Differential GPS (DGPS) Site Operational Assessment

NDGPS Site:	CLARK DGPS Site (850)
Inspector(s):	CWO2 Marin Kaczmar, ETC Jeremiah Brown
Date:	05 Sept 2014

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 Clark 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

CLARK DGPS SITE PARAMETERS:

Frequency	309 KHz
Forward Output Power	750 W
Transmission Rate	100 baud
Field Strength/Range	75µV/m (37.5 dBµV/m) at 400 km

SUMMARY:

The Operational Assessment of the Clark DGPS site revealed that the provided coverage is consistent with the predicted coverage plot and advertised range. Both northwestern and northeastern far-field (FF) signal strength readings exceeded the required signal strength level. The signal strength levels were satisfactory throughout the predicted coverage area and within the advertised range. 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 by reference (3) and (4). Finally, accuracy measurements and analysis proved that at a distance of approximately 289 km from the broadcast site, the horizontal accuracy is sub-meter and within the accuracy requirements set forth by Reference (1) and (2).

RESULTS:

Signal Strength:

A verification of the Clark DGPS coverage area was conducted throughout western Minnesota, North and South Dakota The advertised range is 400 km. Figure 1 below displays adequate signal strength throughout the predicted coverage area. Green points represent areas of satisfactory signal strength. Areas of unsatisfactory signal strength are represented with red points. Far-field signal strength readings were taken at the northwest and northeast point of the advertised range.(Table 1 and Table 2). The NW FF readings were above the required 37.5 dBµV/m signal strength on both sides. The NE FF readings were above the required 37.5

dBµV/m signal strength on side B. The verification team was unable to be determine the NE FF signal strength level on side A.
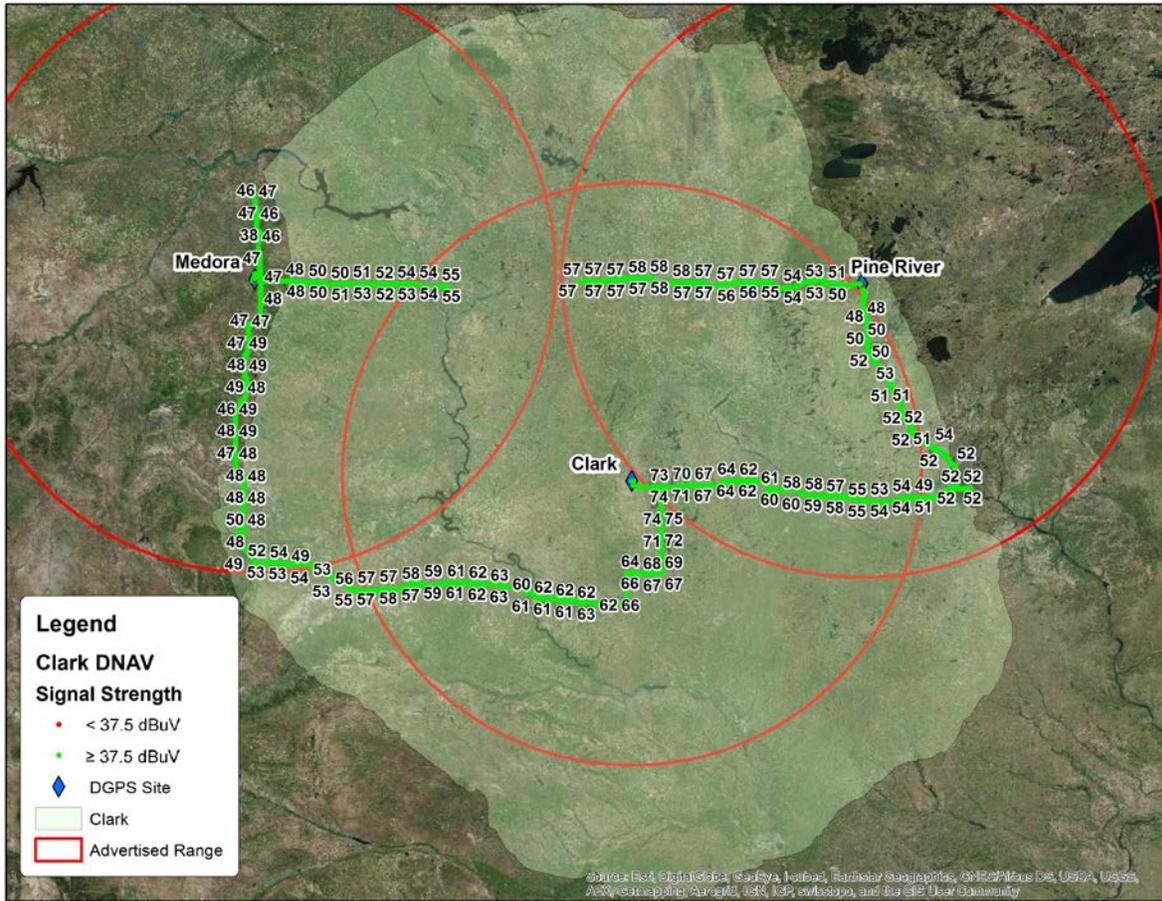

Figure 1: DNAV Signal Strength Results

Side	Signal Strength	Signal to Noise ratio	Position
B	45 dBµV/m	20	46° 51' 46.51" N, 94° 45' 09.80" W

Table 1: North East Far-Field Signal Strength Reading

Side	Signal Strength	Signal to Noise ratio	Position
A	52 dBµV/m	37	46° 49' 21.48" N,100° 32' 28.55" W
B	52 dBµV/m	37	

Table 2: North West Far-Field Signal Strength Reading

RTCM Message Verification:

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 (Table 3 and 4). All message content was verified and is in accordance with Reference (4)

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

Table 3: Side A RTCM Message Validation

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

Table 4: 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 6 and 7). Side A was 0.3411 meters away from the monument, bearing 190º.while Side B was 0.1850 meters away from the monument, bearing 140º. 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 Clark 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. The satellites being tracked by the RS and IM GPS receivers at the site were almost identical to those tracked at the NGS monument location. A two dimension radial review of the same time period was completed for the integrity monitors. Side A's average deviation was 0.40153 meters; Side B's average deviation was 0.36999 meters. Both findings were consistent with the findings observed in the field and are well within system parameters.

NGS Monument ID:	RR0664
Monument LAT:	46º 49' 21.48628" N
Monument LON:	100º 32' 28.54554" W
Distance from DGPS Site	289.8 km

Table 5 Monument ID

Averaged LAT:	46º 49' 21.497124" N
Averaged LON:	100º 32' 28.542480" W
Antenna Distance from Monument:	0.3411 m (1.12 ft)
Antenna Bearing from Monument:	190º

Table 6: Side A Accuracy Check Results

Averaged LAT:	46º 49' 21.490896" N
Averaged LON:	100º 32' 28.551120" W
Distance from Monument:	0.1850 m (0.61 ft)
Bearing from Monument:	140º

Table 7: Side B Accuracy Check Results

Antenna Location	GPS Satellites Tracked (PRN)										
Reference Station A	5	6	8	9	15	16	18	21	22	26	29
Integrity Monitor A	3	5	6	9	15	16	18	21	22	24	26
Reference Station B	3	6	7	10	13	16	20	23	27	29	31
Integrity Monitor B	3	6	7	10	13	16	20	23	27	30	31
NGS Monument Location, Side A	3	5	7	8	10	13	16	19	27	28	30
NGS Monument Location, Side B	3	5	7	8	10	13	16	19	23	27	28

Table 8: GPS Satellite Comparison