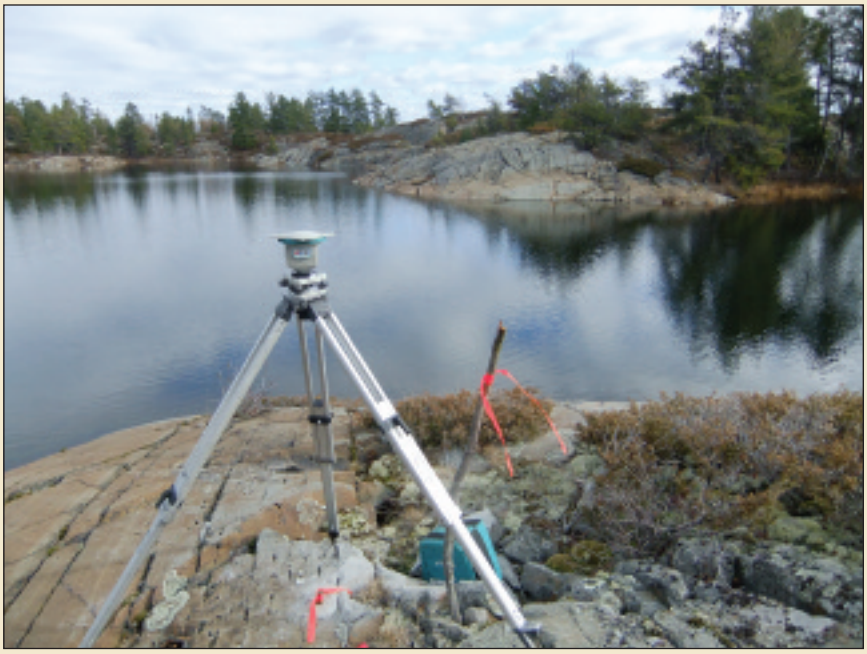
Integrated Surveys – Northern Ontario Perspective

By Bob Halliday, O.L.S., O.L.I.P., C.L.S.

The following article was developed from a presentation at the Geomatics Picnic in September 2011

Blain Martin asked me to talk about how we achieve integrated surveys in Northern Ontario and to help illustrate the varied methods that surveyors are using across this vast province to meet the new regulatory requirements. Since I don't practise in the built-up areas of Southern Ontario, and I haven't done any work south of Parry Sound for 32 years, I don't have a full picture of how surveyors in these regions operate under normal circumstances. From talking to surveyors in the south, I gather that network RTK is in regular use, with UTM co-ordinates readily available through one of the service providers. I also understand that canyons exist in the bigger cities where no GPS signal is available due to the number of tall buildings which block out reliable GPS signals. Except for the Sudbury – Parry Sound – Huntsville area, the network GPS option isn't available in the north. Outside of this area, there isn't sufficient demand and cell coverage is spotty and in many places non-existent. On the other hand, the physical obstructions to satellite signals are mostly trees for us, and they can be dealt with using chain-saws. Bringing in co-ordinates from existing control is often a problem, as well, because in many areas much of the control is old or has been destroyed.



GPS works well in the wilderness

When I opened my business in 2004, one of my planned expenses was the purchase of three single frequency GPS receivers. Within six months I purchased two more, because I found I couldn't be competitive without them, despite the up-front cost. When retracing existing survey fabric for bush lots, we often need to make connections to survey bars we know are in place, but might be five to eight km apart, and using GPS is the only practical way to do so.

In Espanola where my office is located, there was an Ontario Base Mapping (OBM) project done in the early 1980's. Of the 10 or so benchmarks, 2 that are in building walls and 1 in a vertical rock face beside the highway are all that remain. Very few of the horizontal control points (HCPs) remain, and those that still exist are in poor locations for use by GPS.

Along the Highway 6 corridor between Espanola and Little Current (approximately 50km), most of the control is still in place. Unfortunately, it seems that the control was established in two different traverses, (there are two different years associated with these HCP's). Although I'm sure both went through some sort of least squares adjustment, I don't think the data from both networks was included in a common adjustment of all points. When stations from the different traverses are occupied at the same time, the relative positions differ by about 10cm, whereas if we observe points from within the same network, we consistently get good results. I don't like the idea of holding inconsistent points fixed and forcing the difference into my work, since the stand-alone results are much better than that.

Six years ago, a government client started issuing contracts on First Nations' lands with the requirement that the plans be fully geo-referenced, and in NAD83-CSRS. I quickly decided that since I wanted to participate in some of this work I would need to be able to comply. I also had the experience of doing some work for this same client the previous year. We wasted a lot of time because nearly all of the control in Blind River had been destroyed by highway reconstruction. We ended up spending a day looking for points that no longer existed.

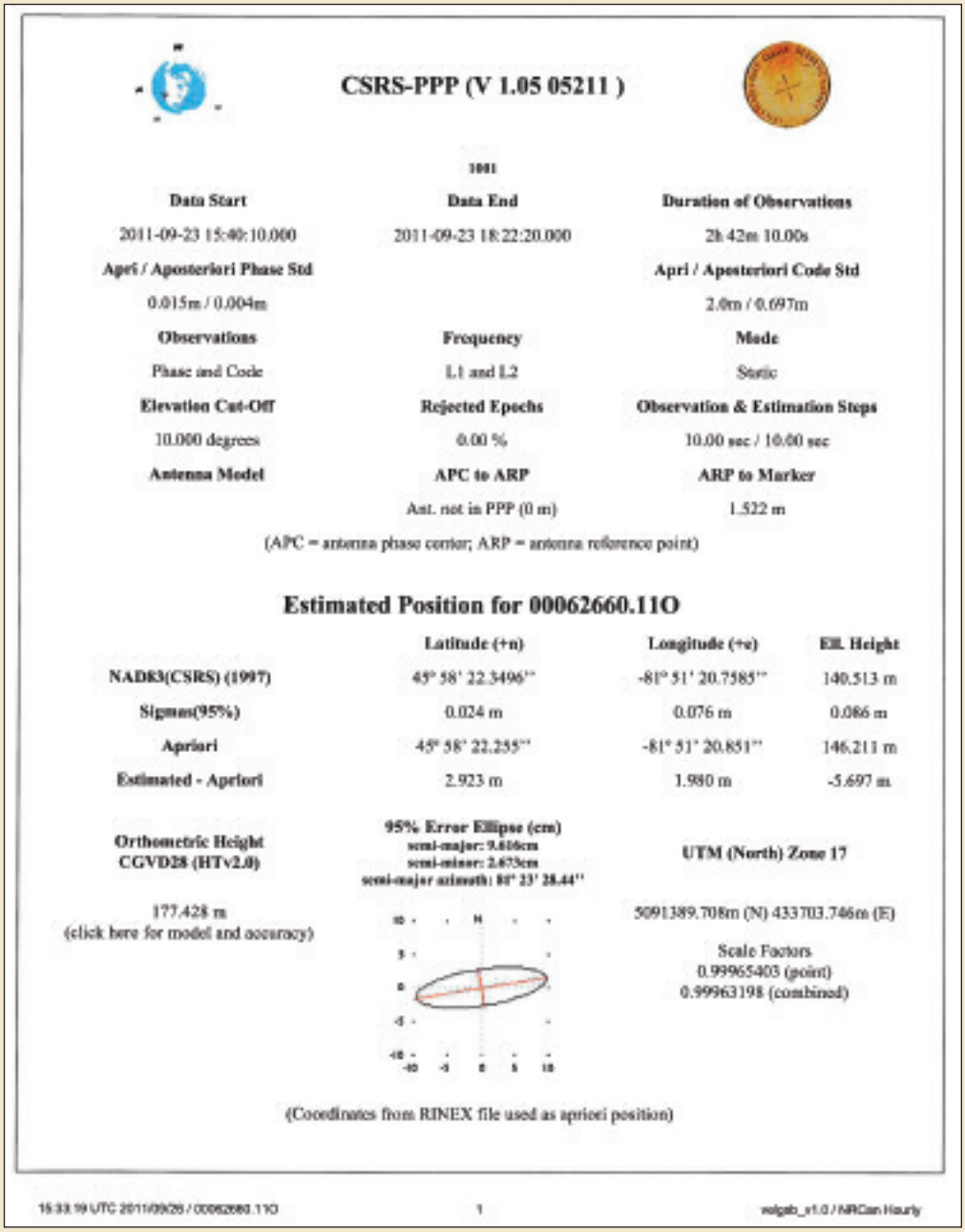
I made some inquiries about the Precise Point Positioning (PPP) Service which I had heard about at the AOLS AGM. I found out what I needed and bought a dual frequency

receiver from Sokkia. With a three hour observation session we normally get statistical values of 5 to 10cm absolute accuracy at the 95% confidence level. Our normal procedure when we are starting a survey in an area where we haven't already got a network is to include one dual frequency observation in a session which also includes a few single frequency receivers, to establish a local network. On another day a second dual frequency session is usually observed, strictly as verification. We could weight the PPP results differently in a least squares adjustment, but I don't think we really prove much that way, and an explanation of what we did would just be confusing ten years from now. Once we have the network in place we reference our RTK system (base and rovers) to the values we have determined for the network.

In the report (see Figure 1) the PPP results show that the duration of the observation session was 2 hours 42 minutes. The height of instrument is also shown (Antenna Reference Point to marker) for verification of the input data. On the bottom half of the report, the geographic and UTM co-ordinates are given, along with ellipsoidal and orthometric heights. Make sure you understand the difference between the ellipsoidal and orthometric heights and use the correct value – in my area there is a difference of about 37m. I have confirmed the vertical reliability several times by observing a PPP session on a published benchmark and have often agreed with the published value within .01m

A report is generated as part of the GPS processing, which show the shape of the network, the processing results for the individual vectors and various reports from the least squares adjustment. All are important: the vector processing page indicates that all vectors worked satisfactorily. If some of them are described as 'float' then there is a problem with some of the data and you will need to vary some of the processing parameters, or possibly even eliminate one or more vectors. In a worst case situation you might need to completely reject one station (there might have been trees or a building partially obstructing this station). The most important part of the least squares report is where there is a statement reading 'standard deviations appear to be too pessimistic', meaning that the results are much better than the expected default standard deviation. Further in the report is a listing of the final adjusted latitudes and longitudes as well as UTM co-ordinates, scale factor and convergence from the meridian. This report gives you everything you need to prove the accuracy level of the survey work you have done to provide an integrated survey.

Last fall we received a contract to resurvey part of the northerly boundary of the Whitefish River Indian Reserve. The boundary is about 5km long with good access near the SW end but then only by water or by foot everywhere else. The project required us to provide a fully geo-referenced digital plan showing all existing bars, replace any that were disturbed or missing and increase density so that there was



CSRS-PPP (V 1.05 05211)

1001

Data Start	Data End	Duration of Observations
2011-09-23 15:40:10.000	2011-09-23 18:22:20.000	2h 42m 10.00s
Apri / Aposteriori Phase Std		**Apri / Aposteriori Code Std**
0.015m / 0.004m		2.0m / 0.697m
Observations	**Frequency**	**Mode**
Phase and Code	L1 and L2	Static
Elevation Cut-Off	**Rejected Epochs**	**Observation & Estimation Steps**
10.000 degrees	0.00 %	10.00 sec / 10.00 sec
Antenna Model	**APC to ARP**	**ARP to Marker**
	Ant. not in PPP (0 m)	1.522 m

(APC = antenna phase center; ARP = antenna reference point)

Estimated Position for 00062660.11O

	Latitude (+n)	Longitude (+e)	Ell. Height
NAD83(CSRS) (1997)	45° 58' 22.3496"	-81° 51' 20.7585"	140.513 m
Sigmas(95%)	0.024 m	0.076 m	0.086 m
Apriori	45° 58' 22.255"	-81° 51' 20.851"	146.211 m
Estimated - Apriori	2.923 m	1.980 m	-5.697 m

Orthometric Height CGVD28 (HTv2.0)

177.428 m
(click here for model and accuracy)

95% Error Ellipse (cm)
semi-major: 9.616cm
semi-minor: 2.673cm
semi-major azimuth: 88° 23' 28.44"

UTM (North) Zone 17

5091389.708m (N) 433703.746m (E)

Scale Factors
0.99965403 (point)
0.99963198 (combined)

(Coordinates from RINEX file used as apriori position)

15:33:19 UTC 2011/09/26 / 00062660.11O 1 wlgab_v1.0 / NRCan Hourly

Figure 1.

cont'd on page 30

never more than 300m between the survey monuments. The 5km of line also needed to be cut out and blazed.

Since most of the area is difficult to access, and since I was going to establish the initial control network by myself, I started with a long narrow network somewhat parallel with the highway, and with two new monuments far enough away from the highway that we could leave our RTK base unit set up for the day without fear of someone tampering with it or stealing it. The old plans were co-ordinated before going to the field and once one point was found the calculated points could be shifted to be consistent with their measured values. Our standard field procedure is to set the base in a random location where it has clear sky and is fairly safe, and then to 'localize' to one of the control points. We then stake that point out again, just to be sure everything is properly saved. Then we stake out a second point in the network, again to make sure the whole system is working properly.

Bob Halliday (left) taking an RTK measurement with crew member Murray Dawson

A survey monument (rock post) along the southerly Reserve boundary

The 600m west of the highway was flagged by RTK then cut out and the fifteen or so existing bars tied in on the first day, not bad production for a start-up day. The same procedure was followed for several days, until we got to the NE corner of the project. That monument is in a low area behind a high hill and radio reception was weak. Rather than risk a poor tie we set another control point high on a hill, so the RTK base could be moved into the northerly area to finish these ties. We also observed a second static session that included two points along the north line and two of the original control points. Holding one point fixed during the adjustment resulted in a comparison within 5mm for the second previously surveyed point, and agreement better than 10mm between

Sites to See

Office of the Surveyor General

www.mnr.gov.on.ca/en/Business/OSG/index.html

The Office of the Surveyor General oversees all Crown land surveys and legal descriptions to ensure Ontario's Crown land is effectively managed. The Office provides professional survey advice and services to the Ministry of Natural Resources and members of the public with property adjacent to Crown land.

The Office of the Surveyor General is also responsible for:

- surveying and maintaining the boundaries of Ontario.
- establishing and maintaining an accurate survey fabric for mapping and legal purposes.
- developing and implementing projects related to cadastral surveying and survey information management.
- maintaining a geographical index of nomenclature of topographical features and place names.
- maintaining all Crown Survey Records (including maps, plans and field notes of surveys made on Crown land)
- representing Ontario at inter-provincial forums on surveying and mapping.

The Surveyor General is appointed by the Lieutenant Governor in Council under Section 5 of the Ministry of Natural Resources Act. The Surveyor General is also the minister's representative on the Council of the Association of Ontario Land Surveyors and the Geographic Names Board.

the static values and RTK values. Check ties were made on another day for the found bars. New bars were planted to meet the 300m requirement and tied in as we proceeded one way, then confirmed by re-localizing to a second point after planting was finished for the day and all planted bars re-tied as we made our way out.

As you will see in the photographs, time was critical since we started in early November, and finished at the end of November. There was some snow on the ground and we had to use the boat to break ice in the morning. Efficiency was greatly enhanced using this approach, and I have far greater confidence in the results we are producing. Sceptics tell me that they have often found discrepancies of .04m when re-measuring RTK work using a Total Station, but when relying on long angles and distances for making these comparisons I suspect that the values generated by older technology have their own problems, which just aren't coming to light.

Easterly Reserve Boundary

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