Additional material from the "Got GPS?" article in the May 2008 *Leader Magazine*
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There's More than One GNNS

The Global Position System (GPS) is actually only one system of an increasing number of Global Navigation Satellite Systems (GNSS). The Russian GNSS (equivalent to GPS), known as GLONASS, is in a rebuilding phase. It plans to have 24 operational satellites by the end of 2008, and currently operates with 18.

The European GNSS, known as Galileo, recently finished funding assignments with anticipation that its system will be fully operational in 2013. It currently has two operational satellites.

The Chinese GNSS, known as Compass, is currently under deployment and has committed to show initial use in the 2008 Olympics. Numerous other countries are also adding satellites which provide atmospheric corrections to improve accuracy (similar to America's WASS and Europe's EGNOS).

Thus in 10 years, it's not hard to imagine tracking 30 satellites from GPS, GLONASS, Galileo and Compass; all the while improving the acquisition time, accuracy and reliability, both in the open and under the forestry canopy.

Weak Signals

Did you know that GPS signals are very weak? Under regular open sky conditions, the signal is 10,000,000,000,000,000 (10^{16}) weaker than when it was sent by the satellite. It's comparable to trying to measure a flickering 100 watt light bulb in Mexico City, while standing in Calgary! Handheld accuracy displays are usually overly optimistic. It's derived from mathematical models, which have problems accounting for weak signals, signals bouncing off of buildings or vehicles, signals traveling through trees or houses and even large variations in the atmosphere.

As GPS signals travel through the atmosphere they slow down. This time delay directly affects the distance measurements, which propagate into the position solution. Also, the effect which causes the northern lights (i.e. aurora borealis) also degrades GPS signals! Although GPS is an all weather system, changes in the local weather can degrade the accuracy by a small amount. This amount of degradation is usually small and of short duration. These effects only becomes significant for very high accuracy (sub-decimetre) applications.

Is WASS Important?

A Wide Area Augmentation System (WASS) works through an entirely different set of satellites, sending down corrections to GPS receivers to improve the distance measurement made by the receiver (mostly to correct the delay from the atmosphere). These satellites only transmit over North America, but the Europeans have a similar system known as EGNOS. If accuracy is important, make sure WAAS is enabled on your receiver.

Vertical Accuracy

The vertical accuracy of GPS is another story. Typically, vertical accuracy is two times worse than that of the horizontal component. Most handhelds report a horizontal accuracy, so for your elevation accuracy multiply the horizontal accuracy by two and you'll get a ballpark accuracy range. The reason for the difference lies with the fact that all the satellites are above the

receiver which doesn't provide good balance. In the horizontal plane, the satellites can be distributed 360 degrees around you, balancing the distance measurements. Vertically however, distance measurements can only be made within 180 degrees (horizon to horizon).

Datums and Elevation

There are a few important aspects like datums and other coordinate systems to keep in mind when comparing your GPS receivers coordinates with those on the map.

Datums are mathematical models used to represent the earth's surface. The current datum standard in Canada since 1990 is NAD83. Previously, NAD27 was used. Global Positioning Systems use a datum known as WGS84. There are literally 100s of datums one can use when creating maps, which is why your GPS receiver has numerous selections. If comparing your GPS receiver's coordinates to a map, it is important to be consistent with the datum used. If, for example, you had an old NAD27 map and were trying to compare the coordinates of that map with the ones from your GPS receiver (set to NAD83 or WGS84), there could be a difference of a few hundred metres! If your maps are on the NAD83 datum, you can use either NAD83 or WGS84 coordinates as the two are virtually the same at the level of 1 metre.

Elevations that GPS receivers output can also be mismatched with maps. GPS receivers will output the elevation in the datum you select. This elevation is *not* the same as elevations referred to the mean sea level. Some GPS receivers may provide you with the option to provide an elevation from mean sea level, but always check your map to make sure you don't compare apples to oranges. Note that elevations between latitude and longitude and UTM coordinates should remain the same.

By using the material found in the May 2008 *Leader Magazine* and this extra information, you will be well equipped to understand how best to buy and use your GPS unit. Whether for fun or work, GPS is here to stay.

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