Using GIS Viewshed and Line of Sight Analyses to Test Wireless Smart Meter Transmission

By Steve Zuppa

The Sault Ste. Marie Innovation Centre's Community Geomatics Centre (CGC) operates a multi enterprise GIS solution for the City and Public Utilities Commission (PUC Inc.) of Sault Ste. Marie and over fifty other local and regional partners. A major task of the CGC is to support all aspects of PUC Inc. electric distribution design, development and maintenance.

In recent years, the Province of Ontario has implemented an energy policy to equip all homes and small businesses with smart utility meters by the end of 2010. Smart meters record total electric consumption hour by hour and send that information to a local utility company through either a wireless connection or another form of technology. The ability to measure when electricity is used allows different prices to be applied at different times of the day.

A viewshed analysis is an interesting capability of GIS which identifies all areas of an input surface that can be 'seen' from an observer point. This concept can also be applied to the transmission of signals from a wireless smart meter to a data collector located on a nearby tower. GIS viewshed analyses can assist utility companies when deciding on the location of data collectors and how to access homes and cottages within their service area, particularly in more rural and rugged areas.

During the past year, GIS analysis was used to determine the location for four collector towers within the city limits of Sault Ste. Marie. These towers will meet the needs of the entire urban area of Sault Ste. Marie, but they will not be able to service all of the rural areas adjoining the city within the PUC Inc. service boundary. The legislated requirements for smart metering are that all homes supplied with electric power be equipped with smart meters. This can prove to be expensive in rugged rural areas. These areas, such as in Prince Township, do not have cell phone coverage and some areas do not have telephone lines at all, eliminating the possibility of transmitting meter readings by direct phone line or cell.

The CGC was asked by PUC Inc. to investigate the potential for wireless smart meter transmission in the Prince Lake area in Prince Township, just northwest of Sault Ste. Marie. The lake and the circling homes and cottages are located in a minor depression within the Canadian Shield. PUC Inc. has pre-determined that the most suitable and cost-effective location for a smart meter data collector receiving tower is on the roof of the Sault Ste. Marie West End Water Treatment Plant (WTP), which is located approximately 8 kilometres southeast of Prince Lake.

The WTP lies approximately 100 metres (328 feet) lower in elevation than Prince Lake, with a steep cliff separating the two locations, thereby presenting a significant challenge in conveying an uninterrupted signal from the smart meters to the tower. It is possible to locate a single repeater somewhere between the smart meters and the receiving tower to retransmit the signals. However, the repeater must be placed on a power pole, preferably lower than 12 metres (39 feet) to limit radio interference, but up to 21.3 metres (70 feet) if necessary. With one access road and power line to the lake, potential locations for a repeater are very limited.

The GIS analysis required spatial information including the potential tower location, area lakes, power poles, homes, roads and elevation. Although the CGC has produced very detailed elevation data for the Sault Ste. Marie area, the best source of elevation data available for Prince Township was a 10

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metre interval contour layer. A raster surface with a 10 metre cell size was generated using the contours as the primary source of elevation.

A point layer was created to represent the location of the receiving tower at the WTP and a number of scenario viewsheds were generated to determine what could be 'seen' from the very top of the tower. Every cell of each resulting viewshed raster specifically indicated whether a repeater pole of x height placed at that location would be 'seen' by a tower of x height at the WTP, ultimately indicating a successful transmission. For the trials, the height of the tower was tested in 7.62 metre (25 feet) increments, from a minimum of 30.48 metres (100 feet) to a maximum of 91.44 metres (300 feet). Only visible power poles were considered as potential repeater locations within each scenario.

Within each scenario, the Line of Sight drawing tool was used to test whether smart meters located around the lake were visible to potentially suitable repeater pole sites. The 'observing' power pole offset height was set to the same value as repeater pole offset in the viewshed, and the 'targeting' offset was set to 1.5 metres (the height off the ground of the average smart meter according to PUC Inc.). Lines were drawn from the nearest visible repeater pole to test sites around Prince Lake. A green dot at the end of the Line of Sight indicates that the smart meter is visible, while a red dot indicates that the smart meter is not visible (see Figure 1). A scenario with any obstructed meters (red dots) indicates a potential transmission error.

There were several possible solutions passed over to PUC Inc. for review. PUC Inc. was made aware of the potential margin of error in using such a coarse interval as a base for the analysis, in that false highs and lows may exist within the resulting surface. Any final decision made by PUC Inc. factored in a margin of error of roughly ±9 metres.

In this case, the GIS viewshed analysis proved that wireless smart meter transmission is possible for the Prince Lake area, and helped indicate a minimum height requirement for both receiving tower and repeater tower.

About the Author

Steve Zuppa is a GIS Technician/ Analyst Intern at the Sault Ste. Marie Innovation Centre's Community Geomatics Centre, and can be contacted at szuppa@ssmic.com.

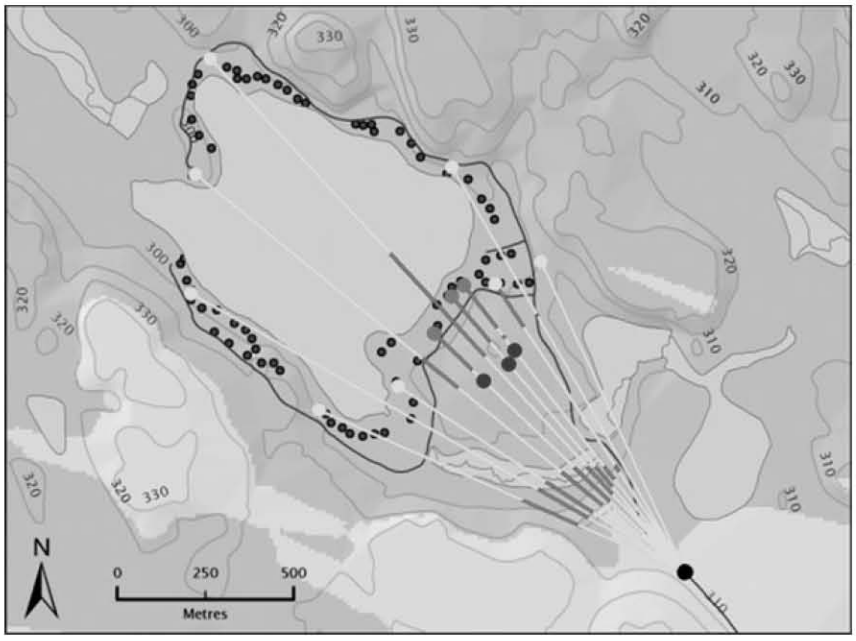

Figure 1. Line of sight analysis scenario showing where smart meters are visible from the repeater location. Note that the red and green line corresponds to whether or not the land surface is visible, while the dots indicate whether x-height off the ground is visible.