



## **DIFFERENTIAL GPS (DGPS) SITE OPERATIONAL ASSESSMENT**

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**NDGPS Site:** Upolu Point DGPS Site (837)  
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**Date:** 04 AUGUST 2014

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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 Upolu Point DGPS site.
- Validate required RTCM message scheduling and delivery.
- Test differential correction accuracy versus a predetermined survey monument.

### **EQUIPMENT:**

Hemisphere R330 Receiver  
Hemisphere R110 Receiver  
Hemisphere A43 Antenna  
Hemisphere A42 Antenna  
MBA-2 Receive Antenna

### **UPOLU POINT DGPS SITE PARAMETERS:**

Frequency	286 KHz
Forward Output Power	500 W
Transmission Rate	100 baud
Field Strength/Range	75 $\mu$ V/m (37.5 dB $\mu$ V/m) at 315 km

### **SUMMARY:**

The Operational Assessment of the Upolu Point DGPS site revealed that the provided coverage does not meet the predicted advertised or coverage area. The signal strength measurements on the northwest regions of the Big Island of Hawaii and in the neighboring islands of Maui, Oahu and Kauai were satisfactory. However, the signal strength on the southeast regions of the Big Island of Hawaii was inadequate. 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 34 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 Upolu Point DGPS coverage area was conducted on the perimeter roads of Oahu, Kauai, Maui and the Big Island of Hawaii. The advertised signal strength range is 315 km. Figure 1 below displays adequate signal strength to the northwest near the advertised range of the site and within most of the predicted coverage area, although inadequate signal strengths are observed in the southeastern side of the Big Island possibly due to terrestrial masking. Green points represent areas of satisfactory signal strength. Areas of unsatisfactory signal strength are represented with red points.

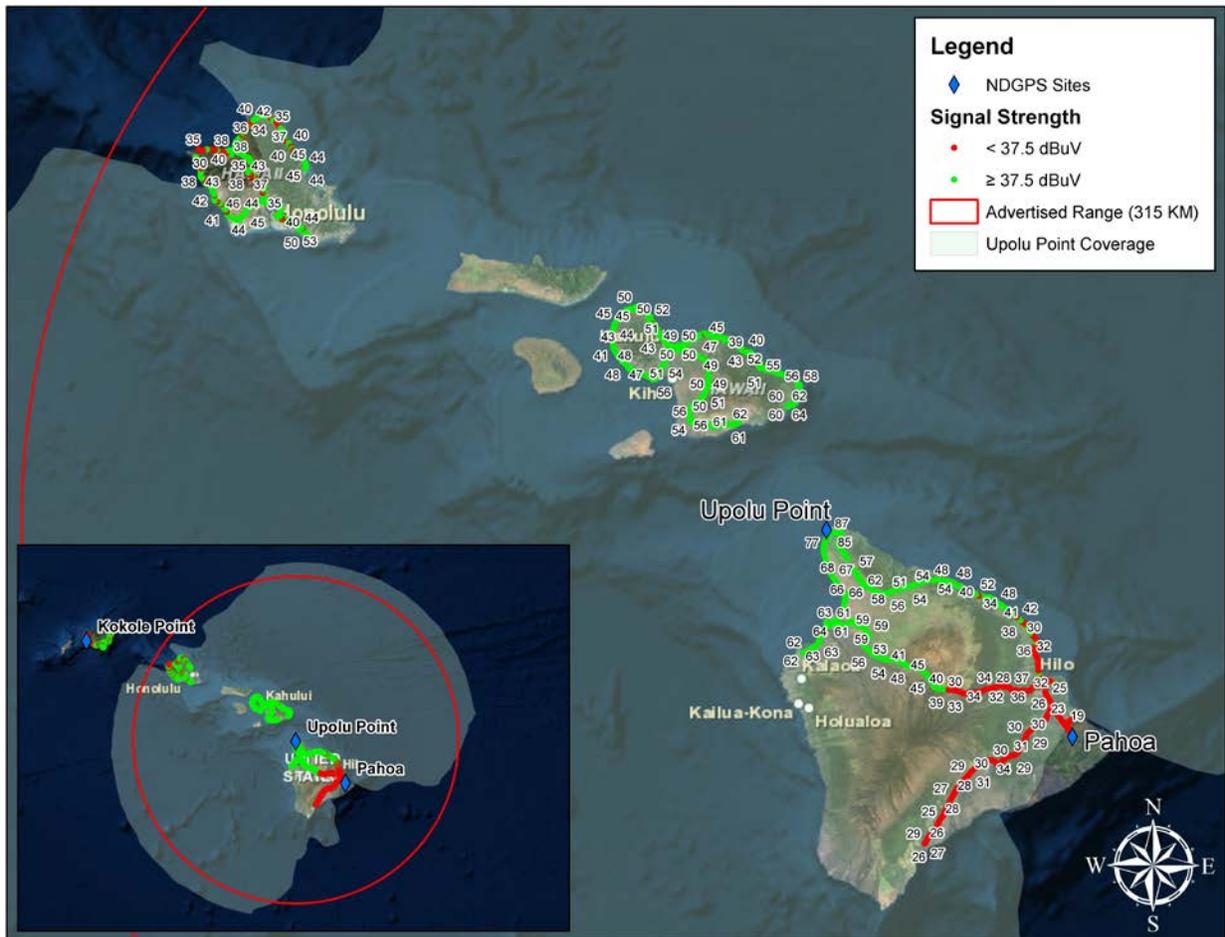


Figure 1: DNAV Signal Strength Results

### ***RTCM Message Verification:***

RTCM message scheduling, receipt, and content were checked during the assessment (Table 1 and 2). RTCM message scheduling on both Side A and Side B was validated with the DGPS watch and is in accordance with the Reference (3). 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 (4).

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 1: 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 2: Side B RTCM Message Validation

**Accuracy Validation:**

Positional data was collected for 10 minutes per side using the Hemisphere R110 receiver with a Trimble MBA-2 antenna placed on a National Geodetic Survey (NGS) monument marker. The data was then post processed and compared to the data of the NGS monument to verify the horizontal accuracy of the broadcast correction (Table 4 and 5). Side A was 0.5581 meters away from the monument, bearing 297.0614°, while Side B was 0.7978 meters away from the monument, bearing 300.57694°. A two dimension radial review of the same time period was completed for the integrity monitors. Side A’s average deviation was 0.08874 meters; Side B’s average deviation was 0.14262 meters. Both findings were consistent with the findings observed in the field and are well within system advertised accuracy requirements of Reference (1) and (2).

A comparison between the GPS satellites in view at the Upolu Point DGPS site and at the NGS monument location was conducted (Table 6) 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 RS and IM GPS receivers at the site were similar to those tracked at the NGS monument location.

Furthermore, a comparison between the uncorrected GPS position and the NGS Monument was conducted to see how effective the DGPS corrections were. GPS accuracy was 2.917 meters away from the monument. Therefore, the DGPS site is effectively improving the positional solution by over 365%.

<b>NGS Monument ID:</b>	<b>AA3576</b>
Monument LAT:	21° 18' 11.98896" N
Monument LON:	157° 51' 51.91933" W
Distance from DGPS Site	237 km

Table 3: Monument ID

<b>Averaged LAT:</b>	21° 18' 11.99718" N
<b>Averaged LON:</b>	157° 51' 55.1598" W
<b>Antenna Distance from Monument:</b>	0.5581 m (1.7894305 ft)
<b>Antenna Bearing from Monument:</b>	297.0614°

Table 4: Side A Accuracy Check Results

<b>Averaged LAT:</b>	21° 18' 12.0021" N
<b>Averaged LON:</b>	157° 51' 51.9432" W
<b>Distance from Monument:</b>	0.7978 m (2.59285 ft)
<b>Bearing from Monument:</b>	300.57694°

Table 5: Side B Accuracy Check Results

<i>Antenna Location</i>	<i>GPS Satellites Tracked (PRN)</i>										
Reference Station A	2	6	12	14	15	24	25	26	29		
Integrity Monitor A	1	3	6	11	14	19	20	22	31	32	
Reference Station B	2	6	12	15	24	25	26	29			
Integrity Monitor B	1	4	6	7	8	10	13	16	20	23	30
NGS Monument Location, Side A	2	6	12	14	15	17	24	25	26	29	
NGS Monument Location, Side B	2	6	12	14	15	24	25	26	29		

Table 6: GPS Satellite Comparison