



DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT

NDGPS Site: Spokane DGPS Site (848)
Inspector(s): CWO3 William Iozzino
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REFERENCES:

- (1) DGPS Concept of Operations, COMDTINST 16577.2 (AUG 1995)
- (2) 2010 Federal Radio Navigation Plan
- (3) Broadcast Standard for the USCG DGPS Navigation Service, CIM 16577.1 (APR 1993).
- (4) RTCM Recommend Standards for Differential GNSS Service, Version 2.3.

PURPOSE:

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

EQUIPMENT:

Raven INVICTA Receiver
Trimble SPS461 Receiver
Trimble GA 530 Antenna

SPOKANE DGPS SITE PARAMETERS:

Frequency	316 KHz
Forward Output Power	1000 W
Transmission Rate	100 baud
Field Strength/Range	75 μ V/m (37.5 dB μ V/m) at 300 km

RESULTS:

Signal Strength:

A verification of the Spokane DGPS coverage area was conducted from Spokane, WA to the western range ring. The advertised signal range is 300 km. Figure 1 below displays satisfactory signal strength west of Spokane until the test vehicle entered the mountain range which caused a loss of adequate signal strength. 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 at the western range ring, see Table 1 below. Measurements taken from both sides did not meet minimum system requirements.

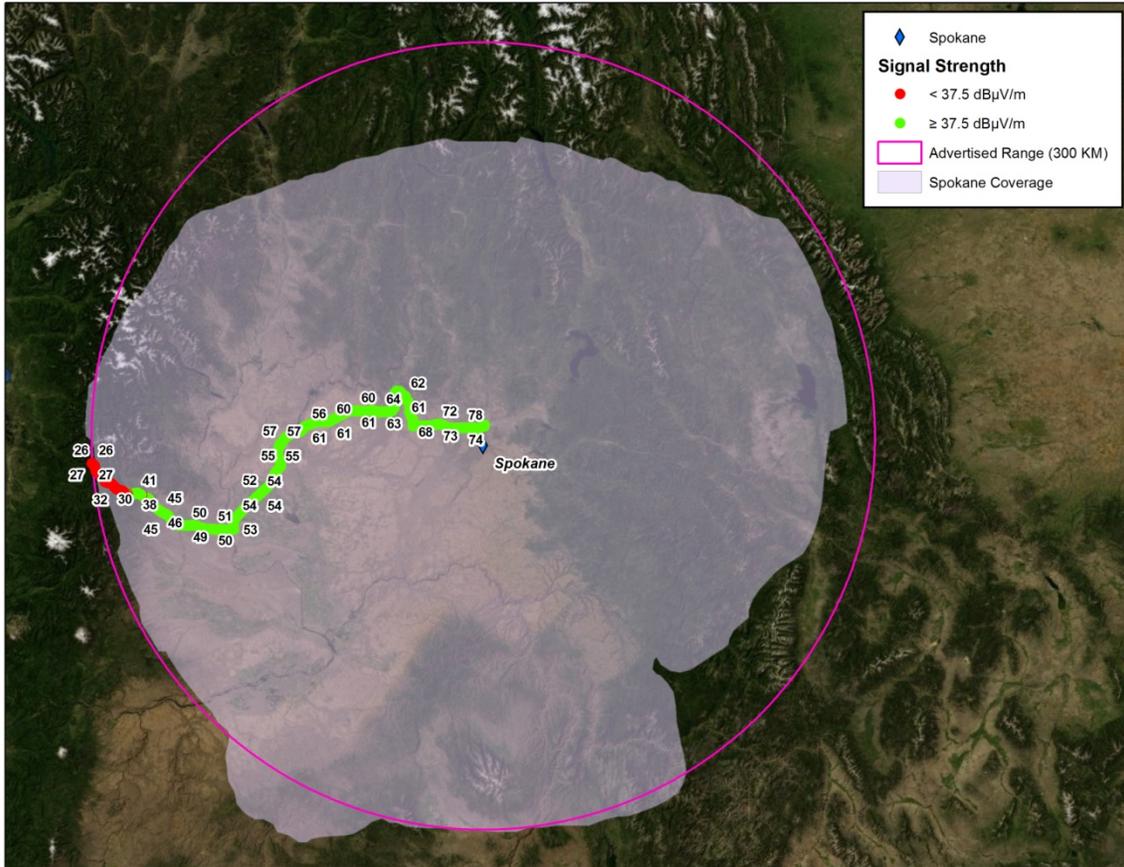


Figure 1: Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
A	26 dB μ V/m	9 dB μ V/m	47 24.103814, -121 24.397613
B	27 dB μ V/m	9 dB μ V/m	

Table 1: Western Far Field Signal Strength Readings measured w/ a Trimble SPS461)

RTCM Message Verification:

RTCM message scheduling, receipt, and content were checked during the assessment (Table 2 and 3). RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with reference (3). Receipt of all RTCM messages was validated utilizing a Raven INVICTA receiver whereby the assessment team witnessed the on time receipt of all RTCM messages. All message content was verified and is in accordance with reference (4) with the exception of the Appleton site location in the Type 7 message. **The position provided is .93 km to the south, which is .63 km greater then allowed.**

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	N
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 2: 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	N
<i>Type 9</i>	Y	Y	Y
<i>Type 16</i>	Y	Y	Y

Table 3: Side B RTCM Message Validation

Accuracy Validation:

Positional data was collected for 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 4 and 5). Side A was 0.4689 meters, bearing 309.5°, away from the monument while Side B was 0.5992 meters, bearing 311.6°, away from the monument. As per Reference (1) and (2), both respective distances were well within advertised accuracy requirements. A comparison between the GPS satellites in view at the Spokane site and the NGS monument was conducted (Table 6) to identify any differences in the GPS satellite geometry; significant differences in satellite geometry could lead to greater position error. In this case, there were nine satellites in view by both the RS/IM and Trimble receiver located at the NGS monument. A minimum of four satellites are required to generate a two dimension correction. Furthermore a two dimension radial review of the same time period was conducted for the integrity monitors. Side A’s average deviation was 0.19448 meters; Side B’s average deviation was 0.19549 meters. Both findings were consistent with the findings observed in the field.

NGS Monument ID:	BBBR69
Monument LAT:	47 52.368768
Monument LON:	-118 19.486874
Distance from DGPS Site:	78.1 km

Averaged LAT:	47° 52.368929'
Averaged LON:	-118° 19.487165'
Antenna Distance from Monument:	0.4689 m/1.54'
Antenna Bearing from Monument:	309.5°

Table 4: Side A Accuracy Check Results

Averaged LAT:	47° 52.368983'
Averaged LON:	-118° 19.487234'
Distance from Monument:	0.5992 m/1.97'
Bearing from Monument:	311.6°

Table 5: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>											
Reference Station A	1	4	8	9	11	12	15	17	24	26	28	
Integrity Monitor A	1	4	8	9	11	12	15	17	24	26	28	
Reference Station B	1	4	8	9	11	15	17	24	26	28		
Integrity Monitor B	1	4	8	9	11	15	17	24	26	28		
NGS Monument Location, Side A	1	4	8	9	15	17	24	26	28			
NGS Monument Location, Side B	1	4	8	9	15	17	24	26	28			

Table 6: GPS Satellite Comparison

SUMMARY:

The Operational Assessment of the Spokane DGPS site revealed consistent coverage throughout the western region. While the signal strength did not meet mission requirements in the Far Field the Trimble receiver was still able to maintain a signal lock and make DGPS correction. Overall site performance was exceptional with only the only exceptions being degraded signal in the mountain ranges and the RTCM type 7 message as noted above.