



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Appleton, WA DGPS Site (871)
Inspector(s): LT M. Brashier
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REFERENCES

- (1) Broadcast Standard for the USCG DGPS Navigation Service, CIM 16577.1 (APR 1993).
- (2) Radio Technical Commission for Maritime Services (RTCM) Recommended Standards for Differential Global Navigation Satellite System (GNSS) Service, Version 2.3.
- (3) Differential Global Positioning System (DGPS) Concept of Operations, COMDTINST 16577.2 (AUG 1995).
- (4) 2014 Federal Radio Navigation Plan.

PURPOSE

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

EQUIPMENT

Trimble SPS461 Receiver
Trimble GA 530 Antenna
Dell Latitude E3620 Laptop

APPLETON DGPS SITE PARAMETERS

Frequency	300 KHz
Forward Output Power	2000 W
Transmission Rate	100 baud
Field Strength/Range	75 μ V/m (37.5 dB μ V/m) at 402 km

SUMMARY

The Operational Assessment of the Appleton DGPS site revealed that the provided coverage is not consistent with the advertised range. Far-field signal strength readings were not within the required parameters. The signal strength measurements, within the advertised range were not satisfactory. 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, evaluated and are consistent with the requirements set forth by Reference (1) and (2). Finally, accuracy measurements and analysis proved that at a distance of approximately 219 km from the broadcast site, the horizontal accuracy is sub-meter and within the 10 meter accuracy requirement as set forth by Reference (3) and (4).

RESULTS

Signal Strength

A verification of the Appleton DGPS coverage area was conducted along the coast of Washington and Oregon, and along a select route within the central coverage area. The advertised signal strength range is 402 km. Figure 1 displays unsatisfactory signal strength throughout the predicted coverage area. Green points represent areas of satisfactory signal strength, whereas areas of unsatisfactory signal strength are represented with red points. As seen in Table 1 and Table 2, far-field signal strength readings were taken at northwestern and southern points of the advertised range from both sides of the site. Both northwestern and southern far-field readings were below the required 37.5 dBuV/m signal strength on both sides.

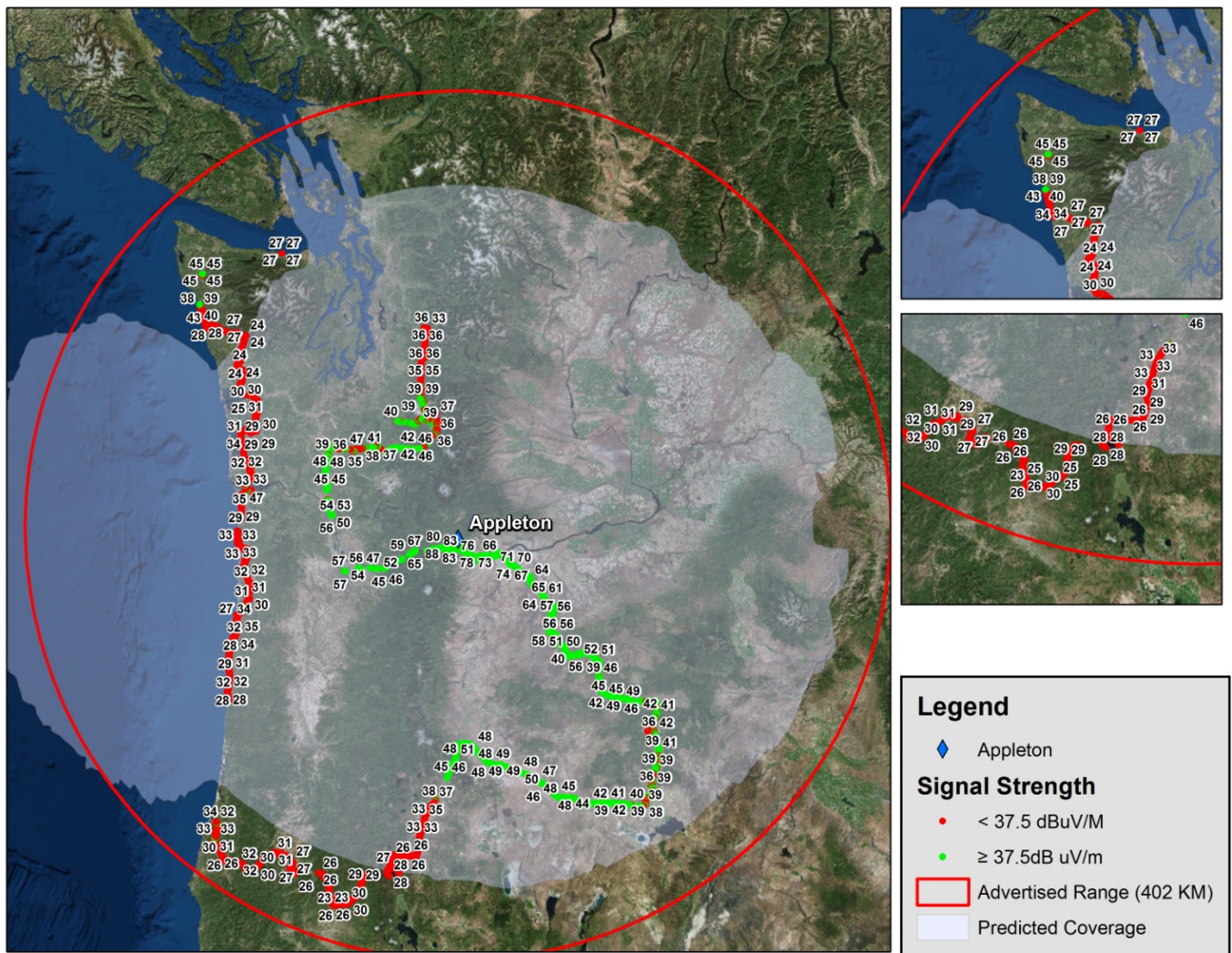


Figure 1: Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	27 dB μ V/m	8 dB μ V/m	48.1131° N, 123.4408° W
B	27 dB μ V/m	8 dB μ V/m	

Table 1: North Far-Field Signal Strength Reading

Side	Signal Strength	Signal to Noise ratio	Position
A	34 dB μ V/m	10 dB μ V/m	43.3764° N, 124.2372° W
B	34 dB μ V/m	10 dB μ V/m	

Table 2: South Far-Field Signal Strength Reading

RTCM Message Verification

Table 3 and Table 4 shows RTCM message scheduling, receipt, and content collected during the assessment. RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with the Reference (1). Receipt of all RTCM messages was validated utilizing a Remote Desktop Session whereby the assessment team witnessed the on-time receipt of all messages on the active and standby Integrity Monitor computers. All message content was verified and is in accordance with Reference (2).

Message Type	Received	Scheduled	Content Verified/Accurate
<i>Type 3</i>	Y	Y	Y
<i>Type 5 (ensure message is not being transmitted)</i>	N	N	N/A
<i>Type 7</i>	Y	Y	Y
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 3: Side A RTCM Message Validation

Message Type	Received	Scheduled	Content Verified/Accurate
<i>Type 3</i>	Y	Y	Y
<i>Type 5 (ensure message is not being transmitted)</i>	N	N	N/A
<i>Type 7</i>	Y	Y	Y
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 4: Side B RTCM Message Validation

Accuracy Validation

Positional data was collected for a minimum of 10 minutes per side using the Trimble SPS461. The data was then post processed and compared to a National Geodetic Survey (NGS) marker to verify the horizontal accuracy of the broadcast correction (Table 6 and Table 7). Side A was 0.3663 meters, bearing 160.4994° from the monument while Side B was 0.502 meters, bearing

162.09027° from the monument. As per Reference (3) and (4), both respective distances were within advertised accuracy requirements. A comparison between the GPS satellites in view at the Appleton DGPS site and at the NGS monument location was conducted (Table 8) to identify any differences in the GPS satellite geometry used at the respective locations; any differences in geometry could lead to accuracy discrepancies. In this case, the satellites being tracked by the Reference Station and Integrity Monitor GPS receivers at the site were almost identical to those tracked at the NGS monument location. No two dimension radial review was completed for the site.

NGS Monument ID:	PB0093
Monument LAT:	43° 50' 58.02704" N
Monument LON:	120° 43' 59.26845" W
Distance from DGPS Site	219 km

Table 5: NGS Monument ID

Averaged LAT:	43° 50' 58.0159N
Averaged LON:	120° 43' 59.2630" W
Distance from Monument:	0.3663 m (1.20ft)
Bearing from Monument:	160.4994°

Table 6: Side A Accuracy Check Results

Averaged LAT:	43° 50' 58.0116" N
Averaged LON:	120° 43' 59.2615" W
Distance from Monument:	0.502 m (1.64 ft)
Bearing from Monument:	162.09027°

Table 7: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>										
Reference Station A	1	3	6	7	9	16	23	25	26	31	32
Integrity Monitor A	1	3	6	7	9	16	23	25	26	31	32
Reference Station B	4	14	15	18	19	21	22	24	27		
Integrity Monitor B	4	14	15	18	19	21	22	24	27		
NGS Monument Location, Side A	2	6	12	17	24	10	25	29			
NGS Monument Location, Side B	2	6	12	24	10	25	29	5			

Table 8: GPS Satellite Comparison

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