



## DGPS SITE OPERATIONAL ASSESSMENT

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**NDGPS Site:** *Upper Keweenaw (831)*

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**Date:** 07AUG12

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### **PURPOSE:**

- Validate advertised DGPS coverage of the Upper Keweenaw DGPS site.
- Validate required RTCM message delivery.
- Test differential correction accuracy versus a predetermined survey monument.

**REFERENCE:** (1) DGPS Concept of Operations, COMDTINST 16577.2 (AUG 1995).  
(2) Broadcast Standard for the USCG DGPS Navigation Service, COMDTINST M1677.1 (APR 1993).  
(3) RTCM Recommend Standards for Differential GNSS Service, Version 2.3.

**EQUIPMENT:** Starlink DNAV -212 DGPS Receiver  
Raven MBA-2 Receive Antenna  
Hemisphere R110 USB DGPS Receiver

### **PARAMETERS:**

Frequency	298 kHz
Forward Output Power	900 W
Transmission Rate	100 baud
Field Strength/Range	75 $\mu$ V/m (37.5dB $\mu$ V/m) at 209 km

### **RESULTS**

#### **Signal Strength:**

A verification of the Upper Keweenaw Differential GPS (DGPS) coverage area was conducted from Green Bay, WI to the site, then west along the southern shore of Lake Superior to Duluth, MN, and lastly north to the Canadian border along the western shore of Lake Superior. The advertised coverage area is 209 KM from the site. Figure 1 displays adequate signal strength along the west coast of Lake Superior from the Canadian border into Duluth, MN and east to Marquette, MI. Intermittent coverage from Marquette, MI south to the edge of the coverage area was observed. Green points represent areas of satisfactory signal strength. Areas of unsatisfactory signal strength are represented with red points. Far-field (FF) signal strength readings were taken on the western shore of Green Bay north of Menominee-Marquette, the south side of Lake Superior east of Duluth, MN, and the western shore of Lake Superior northeast of

Duluth, MN. Satisfactory readings were observed on the western and southern shore of Lake Superior with negative results observed in the Green Bay region (Table 1-3).

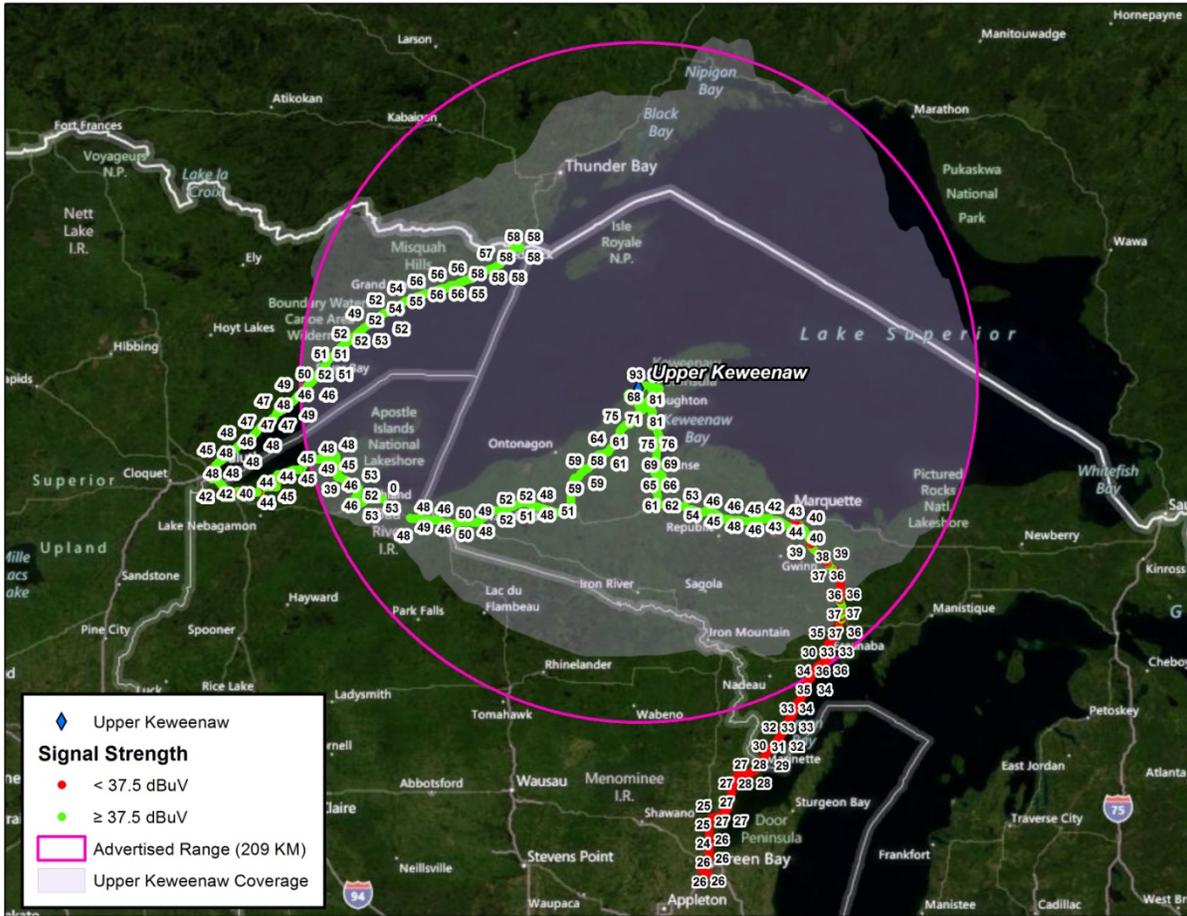


Figure 1: DNAV Measurements for Upper Keeweenaw

Table 1: Green Bay Far-Field Signal Strength Reading

Position:	45° 37.4435'N, 087° 12.55950'W
Side A	SS: 31 dB $\mu$ V/m SNR: 10
Side B	SS: 31 dB $\mu$ V/m SNR: 11

Table 2: South Shore Lake Superior Far-Field Signal Strength Reading

Position:	46° 48.9937'N, 091° 19.3039'W
Side A	SS: 48 dB $\mu$ V/m SNR: 15
Side B	SS: 47 dB $\mu$ V/m SNR: 17

Table 3: Western Shore Lake Superior Far-Field Signal Strength Readings

Position:	47° 11.5660'N, 091° 23.4270'W
Side A	SS: 47 dB $\mu$ V/m SNR: 19
Side B	SS: 48 dB $\mu$ V/m SNR: 20

**RTCM Message Verification:**

RTCM message scheduling, receipt, and content were checked during the assessment (Table 4 and 5). RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with Reference (2). Receipt of all RTCM messages was validated utilizing a Remote Desktop Session where the assessment team witnessed the on-time receipt of all messages on the active and standby Integrity Monitor Computer. All message content was verified and is in accordance with Reference (3).

Table 4: Side A

Message Type	Received	Scheduled	Content Verified/Accurate
<b>Type 3</b>	Y	Y	Y
<b>Type 7</b>	Y	Y	Y
<b>Type 9</b>	Y	Y	Y
<b>Type 16</b>	Y	Y	Y

Table 5: Side B

Message Type	Received	Scheduled	Content Verified/Accurate
<b>Type 3</b>	Y	Y	Y
<b>Type 7</b>	Y	Y	Y
<b>Type 9</b>	Y	Y	Y
<b>Type 16</b>	Y	Y	Y

**Accuracy Validation:**

Positional data was collected for 10 minutes per side using the Hemisphere R110 DGPS Receiver. The data was then post processed and compared to National Geodetic Survey (NGS) marker to verify the horizontal accuracy of the broadcast correction (Table 6 and 7). Side A was 0.53 meters, bearing 230.5°, away from the monument while Side B was 1.3 meters, bearing 203.3 ° away from the monument. Though Side B had 0.77 meters error greater than Side A, both respective distances were well within advertised accuracy requirements. A two dimension radial review of the same time period was completed for the integrity monitor. Side A’s average deviation was 0.09425 meters; Side B’s average deviation was 0.09765.

<b>NGS Monument ID:</b>	<b>RM0072</b>
Monument LAT:	46° 28.625474’ N
Monument LON:	090° 10.067236’ W

Table 6: Side A

<b>Averaged LAT:</b>	46° 28.625293’ N
<b>Averaged LON:</b>	090° 10.067559 ‘ N
<b>Distance from DGPS Site:</b>	144.0 km
<b>Distance from Monument:</b>	0.53 m (1.74 feet)
<b>Bearing from Monument:</b>	230.5°

Table 7: Side B

<b>Averaged LAT:</b>	46° 28.62483574' N
<b>Averaged LON:</b>	90° 10.06763860' N
<b>Distance from DGPS Site:</b>	144.0 km
<b>Distance from Monument:</b>	1.3 m (4.27 feet)
<b>Bearing from Monument:</b>	203.3°

**SUMMARY:**

Analysis of coverage area finds that the southeast region does not meet the requirements set forth in the OP ORDER while the western region exceeds both the advertised and predicted coverage areas by providing service to the end of Lake Superior including Duluth, MN. Additionally, a review of the output/reflected power and near-field signal strength levels was conducted and found to be satisfactory. All RTCM messages were verified and evaluated and are consistent with the requirements set forth in Reference (2) and (3). Finally, accuracy measurements and analysis proved that at a distance of 144 KM from the broadcast site, the horizontal accuracy is well within the requirements set forth in Reference (1) and (2).