number: 403241
Gravity meter operator(s): 120

STATION	OBSGRAV	TIME	DATE	GRAVREF	METERNO
8090.0317	9794531.42	13:53:56	270801	7391.0217	403241
8090.0317	9794531.45	14:44:38	270801	7391.0217	403241
Average Value:	9794531.44				
Max Repeat Error:	0.03				
Std Dev:	0.02				
**Published Value:	9794531.01				
Error:	0.43				

Dataset Summary Statistics:

Observed Gravity Data:
Maximum difference: 0.03
Maximum standard deviation: 0.02

Total number of input readings:	2
Total number of new readings:	1
Total number of invalid readings:	0
Total number of repeat stations:	1
Total number of repeat readings:	1
Percentage repeated readings:	100.00%

Post-survey gravity meter calibration results
METERNO: 9403241

Appendix Two

Base Station Descriptions and Network Diagrams

Primary and Secondary Control Stations - TENNANT INLIER NT GRAVITY SURVEY

Primary ID#	Secondary ID#	Latitude	Longitude	Northing	Easting	Ellip (h)	N Val (N)	AHD (H)	Obs. Grav	Acc_GPS	Acc_GRAV
200181.8001		-19.62258502	134.18799240	7830079.930	414856.934	419.414	33.099	386.315	N/A	good-closed	N/A
200181.8002		-19.43740067	133.73425133	7850285.500	367123.569	344.496	32.495	312.001	N/A	good-closed	N/A
200181.8003		-19.44422081	134.00083079	7849714.851	395115.589	375.120	33.309	341.811	N/A	good-closed	N/A
200181.8004		-19.36212523	134.19573512	7858906.849	415533.826	344.616	33.866	310.750	N/A	good-closed	N/A
200181.8005		-19.72295463	133.74465168	7818689.653	368447.611	311.053	31.666	279.387	N/A	good-closed	N/A
200181.8007		-20.01344619	133.88821722	7786644.552	383705.961	330.343	31.206	299.137	N/A	good-closed	N/A
200181.8008		-19.74707214	134.57067369	7816450.353	455018.602	350.950	33.471	317.479	N/A	good-closed	N/A
200181.8009		-19.89305604	134.45096353	7800259.343	442528.548	378.897	32.962	345.935	N/A	good-closed	N/A
200181.8010		-19.52174434	134.61820540	7841396.451	459942.827	318.378	34.069	284.309	N/A	good-closed	N/A
200181.8011		-19.43286816	134.42415857	7851174.448	439550.394	349.882	33.979	315.903	N/A	good-closed	N/A
200181.8012		-19.88723859	134.80957548	7800985.524	480066.426	364.141	33.575	330.566	N/A	good-closed	N/A
200181.8013		-19.30018059	135.00406365	7865957.683	500426.926	282.114	35.197	246.917	N/A	good-closed	N/A
200181.8014		-19.12234389	134.29145097	7885484.425	425478.461	307.764	34.765	272.999	N/A	good-closed	N/A
200181.8015		-19.21405062	133.76928690	7875030.722	370626.261	361.528	33.592	327.936	N/A	good-closed	N/A
200181.8016		-19.02278169	133.72726215	7896166.838	366053.985	329.577	34.139	295.438	N/A	good-closed	N/A
200181.8018		-19.75315468	133.49638452	7815135.452	342456.190	307.876	30.696	277.180	N/A	good-closed	N/A
200181.8019		-20.11670390	134.51184315	7775529.390	448973.505	417.429	32.575	384.854	N/A	good-closed	N/A
200181.8020		-20.46988342	134.90496011	7736517.129	490088.160	394.440	32.429	362.011	N/A	good-closed	N/A
200181.8021	WAUCHOPE	-20.64028000	134.22278000					383.000	9785643.07	Approx	good-base
200181.9001		-20.01146534	134.20574174	7787052.870	416920.399	429.359	32.173	397.186	9785376.28	good-closed	good-base
200181.9002		-20.42505887	134.24844246	7741301.078	421594.618	392.576	30.880	361.696	9785518.42	good-closed	good-base
200181.9003		-20.34114232	134.64944037	7750728.240	463409.101	428.926	32.260	396.666	9785449.37	good-closed	good-base
200181.9004		-19.33415060	134.74108721	7862178.507	472804.241	304.358	34.683	269.675	9785138.26	good-closed	good-base
200181.9005		-19.09905154	134.17637578	7888008.896	413362.700	350.521	34.782	315.739	9785046.52	good-closed	good-base
NTS 233	SHAMROCK	-19.61729620	134.18849578	7830665.463	414906.936	469.562	33.112	436.450	N/A	NTS	N/A
6793.0134	TNK AIRPORT	-19.64330000	134.18330000					375.000	9785145.8	Approx	AGSO

Abbreviations: Northern Territory Surveys (NTS);
Australian Geological Survey Organisation (AGSO)

Primary ID - Scintrex assigned station number
Secondary ID - NTS assigned geodetic mark name

Notes:-

(a) Horizontal coordinate datum: **GDA94**

(b) Vertical coordinate datum: **GDA94** (Ellipsoidal - h); **AHD71** (Orthometric - H)

(c) N Value derived from **AusGeoid98** geoid model (N)

(d) Orthometric height (AHD) derived from ellipsoidal height and N Value

ie. H = h - N

(e) Observed gravity datum and units: IGSN71;μms^{-2}

(f) Grid coordinates are **MGA ZONE 53**

(g) GPS accuracy as follows:

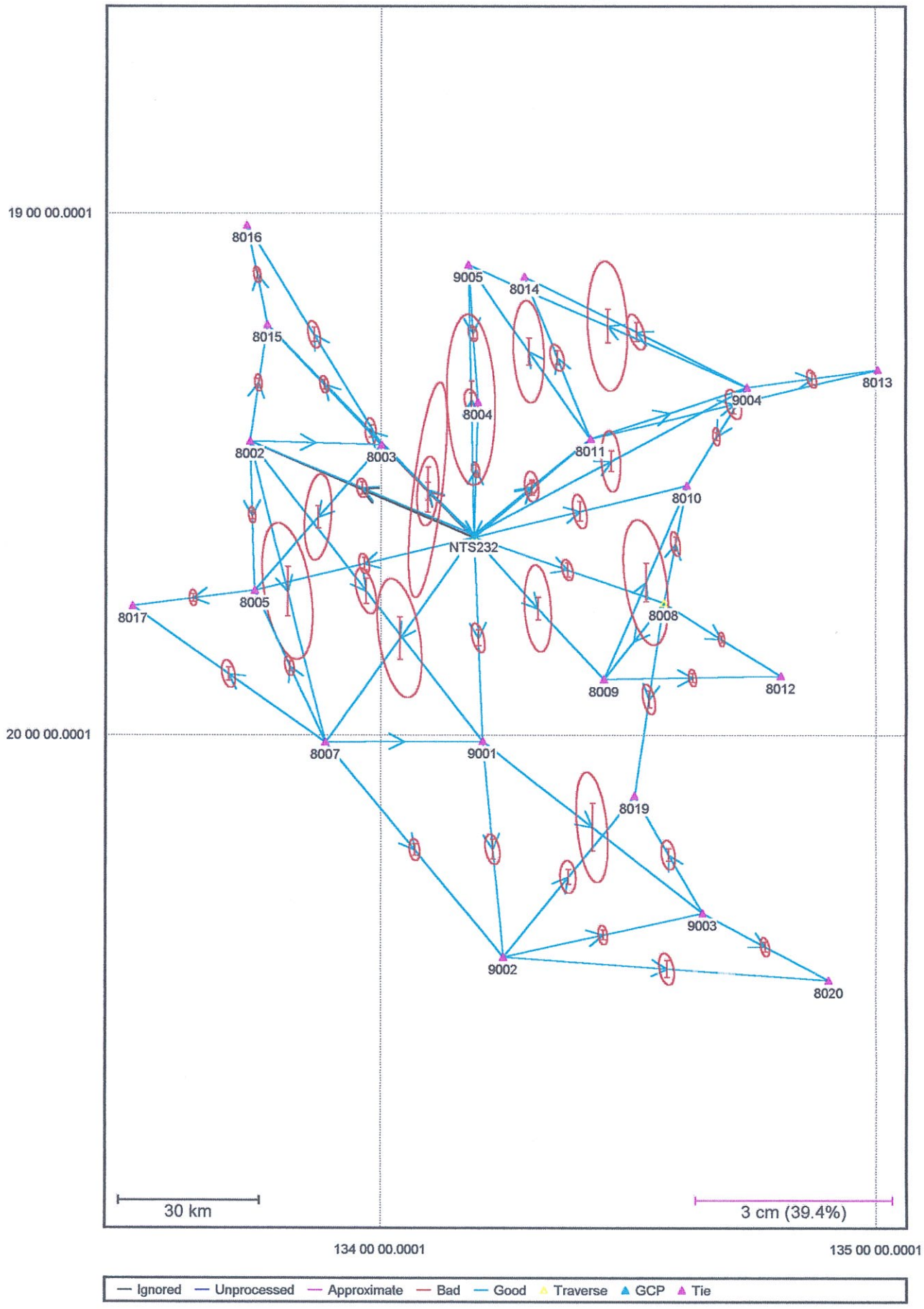
1. good-open: high accuracy single vector traverse solution only
2. good-closed: high accuracy closed polygon network solution
3. approx.: estimated or scaled from map or non-corrected coordinates

(h) GRAV accuracy as follows:

1. good-field: field repeat only (1 gravity meter to establish; <3 readings)
2. good-base: part of primary network (min. 2 gravity meters to establish)

Primary Base Station Information Listing
TENNANT INLIER NT GRAVITY SURVEY

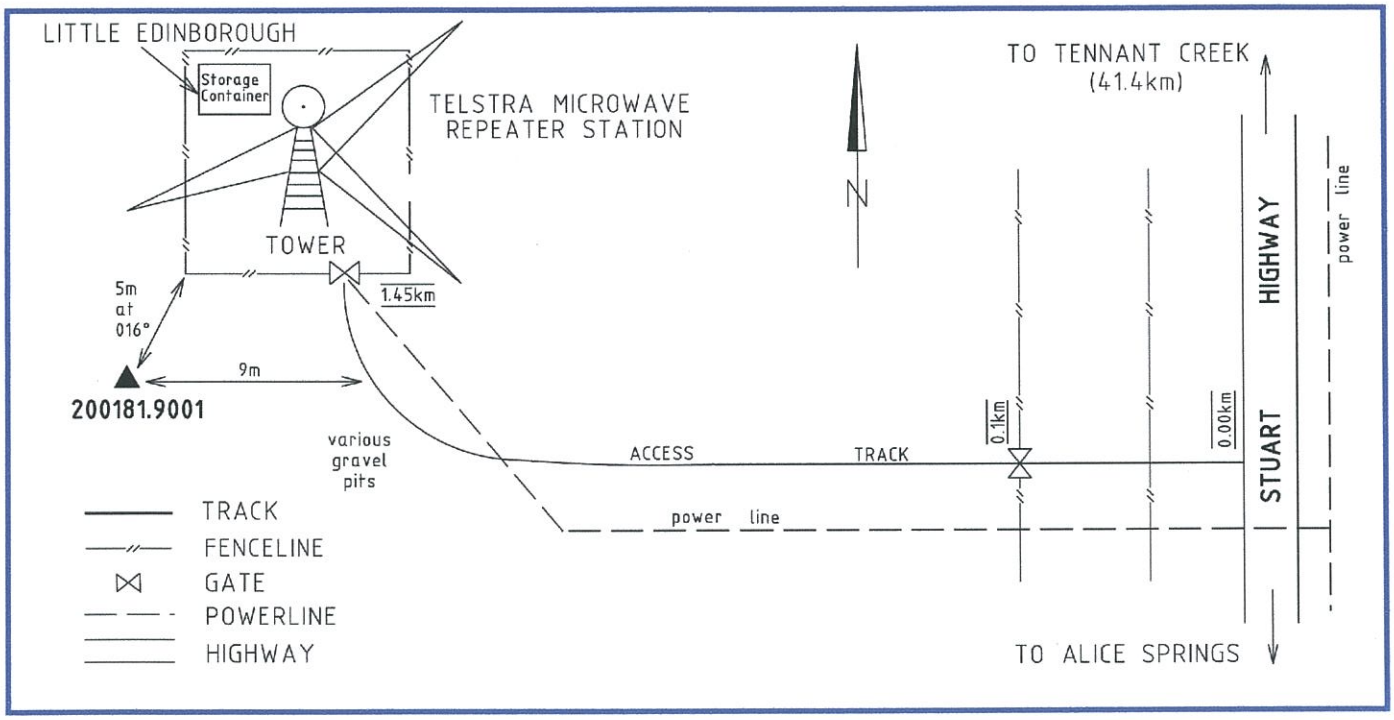
Traverse - Map



GPS Base Station Network – Tennant Inlier NT Gravity Survey

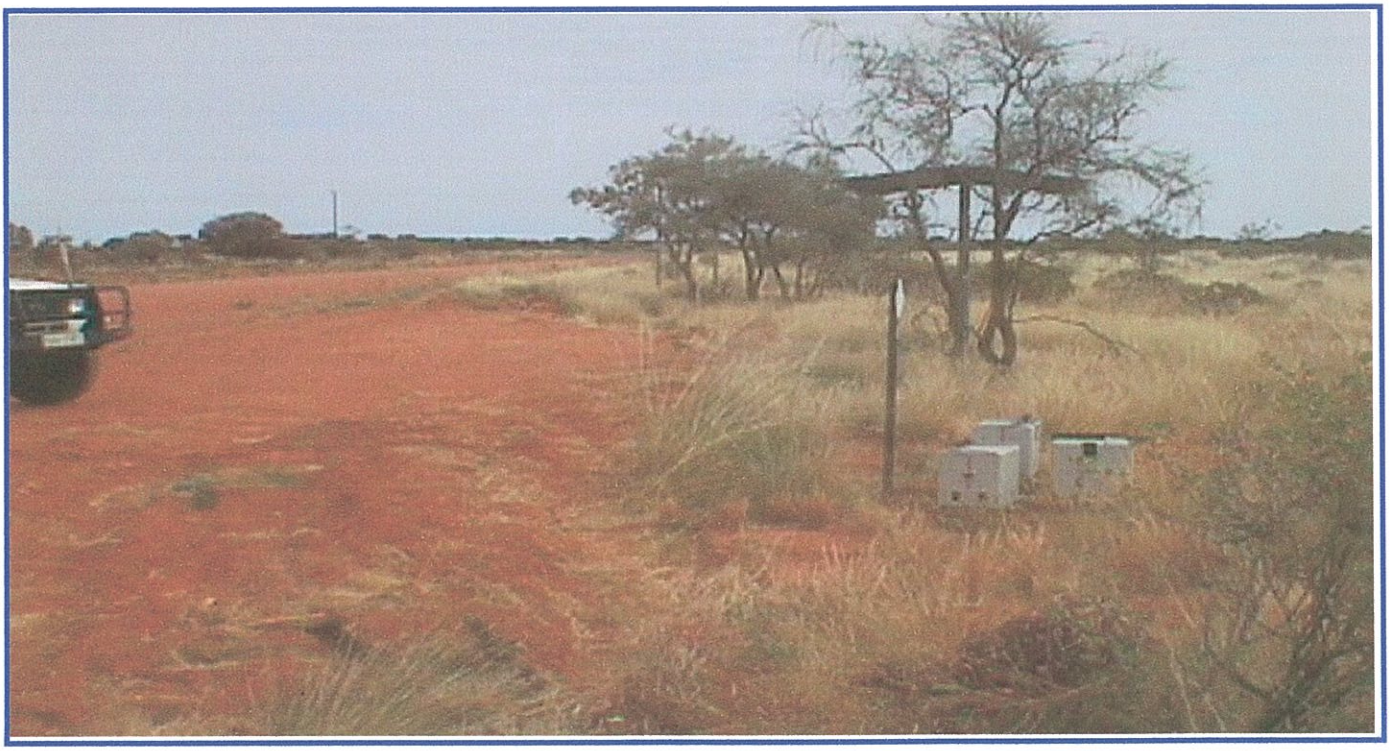
Station ID: **200181.9001**	Station Name: **"Little Edinborough" Repeater Tower**		Date: **07/07/2001**

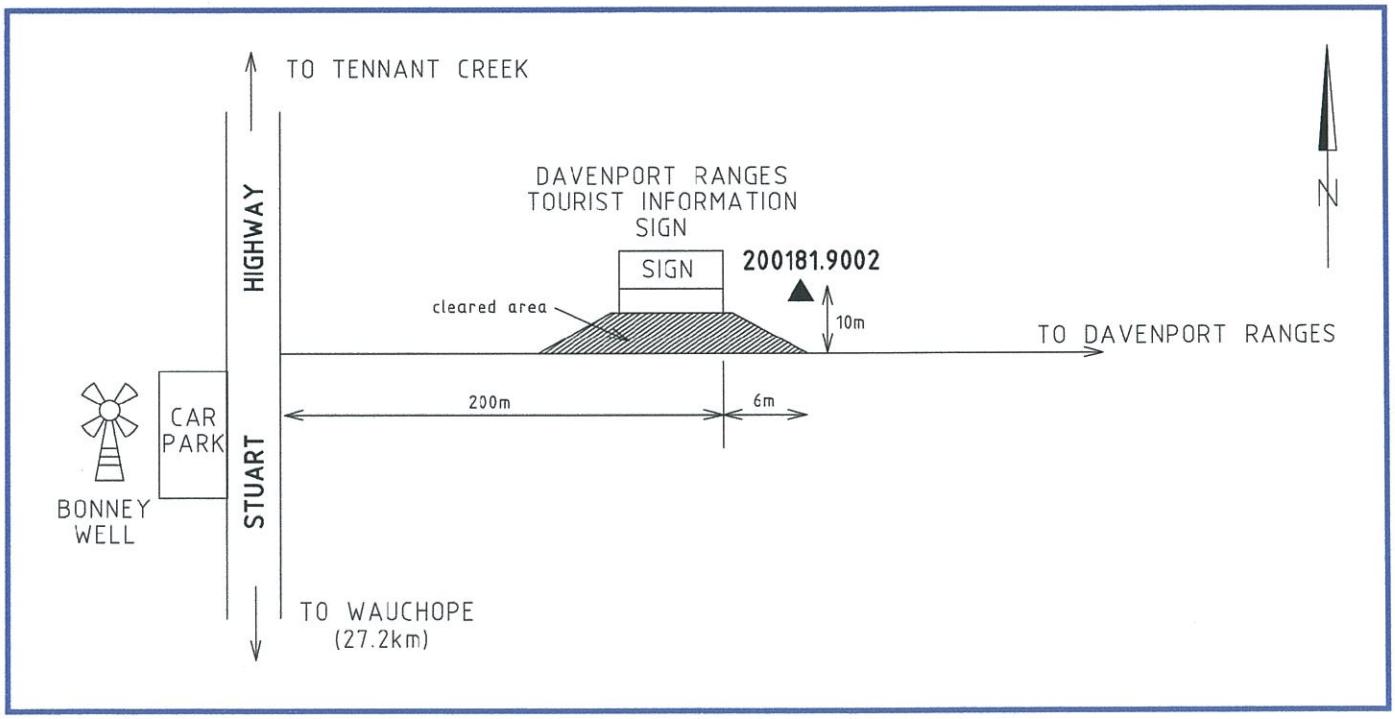
HORIZONTAL DETAIL		VERTICAL DETAIL		MARK DETAIL		GRAVITY DETAIL	
Easting:	416920.399	Elevation:	397.186	Mark Type:	PSM	Obs Gravity:	9785376.28
Northing:	7787052.870	Geoid-Ellips. Sep:	32.173	Witness Mark:	Star Picket		
Zone:	53			Witness Plate:	Survey Mark Plate		
Latitude:	-20.01146534			Monument Type:	Concrete block		
Longitude:	134.20574174				Brass disc		
Datum:	GDA94	Datum:	AHD71	Plaque Stamped:	200181.9001	Datum:	IGSN71
Order:	1	Order:	3				(Isogal 84)
Class:		Class:		Located in Map Sheet:		Units:	μms^{-2}
Method:	GPS	Method:	GPS	Bonney (5757)			



Station ID: **200181.9002**	Station Name: **Bonney Well**		Date: **11/07/2001**

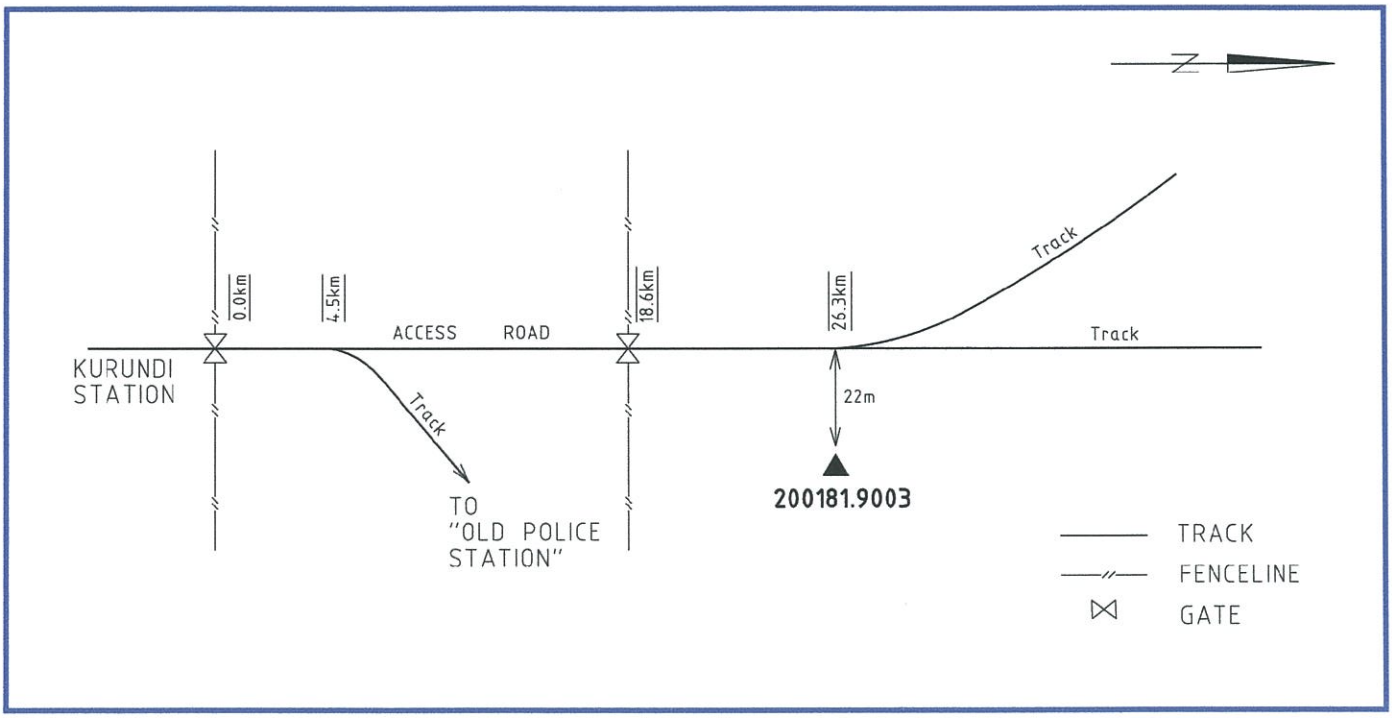
HORIZONTAL DETAIL		VERTICAL DETAIL		MARK DETAIL		GRAVITY DETAIL	
Easting:	421594.618	Elevation:	361.696	Mark Type:	PSM	Obs Gravity:	9785518.42
Northing:	7741301.078	Geoid-Ellips. Sep:	30.880	Witness Mark:	Star Picket		
Zone:	53			Witness Plate:	Survey Mark Plate		
Latitude:	-20.42505887			Monument Type:	Concrete block		
Longitude:	134.24844246				Brass disc		
Datum:	GDA94	Datum:	AHD71	Plaque Stamped:	200181.9002	Datum:	IGSN71
Order:	1	Order:	3				(Isogal 84)
Class:		Class:		Located in Map Sheet:		Units:	μms^{-2}
Method:	GPS	Method:	GPS	Bonney (5757)			



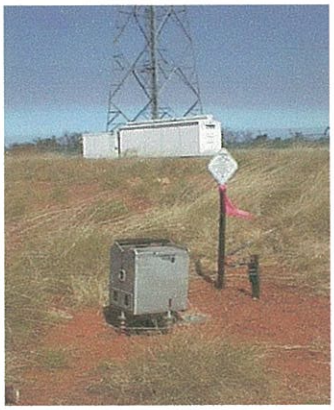


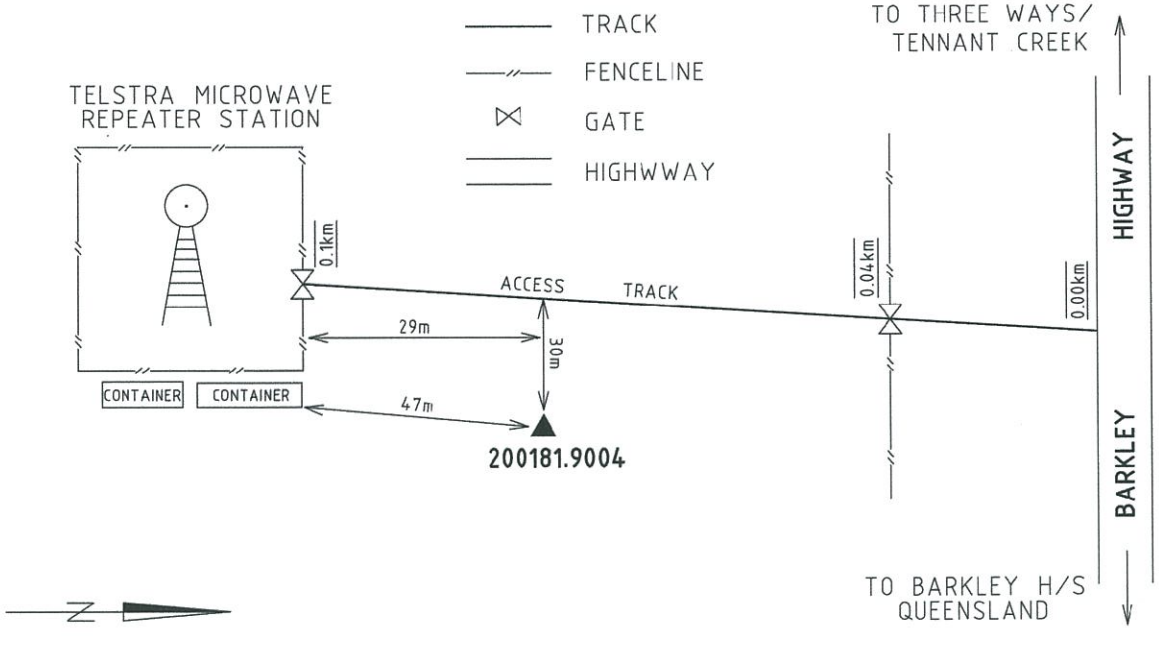
Station ID: **200181.9003**	Station Name:		Date: **11/07/2001**

HORIZONTAL DETAIL		VERTICAL DETAIL		MARK DETAIL		GRAVITY DETAIL	
Easting:	463409.101	Elevation:	396.666	Mark Type:	PSM	Obs Gravity:	9785449.37
Northing:	7750728.240	Geoid-Ellips. Sep:	32.260	Witness Mark:	Star Picket		
Zone:	53			Witness Plate:	Survey Mark Plate		
Latitude:	-20.34114232			Monument Type:	Concrete block		
Longitude:	134.64944037				Brass disc		
Datum:	GDA94	Datum:	AHD71	Plaque Stamped:	200181.9003	Datum:	IGSN71
Order:	1	Order:	3				(Isogal 84)
Class:		Class:		Located in Map Sheet:		Units:	μms^{-2}
Method:	GPS	Method:	GPS	Ooradidgee (5857)			



Station ID: **200181.9004**	Station Name: **Microwave Repeater Tower**		Date: **06/07/2001**
HORIZONTAL DETAIL	VERTICAL DETAIL	MARK DETAIL	GRAVITY DETAIL
Easting: 472804.241	Elevation: 269.675	Mark Type: PSM	Obs Gravity: 9785138.26
Northing: 7862178.507	Geoid-Ellips. Sep: 34.683	Witness Mark: Star Picket	
Zone: 53		Witness Plate: Survey Mark Plate	
Latitude: -13.33415060		Monument Type: Concrete block	
Longitude: 134.74108721		Brass disc	
Datum: GDA94	Datum: AHD71	Plaque Stamped: 200181.9004	Datum: IGSN71
Order: 1	Order: 3		(Isogal 84)
Class:	Class:	Located in Map Sheet:	Units: μms^{-2}
Method: GPS	Method: GPS	Barkly (5859)	

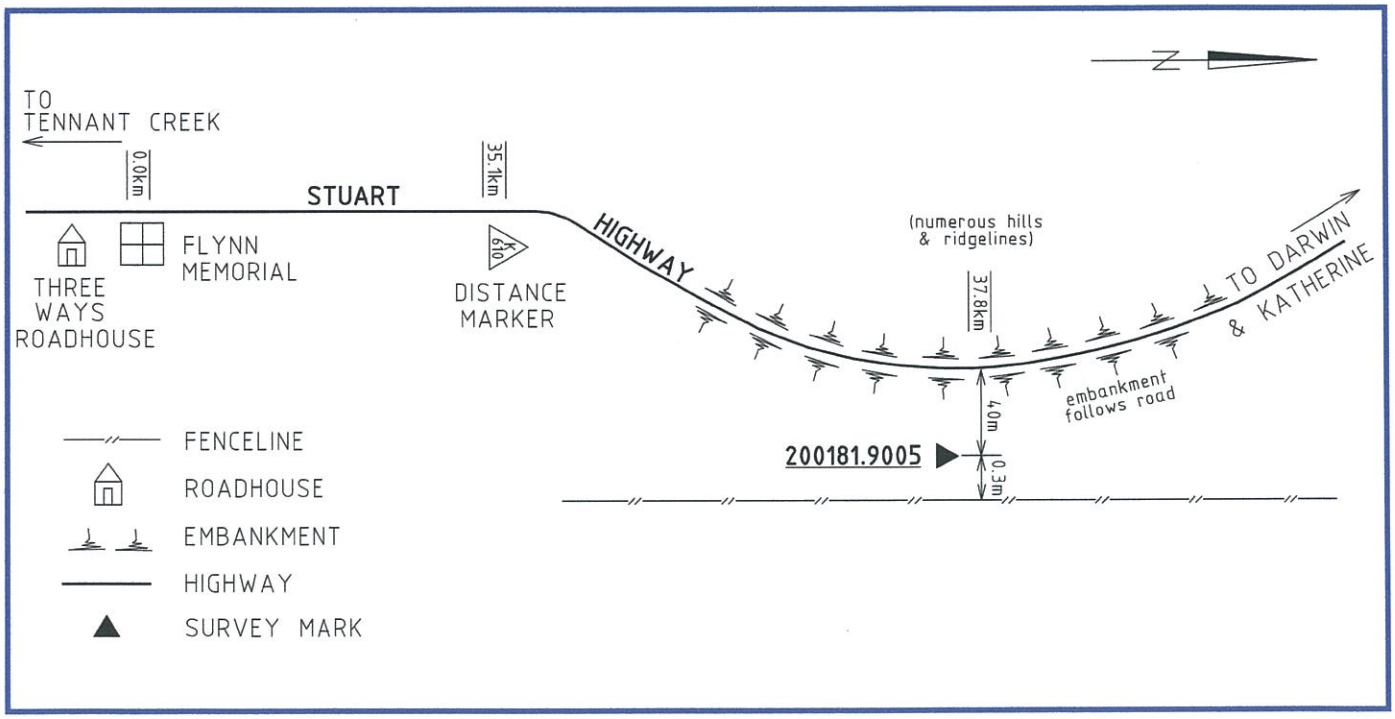




Notes:- GPS position is at centre of small star picket (0.5m west of concrete marker)

Station ID: **200181.9005**	Station Name:		Date: **06/07/2001**

HORIZONTAL DETAIL		VERTICAL DETAIL		MARK DETAIL		GRAVITY DETAIL	
Easting:	413362.700	Elevation:	315.739	Mark Type:	PSM	Obs Gravity:	9785046.52
Northing:	7888008.896	Geoid-Ellips. Sep:	34.782	Witness Mark:	Star Picket		
Zone:	53			Witness Plate:	Survey Mark Plate		
Latitude:	-19.09905154			Monument Type:	Concrete block		
Longitude:	134.17637578				Brass disc		
Datum:	GDA94	Datum:	AHD71	Plaque Stamped:	200181.9005	Datum:	IGSN71
Order:	1	Order:	3				(Isogal 84)
Class:		Class:		Located in Map Sheet:		Units:	μms^{-2}
Method:	GPS	Method:	GPS	Flynn (5759)			



Appendix Three

Gravity Base Station Repeat Listing

Scintrex Gravity Processing - Observed Gravity Only
Base Station Network Repeat Listing - **TENNANT INLIER NT GRAVITY SURVEY**

Datum Information:-
Observed Gravity Datum: IGSN71 (Isogal84)
Observed gravity Units: μms^{-2} or gravity units

Column Information:-
GRAVREF: Gravity base station number used to establish the station
METERNO: Serial number of gravity meter used to establish the station
STATUS: 0 if all repeat differences are within contractual requirements; 1 otherwise
(maximum allowable repeat differences: obsgrav - $0.5\mu ms^{-2}$; elevation - 0.1m; east & north - 10m)
TYPE: Specifies if a repeat station is a Gravity Only or combined Gravity & GPS repeat

**All other column headers are self descriptive

STATION	OBS.GRAV	GRAVREF	TIME	DATE	METERNO	STATUS	TYPE
200181.8021	9785643.19	200181.9002	12:50:51	270701	610358	0	Gravity Only
200181.8021	9785642.90	200181.9002	12:56:58	270701	403241	0	Gravity Only
200181.8021	9785642.98	200181.9002	14:09:10	270701	403241	0	Gravity Only
200181.8021	9785643.23	200181.9002	14:11:20	270701	610358	0	Gravity Only
200181.8021	9785643.06	200181.9002	14:15:46	270701	711402	0	Gravity Only
Average Value:	9785643.07						
Std Dev:	0.12						
Max Repeat Error:	0.33						
200181.9001	9785376.24	6793.0134	16:09:55	060701	711402	0	Gravity Only
200181.9001	9785376.38	6793.0134	16:14:18	060701	403241	0	Gravity Only
200181.9001	9785376.29	6793.0134	08:32:34	070701	610358	0	Gravity Only
200181.9001	9785376.35	6793.0134	08:32:53	070701	711402	0	Gravity Only
200181.9001	9785376.20	6793.0134	08:33:14	070701	403241	0	Gravity Only
200181.9001	9785376.22	6793.0134	15:23:57	070701	610358	0	Gravity Only
200181.9001	9785376.36	6793.0134	15:24:20	070701	711402	0	Gravity Only
200181.9001	9785376.22	6793.0134	15:24:40	070701	403241	0	Gravity Only
Average Value:	9785376.28						
Std Dev:	0.07						
Max Repeat Error:	0.18						

Gravity base station network repeat differences
TENNANT INLIER NT GRAVITY SURVEY

200181.9002	9785518.49	6793.0134	12:11:01	070701	403241	0	Gravity Only
200181.9002	9785518.29	6793.0134	12:11:21	070701	711402	0	Gravity Only
200181.9002	9785518.37	6793.0134	12:13:30	070701	610358	0	Gravity Only
200181.9002	9785518.52	6793.0134	14:40:02	070701	403241	0	Gravity Only
200181.9002	9785518.34	6793.0134	14:43:26	070701	610358	0	Gravity Only
200181.9002	9785518.43	200181.9001	08:52:35	110701	403241	0	Gravity Only
200181.9002	9785518.32	200181.9001	08:53:01	110701	711402	0	Gravity Only
200181.9002	9785518.57	200181.9001	13:46:42	110701	403241	0	Gravity Only
200181.9002	9785518.41	200181.9001	13:49:42	110701	610358	0	Gravity Only
Average Value:	9785518.42						
Std Dev:	0.09						
Max Repeat Error:	0.28						
200181.9003	9785449.26	6793.0134	10:50:22	070701	403241	0	Gravity Only
200181.9003	9785449.41	6793.0134	10:50:40	070701	711402	0	Gravity Only
200181.9003	9785449.33	6793.0134	13:30:41	070701	610358	0	Gravity Only
200181.9003	9785449.49	6793.0134	13:31:06	070701	711402	0	Gravity Only
200181.9003	9785449.27	6793.0134	13:31:27	070701	403241	0	Gravity Only
200181.9003	9785449.30	200181.9001	10:14:30	110701	403241	0	Gravity Only
200181.9003	9785449.54	200181.9001	10:15:00	110701	610358	0	Gravity Only
200181.9003	9785449.25	200181.9001	10:15:12	110701	711402	0	Gravity Only
200181.9003	9785449.47	200181.9001	12:30:05	110701	711402	0	Gravity Only
200181.9003	9785449.40	200181.9001	12:30:30	110701	403241	0	Gravity Only
Average Value:	9785449.37						
Std Dev:	0.10						
Max Repeat Error:	0.29						
200181.9004	9785138.15	6793.0134	10:08:36	060701	403241	0	Gravity Only
200181.9004	9785138.32	6793.0134	10:09:23	060701	711402	0	Gravity Only
200181.9004	9785138.29	6793.0134	13:48:31	060701	711402	0	Gravity Only
200181.9004	9785138.28	6793.0134	13:49:02	060701	403241	0	Gravity Only
200181.9004	9785138.28	6793.0134	13:49:26	060701	610358	0	Gravity Only
Average Value:	9785138.26						
Std Dev:	0.06						
Max Repeat Error:	0.17						
200181.9005	9785046.46	6793.0134	08:56:23	060701	711402	0	Gravity Only
200181.9005	9785046.50	6793.0134	08:57:00	060701	403241	0	Gravity Only
200181.9005	9785046.57	6793.0134	12:38:44	060701	403241	0	Gravity Only
200181.9005	9785046.52	6793.0134	12:39:03	060701	711402	0	Gravity Only
200181.9005	9785046.55	6793.0134	12:39:34	060701	610358	0	Gravity Only
Average Value:	9785046.52						
Std Dev:	0.04						
Max Repeat Error:	0.11						

Gravity base station network repeat differences
TENNANT INLIER NT GRAVITY SURVEY

Maximum Repeat Errors:
Observed Gravity Data: 0.330

Maximum Standard Deviations:
Observed Gravity Data: 0.124

Total number of input readings:	42
Total number of new readings:	6
Total number of repeat stations:	6
Total number of repeat readings:	36
Total number of Gravity only repeat readings:	36
Percentage repeated stations:	600.00%
Number of readings outside precision limits:	0

Gravity base station network repeat differences
TENNANT INLIER NT GRAVITY SURVEY

Appendix Four

Gravity Meter Loop Closures and Drift

Loop closure details for all meters for the **Tennant Inlier NT** Gravity Survey
All gravity readings in relative meter units (in MILLIGALS)
STATION is the primary gravity base station used for the loop
Times are in 24 hour format

METERNO: 9610353

STATION	LOOP	START-TIME	END-TIME	START-GRAV	END-GRAV	CLOSURE	RATE/HR	DATE	METERNO
134	1	07.33639	17.89944	3872.497	3872.489	-0.008	-0.001	130701	610353
134	1	07.26583	18.68083	3872.436	3872.454	0.018	0.002	140701	610353
134	1	07.05583	18.46056	3872.370	3872.361	-0.008	-0.001	150701	610353
134	1	06.98917	18.69889	3872.292	3872.302	0.010	0.001	160701	610353
134	1	07.10139	15.63222	3872.217	3872.211	-0.005	-0.001	170701	610353
134	1	07.05139	18.72833	3872.142	3872.138	-0.003	0.000	180701	610353
134	1	07.03861	18.47000	3872.068	3872.006	-0.062	-0.005	190701	610353
134	1	11.56472	18.33444	3871.935	3871.900	-0.035	-0.005	200701	610353
134	1	07.10000	18.50972	3871.936	3871.992	0.056	0.005	210701	610353
134	1	06.81500	18.25417	3871.895	3871.932	0.037	0.003	220701	610353
134	1	06.88306	18.09194	3871.874	3871.897	0.023	0.002	230701	610353
134	1	06.88278	18.06778	3871.831	3871.841	0.010	0.001	240701	610353
134	1	06.66361	18.16417	3871.776	3871.808	0.032	0.003	250701	610353
134	1	06.71944	18.13833	3871.725	3871.738	0.013	0.001	260701	610353
8021	1	06.98861	18.47389	3921.376	3921.377	0.001	0.000	270701	610353
8021	1	06.11528	18.21889	3921.324	3921.321	-0.003	0.000	280701	610353
8021	1	06.22694	18.39722	3921.251	3921.277	0.026	0.002	290701	610353
8021	1	06.23944	15.24111	3921.198	3921.176	-0.022	-0.002	300701	610353

METERNO: 9610358

STATION	LOOP	START-TIME	END-TIME	START-GRAV	END-GRAV	CLOSURE	RATE/HR	DATE	METERNO
134	1	07.58417	11.67361	4722.836	4722.877	0.042	0.010	060701	610358
134	2	11.67361	16.98889	4722.877	4722.874	-0.003	-0.001	060701	610358
134	1	07.63833	16.18667	4722.684	4722.710	0.026	0.003	070701	610358
9001	1	08.06472	14.56639	4744.969	4744.961	-0.008	-0.001	110701	610358
9002	1	12.20222	13.48833	4755.908	4755.870	-0.038	-0.030	270701	610358
9002	2	13.48833	14.68778	4755.870	4755.929	0.059	0.049	270701	610358

METERNO: 9711402

STATION	LOOP	START-TIME	END-TIME	START-GRAV	END-GRAV	CLOSURE	RATE/HR	DATE	METERNO
134	1	07.59278	11.58889	3530.509	3530.538	0.029	0.007	060701	711402
134	2	11.58889	16.98861	3530.538	3530.578	0.039	0.007	060701	711402
134	1	07.63806	16.19722	3530.672	3530.750	0.078	0.009	070701	711402
134	1	07.56000	13.56583	3531.050	3531.119	0.068	0.011	090701	711402
9001	1	08.03111	14.48139	3554.490	3554.563	0.074	0.011	110701	711402

METERNO: 9403241

STATION	LOOP	START-TIME	END-TIME	START-GRAV	END-GRAV	CLOSURE	RATE/HR	DATE	METERNO
134	1	07.61750	11.59472	3525.805	3525.813	0.007	0.002	060701	403241
134	2	11.59472	16.98889	3525.813	3525.800	-0.012	-0.002	060701	403241
134	1	07.63778	16.25528	3525.840	3525.838	-0.003	0.000	070701	403241
134	1	07.40944	16.92667	3525.855	3525.860	0.005	0.001	080701	403241
134	1	07.31722	17.19889	3525.883	3525.878	-0.005	-0.001	090701	403241
134	1	07.24944	17.21167	3525.900	3525.910	0.010	0.001	100701	403241
9001	1	08.00694	14.47778	3548.968	3548.983	0.015	0.002	110701	403241
134	1	09.39500	16.12444	3526.308	3526.328	0.020	0.003	240701	403241
9002	1	12.33472	13.38972	3572.292	3572.324	0.032	0.031	270701	711402
9002	2	13.38972	14.65722	3572.324	3572.365	0.041	0.032	270701	711402

Daily gravity base station closures
TENNANT INLIER NT GRAVITY SURVEY

Appendix Five

Repeat Data Listing and Repeat Statistics

Scintrex Gravity Processing - Bouguer Gravity
Repeat Station Listing - **TENNANT INLIER NT GRAVITY SURVEY**

Datum Information:-
Horizontal Coordinate Datum: GDA94/WGS84
Vertical Coordinate Datum: AHD71
Observed Gravity Datum: IGSN71 (Isogal84)
Observed gravity Units: μms^{-2} or gravity units

Column Information:-
GRAVREF: Gravity base station number used to establish the station
GPSREF: GPS base station number used to establish the station
METERNO: Serial number of gravity meter used to establish the station
STATUS: 0 if all repeat differences are within contractual requirements; 1 otherwise
(maximum allowable repeat differences: obsgrav - $0.5\mu ms^{-2}$; elevation - 0.1m; east & north - 10m)
TYPE: Specifies if a repeat station is a Gravity Only or combined Gravity & GPS repeat

**All other column headers are self descriptive

STATION	EASTING	NORTHING	ELEV	OBS.GRAV.	GRAVREF	GPSREF	TIME	DATE	METERNO	STATUS	TYPE
200181.0045	360007.094	7892958.017	285.814	9785068.90	6793.0134	200181.8015	08:57:36	230701	610353	0	Gravity and GPS
200181.0045	360007.112	7892958.006	285.757	9785068.82	6793.0134	200181.8016	10:48:25	230701	610353	0	Gravity and GPS
Average Value:	360007.103	7892958.012	285.786	9785068.86							
Std Dev:	0.009	0.005	0.029	0.04							
Max Repeat Error:	0.018	0.011	0.057	0.08							
200181.0049	376011.534	7892982.625	302.235	9785093.83	6793.0134	200181.8016	11:19:09	230701	610353	0	Gravity and GPS
200181.0049	376011.400	7892982.528	302.177	9785093.45	6793.0134	200181.8015	13:19:33	230701	610353	0	Gravity and GPS
Average Value:	376011.467	7892982.577	302.206	9785093.64							
Std Dev:	0.067	0.049	0.029	0.19							
Max Repeat Error:	0.134	0.097	0.058	0.38							
200181.0060	419972.169	7892882.370	278.804	9785036.27	6793.0134	200181.9005	11:44:22	210701	610353	0	Gravity and GPS
200181.0060	419972.228	7892882.173	278.791	9785036.20	6793.0134	200181.9005	13:37:11	210701	610353	0	Gravity and GPS
Average Value:	419972.199	7892882.272	278.798	9785036.24							
Std Dev:	0.030	0.098	0.006	0.04							
Max Repeat Error:	0.059	0.197	0.013	0.07							
200181.0102	428039.574	7889051.575	269.226	9785033.75	6793.0134	200181.9005	11:01:17	210701	610353	0	Gravity and GPS
200181.0102	428039.564	7889051.534	269.184	9785033.68	6793.0134	200181.9005	11:58:43	210701	610353	0	Gravity and GPS
Average Value:	428039.569	7889051.555	269.205	9785033.72							
Std Dev:	0.005	0.020	0.021	0.04							
Max Repeat Error:	0.010	0.041	0.042	0.07							
200181.0103	432036.636	7888979.603	264.018	9785035.32	6793.0134	200181.9005	10:04:41	210701	610353	0	Gravity and GPS
200181.0103	432036.636	7888979.700	264.033	9785035.38	6793.0134	200181.9005	11:06:33	210701	610353	0	Gravity and GPS
Average Value:	432036.636	7888979.652	264.026	9785035.35							
Std Dev:	0.000	0.049	0.008	0.03							
Max Repeat Error:	0.000	0.097	0.015	0.06							

200181.0112	468008.739	7889096.679	229.239	9785138.31	6793.0134	200181.9004	09:52:44	170701	610353	0	Gravity and GPS
200181.0112	468008.818	7889096.694	229.282	9785138.20	6793.0134	200181.9004	11:03:43	170701	610353	0	Gravity and GPS
Average Value:	468008.779	7889096.687	229.261	9785138.26							
Std Dev:	0.040	0.008	0.021	0.06							
Max Repeat Error:	0.079	0.015	0.043	0.11							
200181.0113	471924.529	7888970.804	227.655	9785164.56	6793.0134	200181.9004	16:38:03	160701	610353	0	Gravity and GPS
200181.0113	471924.458	7888970.742	227.605	9785164.90	6793.0134	200181.9004	09:58:21	170701	610353	0	Gravity and GPS
Average Value:	471924.494	7888970.773	227.630	9785164.73							
Std Dev:	0.036	0.031	0.025	0.17							
Max Repeat Error:	0.071	0.062	0.050	0.34							
200181.0117	487887.035	7888994.839	226.429	9785132.25	6793.0134	200181.9004	11:22:36	160701	610353	0	Gravity and GPS
200181.0117	487886.899	7888995.090	226.437	9785131.98	6793.0134	200181.9004	15:01:57	160701	610353	0	Gravity and GPS
Average Value:	487886.967	7888994.965	226.433	9785132.12							
Std Dev:	0.068	0.125	0.004	0.13							
Max Repeat Error:	0.136	0.251	0.008	0.27							
200181.0135	400016.685	7884989.388	371.610	9784920.01	6793.0134	200181.9005	15:35:36	210701	610353	0	Gravity and GPS
200181.0135	400016.526	7884989.761	371.534	9784920.23	6793.0134	200181.8015	14:54:44	230701	610353	0	Gravity and GPS
Average Value:	400016.606	7884989.575	371.572	9784920.12							
Std Dev:	0.080	0.187	0.038	0.11							
Max Repeat Error:	0.159	0.373	0.076	0.22							
200181.0136	403948.543	7885027.636	399.022	9784868.17	6793.0134	200181.9005	14:37:24	210701	610353	0	Gravity and GPS
200181.0136	403948.459	7885027.776	399.047	9784867.99	6793.0134	200181.9005	15:42:37	210701	610353	0	Gravity and GPS
Average Value:	403948.501	7885027.706	399.035	9784868.08							
Std Dev:	0.042	0.070	0.013	0.09							
Max Repeat Error:	0.084	0.140	0.025	0.18							
200181.0146	443985.343	7884964.366	250.939	9785039.20	6793.0134	200181.8014	12:02:15	170701	610353	0	Gravity and GPS
200181.0146	443985.253	7884964.409	250.943	9785039.33	6793.0134	200181.8014	13:58:06	170701	610353	0	Gravity and GPS
Average Value:	443985.298	7884964.388	250.941	9785039.27							
Std Dev:	0.045	0.021	0.002	0.07							
Max Repeat Error:	0.090	0.043	0.004	0.13							
200181.0162	348133.522	7881009.264	360.818	9784992.47	6793.0134	200181.8015	13:42:42	220701	610353	1	Gravity and GPS
200181.0162	348133.196	7881009.375	360.825	9784993.01	6793.0134	200181.8015	09:48:37	230701	610353	1	Gravity and GPS
Average Value:	348133.359	7881009.320	360.822	9784992.74							
Std Dev:	0.163	0.055	0.003	0.27							
Max Repeat Error:	0.326	0.111	0.007	0.54							
200181.0167	367992.769	7880990.970	310.813	9785124.86	6793.0134	200181.8015	08:34:31	230701	610353	0	Gravity and GPS
200181.0167	367992.671	7880990.961	310.746	9785124.88	6793.0134	200181.8015	11:54:11	230701	610353	0	Gravity and GPS
Average Value:	367992.720	7880990.966	310.780	9785124.87							
Std Dev:	0.049	0.005	0.033	0.01							
Max Repeat Error:	0.098	0.009	0.067	0.02							

200181.0172	388063.526	7881050.448	325.720	9785081.27	6793.0134	200181.8003	07:50:40	230701	610353	0	Gravity and GPS
200181.0172	388063.474	7881050.166	325.752	9785080.94	6793.0134	200181.8015	14:32:13	230701	610353	0	Gravity and GPS
Average Value:	388063.500	7881050.307	325.736	9785081.11							
Std Dev:	0.026	0.141	0.016	0.17							
Max Repeat Error:	0.052	0.282	0.032	0.33							
200181.0178	412377.515	7880673.651	303.755	9785169.25	6793.0134	200181.9005	09:58:50	100701	403241	0	Gravity and GPS
200181.0178	412377.560	7880673.639	303.804	9785169.40	6793.0134	200181.9005	12:16:29	100701	403241	0	Gravity and GPS
Average Value:	412377.538	7880673.645	303.780	9785169.33							
Std Dev:	0.022	0.006	0.024	0.08							
Max Repeat Error:	0.045	0.012	0.049	0.15							
200181.0199	495964.110	7880910.109	236.055	9785132.11	6793.0134	200181.9004	12:01:22	160701	610353	0	Gravity and GPS
200181.0199	495964.245	7880909.856	236.056	9785132.30	6793.0134	200181.8013	13:43:26	160701	610353	0	Gravity and GPS
Average Value:	495964.178	7880909.983	236.056	9785132.21							
Std Dev:	0.068	0.127	0.000	0.10							
Max Repeat Error:	0.135	0.253	0.001	0.19							
200181.0207	367984.465	7877009.505	319.796	9785134.32	6793.0134	200181.8015	15:20:33	220701	610353	1	Gravity and GPS
200181.0207	367984.760	7877009.292	319.896	9785134.67	6793.0134	200181.8015	08:29:21	230701	610353	1	Gravity and GPS
Average Value:	367984.613	7877009.399	319.846	9785134.50							
Std Dev:	0.147	0.107	0.050	0.17							
Max Repeat Error:	0.295	0.213	0.100	0.35							
200181.0230	460018.653	7876997.584	242.596	9785163.66	6793.0134	200181.8011	17:13:25	160701	610353	0	Gravity and GPS
200181.0230	460018.740	7876997.567	242.610	9785164.14	6793.0134	200181.9004	09:03:39	170701	610353	0	Gravity and GPS
Average Value:	460018.697	7876997.576	242.603	9785163.90							
Std Dev:	0.043	0.008	0.007	0.24							
Max Repeat Error:	0.087	0.017	0.014	0.48							
200181.0252	387993.120	7872980.789	361.470	9785044.76	6793.0134	200181.8015	16:12:54	220701	610353	0	Gravity and GPS
200181.0252	387993.141	7872980.927	361.399	9785044.83	6793.0134	200181.8003	07:40:54	230701	610353	0	Gravity and GPS
Average Value:	387993.131	7872980.858	361.435	9785044.80							
Std Dev:	0.010	0.069	0.036	0.04							
Max Repeat Error:	0.021	0.138	0.071	0.07							
200181.0257	407994.594	7872965.230	345.234	9785063.59	6793.0134	200181.9005	16:09:39	210701	610353	0	Gravity and GPS
200181.0257	407994.525	7872964.880	345.152	9785063.18	6793.0134	200181.8003	16:00:19	230701	610353	0	Gravity and GPS
Average Value:	407994.560	7872965.055	345.193	9785063.39							
Std Dev:	0.035	0.175	0.041	0.21							
Max Repeat Error:	0.069	0.350	0.082	0.41							
200181.0261	423996.139	7872996.193	294.410	9785099.36	6793.0134	200181.9005	10:36:23	210701	610353	0	Gravity and GPS
200181.0261	423997.409	7873002.494	294.365	9785099.24	6793.0134	200181.8011	16:45:56	210701	610353	0	Gravity and GPS
Average Value:	423996.774	7872999.344	294.388	9785099.30							
Std Dev:	0.635	3.150	0.023	0.06							
Max Repeat Error:	1.270	6.301	0.045	0.12							
200181.0262	428030.167	7873081.231	310.413	9785037.37	6793.0134	200181.8011	09:24:19	210701	610353	0	Gravity and GPS
200181.0262	428030.074	7873081.392	310.505	9785037.22	6793.0134	200181.9005	10:31:45	210701	610353	0	Gravity and GPS
Average Value:	428030.121	7873081.312	310.459	9785037.30							
Std Dev:	0.046	0.081	0.046	0.07							
Max Repeat Error:	0.093	0.161	0.092	0.15							

200181.0266	444031.336	7873075.276	273.709	9785049.37	6793.0134	200181.8011	08:23:35	170701	610353	0	Gravity and GPS
200181.0266	444031.329	7873074.849	273.703	9785049.30	6793.0134	200181.8014	14:24:19	170701	610353	0	Gravity and GPS
Average Value:	444031.333	7873075.063	273.706	9785049.34							
Std Dev:	0.004	0.213	0.003	0.03							
Max Repeat Error:	0.007	0.427	0.006	0.07							
200181.0270	459980.785	7872985.161	247.474	9785145.94	6793.0134	200181.9004	09:53:35	160701	610353	0	Gravity and GPS
200181.0270	459980.446	7872984.848	247.417	9785145.78	6793.0134	200181.8011	17:18:38	160701	610353	0	Gravity and GPS
Average Value:	459980.616	7872985.005	247.446	9785145.86							
Std Dev:	0.170	0.157	0.029	0.08							
Max Repeat Error:	0.339	0.313	0.057	0.16							
200181.0284	355540.762	7868830.537	308.735	9785152.30	6793.0134	200181.8002	11:48:40	220701	610353	0	Gravity and GPS
200181.0284	355540.756	7868830.507	308.760	9785151.90	6793.0134	200181.8015	14:31:39	220701	610353	0	Gravity and GPS
Average Value:	355540.759	7868830.522	308.748	9785152.10							
Std Dev:	0.003	0.015	0.013	0.20							
Max Repeat Error:	0.006	0.030	0.025	0.40							
200181.0287	367564.775	7868820.884	333.238	9785092.67	6793.0134	200181.8002	11:33:52	220701	610353	0	Gravity and GPS
200181.0287	367564.748	7868820.653	333.292	9785092.33	6793.0134	200181.8015	15:33:49	220701	610353	0	Gravity and GPS
Average Value:	367564.762	7868820.769	333.265	9785092.50							
Std Dev:	0.014	0.115	0.027	0.17							
Max Repeat Error:	0.027	0.231	0.054	0.34							
200181.0302	460048.471	7869066.470	252.020	9785153.59	6793.0134	200181.8011	08:30:56	160701	610353	0	Gravity and GPS
200181.0302	460048.640	7869066.496	252.108	9785153.13	6793.0134	200181.9004	09:48:01	160701	610353	0	Gravity and GPS
Average Value:	460048.556	7869066.483	252.064	9785153.36							
Std Dev:	0.084	0.013	0.044	0.23							
Max Repeat Error:	0.169	0.026	0.088	0.46							
200181.0309	487942.005	7868994.246	246.715	9785184.45	6793.0134	200181.9004	10:46:19	160701	610353	0	Gravity and GPS
200181.0309	487941.957	7868994.195	246.710	9785184.11	6793.0134	200181.8013	12:28:01	160701	610353	0	Gravity and GPS
Average Value:	487941.981	7868994.221	246.713	9785184.28							
Std Dev:	0.024	0.025	0.003	0.17							
Max Repeat Error:	0.048	0.051	0.005	0.34							
200181.0330	447972.711	7865010.721	270.879	9785074.88	6793.0134	200181.8011	17:50:39	160701	610353	1	Gravity and GPS
200181.0330	447972.852	7865010.833	270.915	9785075.46	6793.0134	200181.8011	08:08:20	170701	610353	1	Gravity and GPS
Average Value:	447972.782	7865010.777	270.897	9785075.17							
Std Dev:	0.071	0.056	0.018	0.29							
Max Repeat Error:	0.141	0.112	0.036	0.58							
200181.0338	479989.808	7865022.585	242.662	9785169.27	6793.0134	200181.9004	09:18:53	160701	610353	0	Gravity and GPS
200181.0338	479989.853	7865022.653	242.655	9785169.25	6793.0134	200181.9004	10:29:58	160701	610353	0	Gravity and GPS
Average Value:	479989.831	7865022.619	242.659	9785169.26							
Std Dev:	0.022	0.034	0.003	0.01							
Max Repeat Error:	0.045	0.068	0.007	0.02							
200181.0348	360041.986	7860989.059	333.951	9785124.17	6793.0134	200181.8002	11:04:43	220701	610353	0	Gravity and GPS
200181.0348	360042.056	7860989.261	333.967	9785124.05	6793.0134	200181.8002	12:03:23	220701	610353	0	Gravity and GPS
Average Value:	360042.021	7860989.160	333.959	9785124.11							
Std Dev:	0.035	0.101	0.008	0.06							
Max Repeat Error:	0.070	0.202	0.016	0.12							

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200181.0353	392101.295	7861319.922	344.309	9785180.17	6793.0134	200181.8003	07:20:12	230701	610353	0	Gravity and GPS
200181.0353	392102.088	7861319.412	344.330	9785180.10	6793.0134	200181.8003	17:00:52	230701	610353	0	Gravity and GPS
Average Value:	392101.692	7861319.667	344.320	9785180.14							
Std Dev:	0.397	0.255	0.011	0.04							
Max Repeat Error:	0.793	0.510	0.021	0.07							
200181.0390	435951.392	7857055.404	315.413	9785094.56	6793.0134	200181.8011	07:45:34	170701	610353	0	Gravity and GPS
200181.0390	435951.359	7857055.470	315.413	9785094.29	6793.0134	200181.8011	14:59:15	170701	610353	0	Gravity and GPS
Average Value:	435951.376	7857055.437	315.413	9785094.43							
Std Dev:	0.016	0.033	0.000	0.14							
Max Repeat Error:	0.033	0.066	0.000	0.27							
200181.0391	439988.479	7856974.990	308.679	9785130.18	6793.0134	200181.8011	07:51:00	170701	610353	0	Gravity and GPS
200181.0391	439988.584	7856974.941	308.655	9785130.18	6793.0134	200181.8011	07:46:55	160701	610353	0	Gravity and GPS
Average Value:	439988.532	7856974.966	308.667	9785130.18							
Std Dev:	0.053	0.024	0.012	0.00							
Max Repeat Error:	0.105	0.049	0.024	0.00							
200181.0395	456023.578	7856998.818	270.133	9785118.33	6793.0134	200181.8010	16:12:18	200701	610353	0	Gravity and GPS
200181.0395	456023.544	7856998.682	270.147	9785117.98	6793.0134	200181.8011	08:09:02	160701	610353	0	Gravity and GPS
Average Value:	456023.561	7856998.750	270.140	9785118.16							
Std Dev:	0.017	0.068	0.007	0.17							
Max Repeat Error:	0.034	0.136	0.014	0.35							
200181.0402	484000.916	7857036.002	261.273	9785124.05	6793.0134	200181.9004	16:00:59	150701	610353	0	Gravity and GPS
200181.0402	484001.091	7857036.063	261.319	9785124.00	6793.0134	200181.9004	17:39:20	150701	610353	0	Gravity and GPS
Average Value:	484001.004	7857036.033	261.296	9785124.03							
Std Dev:	0.087	0.030	0.023	0.03							
Max Repeat Error:	0.175	0.061	0.046	0.05							
200181.0407	344083.801	7852973.635	264.705	9785209.53	6793.0134	200181.8002	10:09:25	220701	610353	0	Gravity and GPS
200181.0407	344083.621	7852973.725	264.652	9785209.21	6793.0134	200181.8002	13:00:36	220701	610353	0	Gravity and GPS
Average Value:	344083.711	7852973.680	264.679	9785209.37							
Std Dev:	0.090	0.045	0.026	0.16							
Max Repeat Error:	0.180	0.090	0.053	0.32							
200181.0408	348035.224	7852950.352	273.518	9785162.63	6793.0134	200181.8002	10:18:53	220701	610353	0	Gravity and GPS
200181.0408	348035.272	7852950.246	273.540	9785162.98	6793.0134	200181.8002	12:28:08	220701	610353	0	Gravity and GPS
Average Value:	348035.248	7852950.299	273.529	9785162.81							
Std Dev:	0.024	0.053	0.011	0.17							
Max Repeat Error:	0.048	0.106	0.022	0.35							
200181.0413	367932.434	7853137.132	324.926	9785002.95	6793.0134	200181.8002	09:09:49	220701	610353	0	Gravity and GPS
200181.0413	367932.525	7853136.978	324.909	9785002.96	6793.0134	200181.8002	10:44:19	220701	610353	0	Gravity and GPS
Average Value:	367932.480	7853137.055	324.918	9785002.96							
Std Dev:	0.045	0.077	0.008	0.01							
Max Repeat Error:	0.091	0.154	0.017	0.01							
200181.0434	500026.771	7853012.420	244.396	9785204.72	6793.0134	200181.9004	14:28:36	150701	610353	0	Gravity and GPS
200181.0434	500026.840	7853012.688	244.345	9785204.43	6793.0134	200181.9004	16:39:14	150701	610353	0	Gravity and GPS
Average Value:	500026.806	7853012.554	244.371	9785204.58							
Std Dev:	0.034	0.134	0.026	0.15							
Max Repeat Error:	0.069	0.268	0.051	0.29							

200181.0443	387870.946	7849157.720	343.288	9785159.68	6793.0134	200181.8003	13:12:00	090701	403241	0	Gravity and GPS
200181.0443	387871.000	7849157.692	343.268	9785159.57	6793.0134	200181.8003	15:33:47	090701	403241	0	Gravity and GPS
Average Value:	387870.973	7849157.706	343.278	9785159.63							
Std Dev:	0.027	0.014	0.010	0.05							
Max Repeat Error:	0.054	0.028	0.020	0.11							
200181.0485	476040.900	7845026.086	266.196	9785222.60	6793.0134	200181.9004	15:27:24	150701	610353	1	Gravity and GPS
200181.0485	476041.314	7845026.053	266.172	9785223.25	6793.0134	200181.8010	15:16:25	200701	610353	1	Gravity and GPS
Average Value:	476041.107	7845026.070	266.184	9785222.93							
Std Dev:	0.207	0.017	0.012	0.33							
Max Repeat Error:	0.414	0.033	0.024	0.65							
200181.0494	351896.416	7840625.391	265.830	9785287.87	6793.0134	200181.8005	12:53:38	180701	610353	0	Gravity and GPS
200181.0494	351896.697	7840625.714	265.876	9785288.17	6793.0134	200181.8002	17:47:04	180701	610353	0	Gravity and GPS
Average Value:	351896.557	7840625.553	265.853	9785288.02							
Std Dev:	0.140	0.161	0.023	0.15							
Max Repeat Error:	0.281	0.323	0.046	0.30							
200181.0502	384012.317	7841017.415	321.942	9785138.37	6793.0134	200181.8002	08:32:25	220701	610353	0	Gravity and GPS
200181.0502	384012.665	7841017.120	321.860	9785138.42	6793.0134	200181.8002	17:10:18	220701	610353	0	Gravity and GPS
Average Value:	384012.491	7841017.268	321.901	9785138.40							
Std Dev:	0.174	0.148	0.041	0.03							
Max Repeat Error:	0.348	0.295	0.082	0.05							
200181.0508	408022.143	7840998.260	368.809	9784990.92	6793.0134	200181.8001	17:42:28	220701	610353	0	Gravity and GPS
200181.0508	408022.347	7840998.147	368.776	9784990.75	6793.0134	200181.8003	17:42:19	230701	610353	0	Gravity and GPS
Average Value:	408022.245	7840998.204	368.793	9784990.84							
Std Dev:	0.102	0.057	0.017	0.08							
Max Repeat Error:	0.204	0.113	0.033	0.17							
200181.0522	484051.631	7841047.486	262.876	9785297.24	6793.0134	200181.8010	13:45:51	150701	610353	0	Gravity and GPS
200181.0522	484051.859	7841045.896	262.906	9785297.15	6793.0134	200181.9004	15:09:08	150701	610353	0	Gravity and GPS
Average Value:	484051.745	7841046.691	262.891	9785297.20							
Std Dev:	0.114	0.795	0.015	0.04							
Max Repeat Error:	0.228	1.590	0.030	0.09							
200181.0533	368040.690	7836996.854	283.139	9785193.69	6793.0134	200181.8005	11:27:06	180701	610353	0	Gravity and GPS
200181.0533	368041.063	7836996.173	283.219	9785193.88	6793.0134	200181.8005	12:29:00	180701	610353	0	Gravity and GPS
Average Value:	368040.877	7836996.514	283.179	9785193.79							
Std Dev:	0.186	0.340	0.040	0.10							
Max Repeat Error:	0.373	0.681	0.080	0.19							
200181.0537	384022.887	7836979.812	317.180	9785198.58	6793.0134	200181.8005	10:56:12	180701	610353	0	Gravity and GPS
200181.0537	384022.941	7836979.727	317.087	9785198.73	6793.0134	200181.8002	08:28:01	220701	610353	0	Gravity and GPS
Average Value:	384022.914	7836979.770	317.134	9785198.66							
Std Dev:	0.027	0.043	0.046	0.08							
Max Repeat Error:	0.054	0.085	0.093	0.15							
200181.0557	484011.488	7836936.534	267.258	9785285.60	6793.0134	200181.8010	11:41:18	150701	610353	0	Gravity and GPS
200181.0557	484011.575	7836937.144	267.357	9785285.32	6793.0134	200181.8010	13:37:54	150701	610353	0	Gravity and GPS
Average Value:	484011.532	7836936.839	267.308	9785285.46							
Std Dev:	0.043	0.305	0.050	0.14							
Max Repeat Error:	0.087	0.610	0.099	0.28							

200181.0579	411817.322	7832859.637	377.353	9785080.52	6793.0134	200181.8001	08:00:27	080701	403241	0	Gravity and GPS
200181.0579	411817.098	7832859.728	377.345	9785080.68	6793.0134	200181.8001	11:50:19	080701	403241	0	Gravity and GPS
200181.0579	411817.358	7832859.678	377.400	9785080.62	6793.0134	200181.8001	13:00:13	090701	711402	0	Gravity and GPS
Average Value:	411817.259	7832859.681	377.366	9785080.61							
Std Dev:	0.115	0.037	0.024	0.07							
Max Repeat Error:	0.260	0.091	0.055	0.16							
200181.0580	415851.042	7833481.371	372.060	9785087.66	6793.0134	200181.8001	10:33:12	080701	403241	0	Gravity and GPS
200181.0580	415851.059	7833481.341	372.078	9785087.63	6793.0134	200181.8001	16:34:53	080701	403241	0	Gravity and GPS
Average Value:	415851.051	7833481.356	372.069	9785087.65							
Std Dev:	0.009	0.015	0.009	0.01							
Max Repeat Error:	0.017	0.030	0.018	0.03							
200181.0617	356075.493	7828998.204	270.526	9785324.75	6793.0134	200181.8005	12:02:34	180701	610353	0	Gravity and GPS
200181.0617	356075.498	7828998.238	270.483	9785324.71	6793.0134	200181.8005	13:14:33	180701	610353	0	Gravity and GPS
Average Value:	356075.496	7828998.221	270.505	9785324.73							
Std Dev:	0.002	0.017	0.021	0.02							
Max Repeat Error:	0.005	0.034	0.043	0.04							
200181.0646	412026.731	7828999.154	362.318	9785155.49	6793.0134	200181.8001	07:19:25	220701	610353	0	Gravity and GPS
200181.0646	412026.950	7828999.656	362.318	9785155.42	6793.0134	200181.8001	18:00:01	220701	610353	0	Gravity and GPS
Average Value:	412026.841	7828999.405	362.318	9785155.46							
Std Dev:	0.109	0.251	0.000	0.04							
Max Repeat Error:	0.219	0.502	0.000	0.07							
200181.0648	420290.500	7829131.512	410.764	9785071.68	6793.0134	200181.8001	12:33:51	200701	610353	0	Gravity and GPS
200181.0648	420290.035	7829131.359	410.789	9785072.00	6793.0134	200181.8001	07:18:59	210701	610353	0	Gravity and GPS
Average Value:	420290.268	7829131.436	410.777	9785071.84							
Std Dev:	0.232	0.076	0.013	0.16							
Max Repeat Error:	0.465	0.153	0.025	0.32							
200181.0656	468059.792	7829040.505	292.970	9785281.57	6793.0134	200181.8008	14:33:12	200701	610353	0	Gravity and GPS
200181.0656	468059.795	7829040.329	292.982	9785281.49	6793.0134	200181.8010	17:36:31	200701	610353	0	Gravity and GPS
Average Value:	468059.794	7829040.417	292.976	9785281.53							
Std Dev:	0.001	0.088	0.006	0.04							
Max Repeat Error:	0.003	0.176	0.012	0.08							
200181.0737	356022.280	7824964.889	273.459	9785337.82	6793.0134	200181.8005	11:57:43	180701	610353	0	Gravity and GPS
200181.0737	356022.304	7824964.627	273.509	9785337.79	6793.0134	200181.8005	13:26:10	180701	610353	0	Gravity and GPS
Average Value:	356022.292	7824964.758	273.484	9785337.81							
Std Dev:	0.012	0.131	0.025	0.02							
Max Repeat Error:	0.024	0.262	0.050	0.03							
200181.0877	348182.862	7821168.993	272.680	9785378.53	6793.0134	200181.8018	11:43:19	240701	403241	0	Gravity and GPS
200181.0877	348182.922	7821169.065	272.754	9785378.54	6793.0134	200181.8018	13:05:12	240701	403241	0	Gravity and GPS
Average Value:	348182.892	7821169.029	272.717	9785378.54							
Std Dev:	0.030	0.036	0.037	0.01							
Max Repeat Error:	0.060	0.072	0.074	0.01							

200181.0926	467978.992	7821038.778	298.358	9785354.88	6793.0134	200181.8008	14:12:04	200701	610353	0	Gravity and GPS
200181.0926	467979.048	7821038.666	298.348	9785354.88	6793.0134	200181.8008	08:02:23	260701	610353	0	Gravity and GPS
Average Value:	467979.020	7821038.722	298.353	9785354.88							
Std Dev:	0.028	0.056	0.005	0.00							
Max Repeat Error:	0.056	0.112	0.010	0.00							
200181.0927	471968.938	7821032.946	292.019	9785373.68	6793.0134	200181.8008	14:20:20	200701	610353	0	Gravity and GPS
200181.0927	471968.877	7821033.065	292.000	9785373.55	6793.0134	200181.8008	07:59:47	150701	610353	0	Gravity and GPS
Average Value:	471968.908	7821033.006	292.010	9785373.62							
Std Dev:	0.031	0.059	0.009	0.06							
Max Repeat Error:	0.061	0.119	0.019	0.13							
200181.0930	484026.698	7820994.603	280.160	9785356.28	6793.0134	200181.8008	08:14:23	150701	610353	0	Gravity and GPS
200181.0930	484026.728	7820993.930	280.246	9785356.50	6793.0134	200181.8008	09:24:21	150701	610353	0	Gravity and GPS
Average Value:	484026.713	7820994.267	280.203	9785356.39							
Std Dev:	0.015	0.336	0.043	0.11							
Max Repeat Error:	0.030	0.673	0.086	0.22							
200181.0933	496034.351	7821079.406	266.795	9785347.89	6793.0134	200181.8008	09:09:40	150701	610353	0	Gravity and GPS
200181.0933	496034.182	7821079.464	266.801	9785347.93	6793.0134	200181.8008	10:13:59	150701	610353	0	Gravity and GPS
Average Value:	496034.267	7821079.435	266.798	9785347.91							
Std Dev:	0.084	0.029	0.003	0.02							
Max Repeat Error:	0.169	0.058	0.006	0.04							
200181.1076	448132.363	7817001.616	343.347	9785266.14	6793.0134	200181.8009	12:21:17	130701	610353	0	Gravity and GPS
200181.1076	448131.502	7817001.351	343.412	9785265.75	6793.0134	200181.8008	17:04:17	130701	610353	0	Gravity and GPS
200181.1076	448132.090	7817001.575	343.370	9785265.73	6793.0134	200181.8008	13:29:47	200701	610353	0	Gravity and GPS
Average Value:	448131.985	7817001.514	343.376	9785265.87							
Std Dev:	0.359	0.116	0.027	0.19							
Max Repeat Error:	0.861	0.265	0.065	0.41							
200181.1082	472027.615	7817056.753	294.218	9785399.12	6793.0134	200181.8012	12:35:45	140701	610353	0	Gravity and GPS
200181.1082	472027.457	7817057.159	294.280	9785399.30	6793.0134	200181.8008	07:54:54	150701	610353	0	Gravity and GPS
Average Value:	472027.536	7817056.956	294.249	9785399.21							
Std Dev:	0.079	0.203	0.031	0.09							
Max Repeat Error:	0.158	0.406	0.062	0.18							
200181.1176	366037.905	7813080.620	282.839	9785527.65	6793.0134	200181.8005	14:56:13	240701	610353	0	Gravity and GPS
200181.1176	366037.787	7813080.618	282.860	9785528.07	6793.0134	200181.8005	08:12:17	250701	610353	0	Gravity and GPS
Average Value:	366037.846	7813080.619	282.850	9785527.86							
Std Dev:	0.059	0.001	0.011	0.21							
Max Repeat Error:	0.118	0.002	0.021	0.42							
200181.1253	369948.753	7811188.213	282.891	9785553.12	6793.0134	200181.8005	14:09:30	240701	610353	0	Gravity and GPS
200181.1253	369948.663	7811188.436	282.918	9785553.40	6793.0134	200181.8005	07:46:40	250701	610353	0	Gravity and GPS
200181.1253	369948.851	7811188.225	282.883	9785553.21	6793.0134	200181.8005	17:34:55	250701	610353	0	Gravity and GPS
Average Value:	369948.756	7811188.291	282.897	9785553.24							
Std Dev:	0.077	0.102	0.015	0.12							
Max Repeat Error:	0.188	0.223	0.035	0.28							

200181.1340	435996.986	7808983.185	353.974	9785277.28	6793.0134	200181.8009	10:23:19	130701	610353	0	Gravity and GPS
200181.1340	435996.800	7808983.011	354.005	9785277.43	6793.0134	200181.8009	11:22:37	130701	610353	0	Gravity and GPS
Average Value:	435996.893	7808983.098	353.990	9785277.36							
Std Dev:	0.093	0.087	0.015	0.08							
Max Repeat Error:	0.186	0.174	0.031	0.15							
200181.1465	423986.697	7805057.706	356.230	9785351.19	6793.0134	200181.8001	08:16:14	130701	610353	0	Gravity and GPS
200181.1465	423986.617	7805057.392	356.152	9785351.33	6793.0134	200181.8009	09:05:27	130701	610353	0	Gravity and GPS
Average Value:	423986.657	7805057.549	356.191	9785351.26							
Std Dev:	0.040	0.157	0.039	0.07							
Max Repeat Error:	0.080	0.314	0.078	0.14							
200181.1466	427985.673	7805035.217	374.043	9785278.02	6793.0134	200181.8009	09:10:30	130701	610353	0	Gravity and GPS
200181.1466	427985.698	7805035.382	374.022	9785277.97	6793.0134	200181.8009	09:58:19	130701	610353	0	Gravity and GPS
Average Value:	427985.686	7805035.300	374.033	9785278.00							
Std Dev:	0.013	0.082	0.011	0.02							
Max Repeat Error:	0.025	0.165	0.021	0.05							
200181.1477	471946.686	7804973.700	308.651	9785349.10	6793.0134	200181.8008	08:33:33	140701	610353	0	Gravity and GPS
200181.1477	471946.712	7804973.563	308.574	9785349.05	6793.0134	200181.8012	12:21:34	140701	610353	0	Gravity and GPS
Average Value:	471946.699	7804973.632	308.613	9785349.08							
Std Dev:	0.013	0.068	0.038	0.02							
Max Repeat Error:	0.026	0.137	0.077	0.05							
200181.1481	488020.379	7804924.252	282.235	9785481.90	6793.0134	200181.8012	14:26:19	140701	610353	0	Gravity and GPS
200181.1481	488020.153	7804924.514	282.174	9785481.99	6793.0134	200181.8008	08:38:59	260701	610353	0	Gravity and GPS
Average Value:	488020.266	7804924.383	282.205	9785481.95							
Std Dev:	0.113	0.131	0.031	0.04							
Max Repeat Error:	0.226	0.262	0.061	0.09							
200181.1482	492006.540	7804972.958	276.578	9785467.18	6793.0134	200181.8012	14:33:07	140701	610353	0	Gravity and GPS
200181.1482	492006.471	7804973.057	276.625	9785467.16	6793.0134	200181.8012	15:44:11	140701	610353	0	Gravity and GPS
Average Value:	492006.506	7804973.008	276.602	9785467.17							
Std Dev:	0.034	0.049	0.023	0.01							
Max Repeat Error:	0.069	0.099	0.047	0.02							
200181.1563	343983.219	7800990.400	287.762	9785424.11	6793.0134	200181.8018	09:34:33	250701	610353	0	Gravity and GPS
200181.1563	343983.327	7800990.606	287.729	9785423.75	6793.0134	200181.8018	16:01:21	250701	610353	0	Gravity and GPS
Average Value:	343983.273	7800990.503	287.746	9785423.93							
Std Dev:	0.054	0.103	0.017	0.18							
Max Repeat Error:	0.108	0.206	0.033	0.36							
200181.1576	369860.881	7800942.922	290.263	9785524.60	6793.0134	200181.8007	10:25:51	240701	610353	0	Gravity and GPS
200181.1576	369860.927	7800942.955	290.291	9785524.69	6793.0134	200181.8005	13:46:42	240701	610353	0	Gravity and GPS
Average Value:	369860.904	7800942.939	290.277	9785524.65							
Std Dev:	0.023	0.017	0.014	0.04							
Max Repeat Error:	0.046	0.033	0.028	0.09							
200181.1578	374034.281	7801135.304	289.670	9785537.64	6793.0134	200181.8007	10:22:54	190701	610353	0	Gravity and GPS
200181.1578	374034.329	7801135.415	289.616	9785537.54	6793.0134	200181.8007	10:17:34	240701	610353	0	Gravity and GPS
Average Value:	374034.305	7801135.360	289.643	9785537.59							
Std Dev:	0.024	0.055	0.027	0.05							
Max Repeat Error:	0.048	0.111	0.054	0.10							

200181.1602	448049.970	7800988.931	362.676	9785285.76	6793.0134	200181.8009	11:58:25	130701	610353	0	Gravity and GPS
200181.1602	448049.916	7800988.991	362.666	9785285.55	6793.0134	200181.8009	13:34:24	130701	610353	0	Gravity and GPS
Average Value:	448049.943	7800988.961	362.671	9785285.66							
Std Dev:	0.027	0.030	0.005	0.10							
Max Repeat Error:	0.054	0.060	0.010	0.21							
200181.1603	452027.370	7801010.673	361.948	9785293.61	6793.0134	200181.8009	13:27:52	130701	610353	0	Gravity and GPS
200181.1603	452027.552	7801010.667	361.986	9785293.70	6793.0134	200181.8009	14:36:35	130701	610353	0	Gravity and GPS
Average Value:	452027.461	7801010.670	361.967	9785293.66							
Std Dev:	0.091	0.003	0.019	0.04							
Max Repeat Error:	0.182	0.006	0.038	0.09							
200181.1605	460014.913	7801054.568	321.293	9785363.92	6793.0134	200181.8009	15:22:45	130701	610353	0	Gravity and GPS
200181.1605	460015.192	7801054.478	321.251	9785363.97	6793.0134	200181.8008	16:11:02	130701	610353	0	Gravity and GPS
Average Value:	460015.053	7801054.523	321.272	9785363.95							
Std Dev:	0.140	0.045	0.021	0.03							
Max Repeat Error:	0.279	0.090	0.042	0.05							
200181.1606	463907.195	7801042.468	318.456	9785398.54	6793.0134	200181.8008	16:18:24	130701	610353	0	Gravity and GPS
200181.1606	463907.412	7801042.451	318.441	9785398.68	6793.0134	200181.8012	12:01:55	140701	610353	0	Gravity and GPS
Average Value:	463907.304	7801042.460	318.449	9785398.61							
Std Dev:	0.108	0.009	0.008	0.07							
Max Repeat Error:	0.217	0.017	0.015	0.14							
200181.1610	480053.055	7800978.876	330.366	9785446.36	6793.0134	200181.8008	08:52:29	140701	610353	0	Gravity and GPS
200181.1610	480052.920	7800978.919	330.342	9785446.19	6793.0134	200181.8012	17:52:01	140701	610353	0	Gravity and GPS
Average Value:	480052.988	7800978.898	330.354	9785446.28							
Std Dev:	0.068	0.022	0.012	0.09							
Max Repeat Error:	0.135	0.043	0.024	0.17							
200181.1618	328030.828	7798997.144	292.887	9785365.20	6793.0134	200181.8018	10:17:08	250701	610353	0	Gravity and GPS
200181.1618	328030.706	7798997.228	292.904	9785365.18	6793.0134	200181.8018	11:55:59	250701	610353	0	Gravity and GPS
Average Value:	328030.767	7798997.186	292.896	9785365.19							
Std Dev:	0.061	0.042	0.008	0.01							
Max Repeat Error:	0.122	0.084	0.017	0.02							
200181.1624	340025.213	7798992.985	292.222	9785447.54	6793.0134	200181.8018	09:46:54	250701	610353	0	Gravity and GPS
200181.1624	340024.763	7798992.827	292.145	9785447.48	6793.0134	200181.8018	10:44:09	250701	610353	0	Gravity and GPS
Average Value:	340024.988	7798992.906	292.184	9785447.51							
Std Dev:	0.225	0.079	0.038	0.03							
Max Repeat Error:	0.450	0.158	0.077	0.06							
200181.1636	364040.206	7798986.657	289.397	9785485.24	6793.0134	200181.8005	17:02:31	250701	610353	0	Gravity and GPS
200181.1636	364040.173	7798986.768	289.381	9785484.85	6793.0134	200181.8005	15:51:23	240701	610353	0	Gravity and GPS
Average Value:	364040.190	7798986.713	289.389	9785485.05							
Std Dev:	0.016	0.056	0.008	0.20							
Max Repeat Error:	0.033	0.111	0.016	0.39							
200181.1637	366024.415	7799040.143	288.612	9785493.05	6793.0134	200181.8007	13:34:14	240701	610353	0	Gravity and GPS
200181.1637	366024.536	7799040.369	288.628	9785493.28	6793.0134	200181.8005	15:41:01	240701	610353	0	Gravity and GPS
Average Value:	366024.476	7799040.256	288.620	9785493.17							
Std Dev:	0.060	0.113	0.008	0.11							
Max Repeat Error:	0.121	0.226	0.016	0.23							

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200181.1643	378016.721	7798976.780	291.071	9785560.80	6793.0134	200181.8007	10:09:01	190701	610353	0	Gravity and GPS
200181.1643	378016.559	7798976.547	291.081	9785560.90	6793.0134	200181.8007	11:02:42	190701	610353	0	Gravity and GPS
Average Value:	378016.640	7798976.664	291.076	9785560.85							
Std Dev:	0.081	0.117	0.005	0.05							
Max Repeat Error:	0.162	0.233	0.010	0.10							
200181.1646	383987.666	7798982.191	292.152	9785542.42	6793.0134	200181.8007	08:39:21	190701	610353	0	Gravity and GPS
200181.1646	383987.692	7798982.131	292.115	9785542.50	6793.0134	200181.8007	09:46:04	190701	610353	0	Gravity and GPS
Average Value:	383987.679	7798982.161	292.134	9785542.46							
Std Dev:	0.013	0.030	0.019	0.04							
Max Repeat Error:	0.026	0.060	0.037	0.08							
200181.1650	391883.278	7798964.309	315.023	9785495.01	6793.0134	200181.8001	08:15:44	190701	610353	0	Gravity and GPS
200181.1650	391883.289	7798964.298	314.993	9785494.84	6793.0134	200181.8007	08:54:56	190701	610353	0	Gravity and GPS
Average Value:	391883.284	7798964.304	315.008	9785494.93							
Std Dev:	0.006	0.006	0.015	0.09							
Max Repeat Error:	0.011	0.011	0.030	0.17							
200181.1689	399994.686	7796985.886	341.507	9785426.50	6793.0134	200181.8007	15:21:48	190701	610353	0	Gravity and GPS
200181.1689	399994.508	7796986.255	341.438	9785426.62	6793.0134	200181.9001	16:13:24	190701	610353	0	Gravity and GPS
Average Value:	399994.597	7796986.071	341.473	9785426.56							
Std Dev:	0.089	0.185	0.035	0.06							
Max Repeat Error:	0.178	0.369	0.069	0.12							
200181.1709	479963.607	7796981.839	311.600	9785542.04	6793.0134	200181.8012	09:00:31	140701	610353	0	Gravity and GPS
200181.1709	479963.502	7796981.687	311.603	9785542.13	6793.0134	200181.8012	09:51:14	140701	610353	0	Gravity and GPS
Average Value:	479963.555	7796981.763	311.602	9785542.09							
Std Dev:	0.052	0.076	0.001	0.05							
Max Repeat Error:	0.105	0.152	0.003	0.09							
200181.1718	330060.715	7794980.645	300.487	9785406.37	6793.0134	200181.8018	11:38:14	250701	610353	0	Gravity and GPS
200181.1718	330060.819	7794980.101	300.518	9785406.33	6793.0134	200181.8018	13:00:57	250701	610353	0	Gravity and GPS
Average Value:	330060.767	7794980.373	300.503	9785406.35							
Std Dev:	0.052	0.272	0.015	0.02							
Max Repeat Error:	0.104	0.544	0.031	0.04							
200181.1724	342006.575	7795085.146	293.209	9785463.75	6793.0134	200181.8018	10:57:32	250701	610353	0	Gravity and GPS
200181.1724	342006.539	7795084.981	293.285	9785463.71	6793.0134	200181.8018	15:38:03	250701	610353	0	Gravity and GPS
Average Value:	342006.557	7795085.064	293.247	9785463.73							
Std Dev:	0.018	0.083	0.038	0.02							
Max Repeat Error:	0.036	0.165	0.076	0.04							
200181.1725	343998.844	7795056.221	292.130	9785479.59	6793.0134	200181.8018	15:43:02	250701	610353	0	Gravity and GPS
200181.1725	343998.608	7795055.980	292.094	9785479.72	200181.8021	200181.8007	10:16:01	290701	610353	0	Gravity and GPS
Average Value:	343998.726	7795056.101	292.112	9785479.66							
Std Dev:	0.118	0.121	0.018	0.07							
Max Repeat Error:	0.236	0.241	0.036	0.13							

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200181.1846	392026.556	7790962.279	321.423	9785497.27	6793.0134	200181.8007	12:12:23	190701	610353	0	Gravity and GPS
200181.1846	392026.514	7790962.139	321.349	9785497.12	6793.0134	200181.8007	14:50:19	190701	610353	0	Gravity and GPS
Average Value:	392026.535	7790962.209	321.386	9785497.20							
Std Dev:	0.021	0.070	0.037	0.08							
Max Repeat Error:	0.042	0.140	0.074	0.15							
200181.1860	347995.098	7789017.894	295.921	9785475.79	200181.8021	200181.8007	11:01:12	290701	610353	0	Gravity and GPS
200181.1860	347994.967	7789017.717	295.956	9785475.66	200181.8021	200181.8007	15:32:21	290701	610353	0	Gravity and GPS
Average Value:	347995.033	7789017.806	295.939	9785475.73							
Std Dev:	0.066	0.088	0.018	0.06							
Max Repeat Error:	0.131	0.177	0.035	0.13							
200181.1864	356036.722	7789022.063	294.806	9785527.66	6793.0134	200181.8007	12:46:21	240701	610353	0	Gravity and GPS
200181.1864	356036.197	7789021.716	294.843	9785527.28	200181.8021	200181.8007	13:35:04	290701	610353	0	Gravity and GPS
Average Value:	356036.460	7789021.890	294.825	9785527.47							
Std Dev:	0.262	0.174	0.019	0.19							
Max Repeat Error:	0.525	0.347	0.037	0.38							
200181.1870	368011.412	7789044.339	294.061	9785541.87	6793.0134	200181.8007	12:19:30	240701	610353	0	Gravity and GPS
200181.1870	368011.031	7789044.983	294.070	9785541.56	200181.8021	200181.8007	13:07:17	290701	610353	0	Gravity and GPS
Average Value:	368011.222	7789044.661	294.066	9785541.72							
Std Dev:	0.190	0.322	0.004	0.15							
Max Repeat Error:	0.381	0.644	0.009	0.31							
200181.1885	420075.374	7789072.433	358.796	9785422.87	6793.0134	200181.8009	08:41:17	130701	610353	0	Gravity and GPS
200181.1885	420075.175	7789072.623	358.764	9785422.90	200181.8021	200181.9001	09:13:00	300701	610353	0	Gravity and GPS
Average Value:	420075.275	7789072.528	358.780	9785422.89							
Std Dev:	0.099	0.095	0.016	0.02							
Max Repeat Error:	0.199	0.190	0.032	0.03							
200181.1945	352016.520	7781054.691	302.788	9785460.30	200181.8021	200181.8007	09:31:09	290701	610353	0	Gravity and GPS
200181.1945	352016.400	7781054.638	302.844	9785460.12	200181.8021	200181.8007	11:12:02	290701	610353	0	Gravity and GPS
Average Value:	352016.460	7781054.665	302.816	9785460.21							
Std Dev:	0.060	0.027	0.028	0.09							
Max Repeat Error:	0.120	0.053	0.056	0.18							
200181.1947	360001.413	7781028.123	300.068	9785545.23	200181.8021	200181.8007	11:22:01	290701	610353	0	Gravity and GPS
200181.1947	360001.440	7781028.132	300.084	9785545.11	200181.8021	200181.8007	16:02:25	290701	610353	0	Gravity and GPS
Average Value:	360001.427	7781028.128	300.076	9785545.17							
Std Dev:	0.014	0.005	0.008	0.06							
Max Repeat Error:	0.027	0.009	0.016	0.12							
200181.1956	416013.717	7781016.002	370.653	9785422.20	200181.8021	200181.9001	09:30:43	300701	610353	0	Gravity and GPS
200181.1956	416013.734	7781015.780	370.630	9785422.29	200181.8021	200181.9001	10:10:27	300701	610353	0	Gravity and GPS
Average Value:	416013.726	7781015.891	370.642	9785422.25							
Std Dev:	0.009	0.111	0.012	0.05							
Max Repeat Error:	0.017	0.222	0.023	0.09							
200181.1972	479963.668	7780988.662	350.380	9785445.10	6793.0134	200181.8012	09:31:48	140701	610353	0	Gravity and GPS
200181.1972	479963.679	7780988.621	350.396	9785445.02	6793.0134	200181.8012	10:32:16	140701	610353	0	Gravity and GPS
Average Value:	479963.674	7780988.642	350.388	9785445.06							
Std Dev:	0.006	0.021	0.008	0.04							
Max Repeat Error:	0.011	0.041	0.016	0.08							

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200181.2006	487998.607	7777002.926	335.536	9785525.15	6793.0134	200181.8019	09:29:49	260701	610353	0	Gravity and GPS
200181.2006	487998.838	7777003.094	335.609	9785525.12	6793.0134	200181.8019	10:49:06	260701	610353	0	Gravity and GPS
Average Value:	487998.723	7777003.010	335.573	9785525.14							
Std Dev:	0.115	0.084	0.036	0.02							
Max Repeat Error:	0.231	0.168	0.073	0.03							
200181.2024	444010.956	7772951.684	396.322	9785417.31	200181.8021	200181.9003	10:40:08	280701	610353	0	Gravity and GPS
200181.2024	444010.586	7772951.642	396.275	9785417.15	200181.8021	200181.8019	14:28:53	280701	610353	0	Gravity and GPS
Average Value:	444010.771	7772951.663	396.299	9785417.23							
Std Dev:	0.185	0.021	0.023	0.08							
Max Repeat Error:	0.370	0.042	0.047	0.16							
200181.2033	479994.691	7773018.491	368.425	9785386.38	6793.0134	200181.8019	11:01:44	260701	610353	0	Gravity and GPS
200181.2033	479994.446	7773018.267	368.483	9785386.40	6793.0134	200181.8012	10:42:33	140701	610353	0	Gravity and GPS
Average Value:	479994.569	7773018.379	368.454	9785386.39							
Std Dev:	0.123	0.112	0.029	0.01							
Max Repeat Error:	0.245	0.224	0.058	0.02							
200181.2046	427995.695	7768907.484	399.766	9785478.53	200181.8021	200181.8019	16:41:07	280701	610353	0	Gravity and GPS
200181.2046	427995.546	7768907.019	399.734	9785478.19	200181.8021	200181.9001	08:38:09	300701	610353	0	Gravity and GPS
Average Value:	427995.621	7768907.252	399.750	9785478.36							
Std Dev:	0.075	0.232	0.016	0.17							
Max Repeat Error:	0.149	0.465	0.032	0.34							
200181.2047	432048.599	7768977.003	512.662	9785256.25	200181.8021	200181.8019	15:53:00	280701	610353	0	Gravity and GPS
200181.2047	432048.340	7768977.112	512.686	9785256.48	200181.8021	200181.8019	16:47:32	280701	610353	0	Gravity and GPS
Average Value:	432048.470	7768977.058	512.674	9785256.37							
Std Dev:	0.130	0.054	0.012	0.12							
Max Repeat Error:	0.259	0.109	0.024	0.23							
200181.2048	436134.935	7769264.369	520.449	9785230.17	200181.8021	200181.8019	14:13:29	280701	610353	0	Gravity and GPS
200181.2048	436135.076	7769264.272	520.437	9785230.58	200181.8021	200181.8019	15:47:49	280701	610353	0	Gravity and GPS
Average Value:	436135.006	7769264.321	520.443	9785230.38							
Std Dev:	0.070	0.048	0.006	0.21							
Max Repeat Error:	0.141	0.097	0.012	0.41							
200181.2055	463970.115	7769047.825	389.045	9785410.53	200181.8021	200181.9003	16:35:15	270701	610353	0	Gravity and GPS
200181.2055	463969.941	7769047.757	389.051	9785410.70	200181.8021	200181.9003	10:11:19	280701	610353	0	Gravity and GPS
Average Value:	463970.028	7769047.791	389.048	9785410.62							
Std Dev:	0.087	0.034	0.003	0.08							
Max Repeat Error:	0.174	0.068	0.006	0.17							
200181.2057	472013.157	7768969.775	374.361	9785366.11	200181.8021	200181.9003	16:24:58	270701	610353	0	Gravity and GPS
200181.2057	472013.256	7768969.706	374.312	9785365.96	6793.0134	200181.8019	11:21:36	260701	610353	0	Gravity and GPS
Average Value:	472013.207	7768969.741	374.337	9785366.04							
Std Dev:	0.049	0.034	0.025	0.07							
Max Repeat Error:	0.099	0.069	0.049	0.15							

200181.2066	379958.876	7764992.908	311.562	9785626.01	200181.8021	200181.8007	08:46:32	290701	610353	0	Gravity and GPS
200181.2066	379959.119	7764993.412	311.523	9785625.93	200181.8021	200181.9002	16:54:25	290701	610353	0	Gravity and GPS
Average Value:	379958.998	7764993.160	311.543	9785625.97							
Std Dev:	0.121	0.252	0.020	0.04							
Max Repeat Error:	0.243	0.504	0.039	0.08							
200181.2069	420031.306	7765023.829	373.803	9785476.84	200181.8021	200181.9002	08:21:33	300701	610353	0	Gravity and GPS
200181.2069	420031.336	7765024.035	373.769	9785476.71	200181.8021	200181.9001	11:36:33	300701	610353	0	Gravity and GPS
Average Value:	420031.321	7765023.932	373.786	9785476.78							
Std Dev:	0.015	0.103	0.017	0.06							
Max Repeat Error:	0.030	0.206	0.034	0.13							
200181.2098	411988.231	7760984.830	349.455	9785605.15	200181.8021	200181.9001	11:54:31	300701	610353	0	Gravity and GPS
200181.2098	411988.029	7760984.670	349.425	9785604.94	200181.8021	200181.9002	13:11:41	300701	610353	0	Gravity and GPS
Average Value:	411988.130	7760984.750	349.440	9785605.05							
Std Dev:	0.101	0.080	0.015	0.11							
Max Repeat Error:	0.202	0.160	0.030	0.21							
200181.2117	488032.269	7761027.614	341.174	9785491.44	200181.8021	200181.8020	11:25:41	270701	610353	0	Gravity and GPS
200181.2117	488032.190	7761027.829	341.139	9785491.59	200181.8021	200181.9003	14:18:39	270701	610353	0	Gravity and GPS
Average Value:	488032.230	7761027.722	341.157	9785491.52							
Std Dev:	0.039	0.108	0.017	0.08							
Max Repeat Error:	0.079	0.215	0.035	0.15							
200181.2124	395988.866	7757012.784	323.389	9785671.73	200181.8021	200181.9002	17:25:06	290701	610353	0	Gravity and GPS
200181.2124	395988.750	7757012.912	323.438	9785671.93	200181.8021	200181.9002	12:25:29	300701	610353	0	Gravity and GPS
Average Value:	395988.808	7757012.848	323.414	9785671.83							
Std Dev:	0.058	0.064	0.024	0.10							
Max Repeat Error:	0.116	0.128	0.049	0.20							
200181.2137	448013.176	7757022.844	433.595	9785421.23	200181.8021	200181.9003	08:21:30	280701	610353	0	Gravity and GPS
200181.2137	448013.177	7757023.013	433.566	9785421.40	200181.8021	200181.9003	11:23:55	280701	610353	0	Gravity and GPS
Average Value:	448013.177	7757022.929	433.581	9785421.32							
Std Dev:	0.001	0.085	0.015	0.08							
Max Repeat Error:	0.001	0.169	0.029	0.17							
200181.2140	459905.389	7756957.569	405.302	9785355.70	200181.8021	200181.9003	16:56:30	270701	610353	0	Gravity and GPS
200181.2140	459905.346	7756957.802	405.279	9785356.04	200181.8021	200181.9003	09:27:53	280701	610353	0	Gravity and GPS
Average Value:	459905.368	7756957.686	405.291	9785355.87							
Std Dev:	0.022	0.117	0.012	0.17							
Max Repeat Error:	0.043	0.233	0.023	0.34							
200181.2153	395995.306	7752950.025	325.555	9785655.05	200181.8021	200181.9002	08:16:52	290701	610353	0	Gravity and GPS
200181.2153	395996.127	7752950.085	325.466	9785654.89	200181.8021	200181.9002	17:30:41	290701	610353	0	Gravity and GPS
Average Value:	395995.717	7752950.055	325.511	9785654.97							
Std Dev:	0.410	0.030	0.045	0.08							
Max Repeat Error:	0.821	0.060	0.089	0.16							
200181.2164	439958.594	7752954.644	394.412	9785539.74	200181.8021	200181.9003	11:39:55	280701	610353	0	Gravity and GPS
200181.2164	439958.244	7752954.724	394.458	9785539.54	200181.8021	200181.9002	13:37:52	280701	610353	0	Gravity and GPS
Average Value:	439958.419	7752954.684	394.435	9785539.64							
Std Dev:	0.175	0.040	0.023	0.10							
Max Repeat Error:	0.350	0.080	0.046	0.20							

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200181.2178	495936.117	7752974.851	328.620	9785522.50	200181.8021	200181.8020	10:25:41	270701	610353	0	Gravity and GPS
200181.2178	495936.178	7752974.878	328.692	9785522.40	200181.8021	200181.8020	11:46:10	270701	610353	0	Gravity and GPS
Average Value:	495936.148	7752974.865	328.656	9785522.45							
Std Dev:	0.031	0.014	0.036	0.05							
Max Repeat Error:	0.061	0.027	0.072	0.10							
200181.2199	472010.084	7748967.653	370.873	9785518.01	200181.8021	200181.9003	13:22:53	270701	610353	1	Gravity and GPS
200181.2199	472010.129	7748967.644	370.841	9785518.54	200181.8021	200181.9003	15:18:00	270701	610353	1	Gravity and GPS
Average Value:	472010.107	7748967.649	370.857	9785518.28							
Std Dev:	0.023	0.004	0.016	0.26							
Max Repeat Error:	0.045	0.009	0.032	0.53							
200181.2236	416138.771	7741031.147	353.337	9785622.26	200181.8021	200181.9002	07:22:54	290701	610353	0	Gravity and GPS
200181.2236	416138.967	7741030.721	353.352	9785622.22	200181.8021	200181.9002	14:30:04	300701	610353	0	Gravity and GPS
Average Value:	416138.869	7741030.934	353.345	9785622.24							
Std Dev:	0.098	0.213	0.007	0.02							
Max Repeat Error:	0.196	0.426	0.015	0.04							
200181.2251	476015.633	7741004.924	370.399	9785623.71	200181.8021	200181.8020	09:24:35	270701	610353	0	Gravity and GPS
200181.2251	476015.473	7741004.720	370.336	9785623.58	200181.8021	200181.8020	12:22:59	270701	610353	0	Gravity and GPS
Average Value:	476015.553	7741004.822	370.368	9785623.65							
Std Dev:	0.080	0.102	0.031	0.07							
Max Repeat Error:	0.160	0.204	0.063	0.13							
200181.2263	427983.425	7736998.321	389.459	9785495.68	200181.8021	200181.9002	17:42:43	280701	610353	0	Gravity and GPS
200181.2263	427983.337	7736998.496	389.483	9785495.49	200181.8021	200181.9002	07:37:30	300701	610353	0	Gravity and GPS
Average Value:	427983.381	7736998.409	389.471	9785495.59							
Std Dev:	0.044	0.087	0.012	0.09							
Max Repeat Error:	0.088	0.175	0.024	0.19							
200181.2264	432005.548	7737047.979	410.738	9785480.64	200181.8021	200181.9002	13:08:36	280701	610353	0	Gravity and GPS
200181.2264	432005.671	7737048.186	410.656	9785480.81	200181.8021	200181.9002	17:48:05	280701	610353	0	Gravity and GPS
Average Value:	432005.610	7737048.083	410.697	9785480.73							
Std Dev:	0.062	0.103	0.041	0.08							
Max Repeat Error:	0.123	0.207	0.082	0.17							
200181.2265	435941.065	7737044.632	384.873	9785541.11	200181.8021	200181.9002	07:27:12	280701	610353	0	Gravity and GPS
200181.2265	435941.104	7737044.455	384.926	9785541.34	200181.8021	200181.9003	12:28:10	280701	610353	0	Gravity and GPS
Average Value:	435941.085	7737044.544	384.900	9785541.23							
Std Dev:	0.019	0.088	0.026	0.12							
Max Repeat Error:	0.039	0.177	0.053	0.23							
200181.2275	475922.717	7736985.000	380.669	9785684.30	200181.8021	200181.9003	08:11:16	270701	610353	0	Gravity and GPS
200181.2275	475922.604	7736984.991	380.639	9785684.36	200181.8021	200181.8020	09:20:39	270701	610353	0	Gravity and GPS
Average Value:	475922.661	7736984.996	380.654	9785684.33							
Std Dev:	0.057	0.004	0.015	0.03							
Max Repeat Error:	0.113	0.009	0.030	0.06							

Repeat Station Listing
Tennant Inlier NT Gravity Survey

200181.2281	500014.707	7737047.791	337.507	9785594.53	200181.8021	200181.9003	08:52:36	270701	610353	0	Gravity and GPS
200181.2281	500014.321	7737047.728	337.462	9785594.79	200181.8021	200181.8020	09:57:25	270701	610353	0	Gravity and GPS
Average Value:	500014.514	7737047.760	337.485	9785594.66							
Std Dev:	0.193	0.031	0.022	0.13							
Max Repeat Error:	0.386	0.063	0.045	0.26							
200181.2289	443975.640	7732967.555	405.515	9785553.55	200181.8021	200181.9002	07:43:30	280701	610353	0	Gravity and GPS
200181.2289	443975.341	7732967.850	405.496	9785554.03	200181.8021	200181.9002	07:22:21	270701	610353	0	Gravity and GPS
Average Value:	443975.491	7732967.703	405.506	9785553.79							
Std Dev:	0.150	0.147	0.010	0.24							
Max Repeat Error:	0.299	0.295	0.019	0.48							

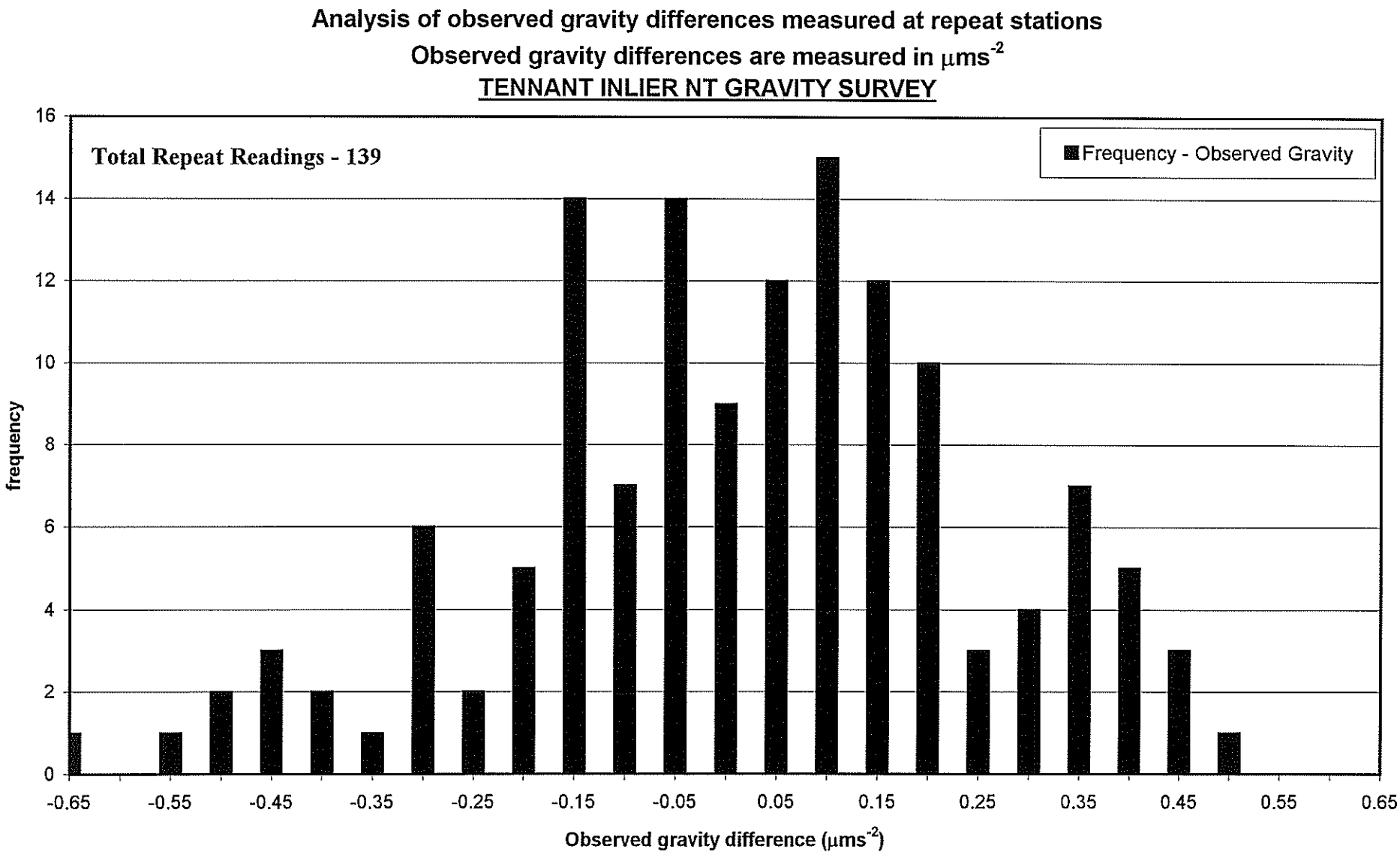
Maximum Repeat Errors:

Easting Data (m):	1.270
Northing Data (m):	6.301
Elevation Data (m):	0.100
Observed Gravity Data:	0.650

Maximum Standard Deviations:

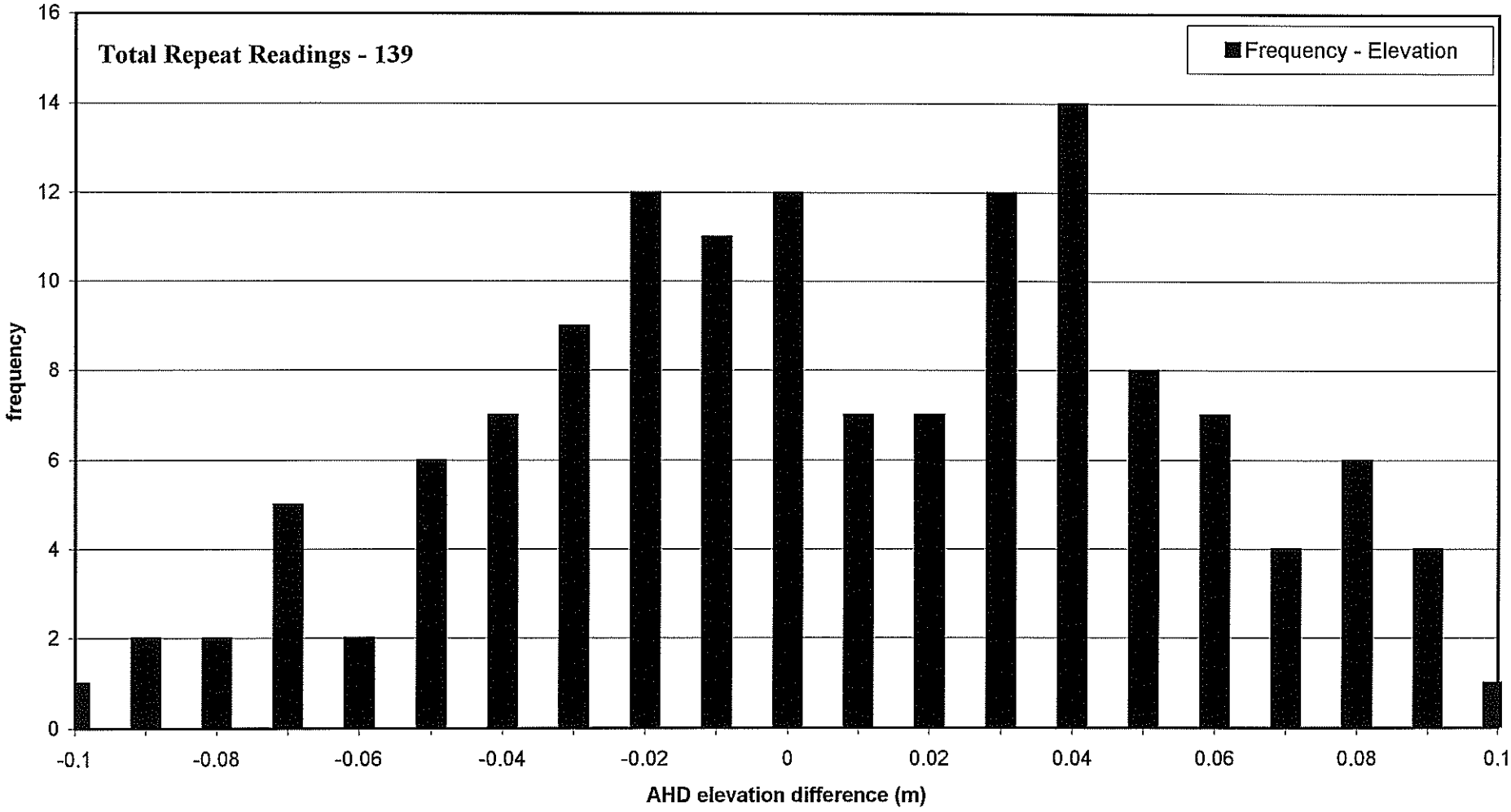
Easting Data (m):	0.635
Northing Data (m):	3.150
Elevation Data (m):	0.050
Observed Gravity Data:	0.325

Total number of input readings:	1744
Total number of new readings:	1605
Total number of repeat stations:	135
Total number of repeat readings:	139
Total number of Gravity only repeat readings:	0
Total number of Gravity and GPS repeat readings:	139
Percentage repeated stations:	08.66%
Number of readings outside precision limits:	5



Observed gravity repeat station differences
TENNANT INLIER NT GRAVITY SURVEY

Analysis of AHD elevation differences measured at repeat stations
Elevation differences are measured in metres
TENNANT INLIER NT GRAVITY SURVEY



AHD elevation repeat station differences
TENNANT INLIER NT GRAVITY SURVEY