

## OPUS-RS solution : 018697\_14\_227\_A2.14O OP1408381998068

opus &lt;opus@ngs.noaa.gov&gt;

Mon 8/18/2014 11:16 AM

To:John Freetly &lt;John.Freetly@neciusa.com&gt;;

FILE: 018697\_14\_227\_A2.14O OP1408381998068

## NGS OPUS-RS SOLUTION REPORT

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All computed coordinate accuracies are listed as 1-sigma RMS values.

For additional information: <http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy>

USER: john.freetly@neciusa.com                      DATE: August 18, 2014  
 RINEX FILE: 0186227v.14o                              TIME: 17:15:52 UTC

SOFTWARE: rsgps 1.37 RS51.prl 1.99.2              START: 2014/08/15 21:25:30  
 EPHEMERIS: igr18055.eph [rapid]                      STOP: 2014/08/15 21:59:45  
 NAV FILE: brdc2270.14n                              OBS USED: 1160 / 1376 : 84%  
 ANT NAME: CHCX90D-OPUS    NONE                      QUALITY IND. 13.83/ 18.22  
 ARP HEIGHT: 1.80000                                  NORMALIZED RMS:    0.361

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)              IGS08 (EPOCH:2014.62166)

X: -1380722.395(m) 0.006(m)                      -1380723.270(m) 0.006(m)  
 Y: -4035655.366(m) 0.010(m)                      -4035654.143(m) 0.010(m)  
 Z: 4727557.011(m) 0.015(m)                      4727557.002(m) 0.015(m)

LAT: 48 8 1.61908 0.004(m)                      48 8 1.63995 0.004(m)  
 E LON: 251 6 45.35191 0.005(m)                      251 6 45.29273 0.005(m)  
 W LON: 108 53 14.64809 0.005(m)                      108 53 14.70727 0.005(m)  
 EL HGT: 993.555(m) 0.018(m)                      992.965(m) 0.018(m)  
 ORTHO HGT: 1009.007(m) 0.020(m) [NAVD88 (Computed using GEOID12A)]

## UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 12)              SPC (2500 MT )

Northing (Y) [meters]    5333328.249                      431743.197  
 Easting (X) [meters]    657178.573                      645577.607  
 Convergence [degrees]    1.57358297                      0.44811783  
 Point Scale              0.99990356                      0.99958477  
 Combined Factor              0.99974788                      0.99942914

US NATIONAL GRID DESIGNATOR: 12UXU5717833328(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DG9749	MTMS MONTANA STATE UNI CORS ARP	N483227.426	W1094111.858	74580.1
DM7133	MTLW LEWISTOWN CORS ARP	N470314.929	W1092633.764	127114.0
DI3425	P052 LRRNCHJRDNMT2006 CORS ARP	N472229.026	W1070107.185	163582.6
DI3422	P050 WICKUMRNCHMT2006 CORS ARP	N484834.096	W1111454.296	190077.7

NEAREST NGS PUBLISHED CONTROL POINT

Information on nearest mark is not available due to database connectivity issues or has restrictions on when or how it can be published.

OPUS-RS Extended Output, Level 2

FINAL COORDINATES (ITRF at epoch of observations)

mtms	-1425435.583	-3984013.204	4757493.873
mtlw	-1449333.483	-4105829.826	4646773.504
p052	-1266648.331	-4138194.569	4670709.496
p050	-1525480.191	-3923083.442	4777585.201
0186	-1380723.270	-4035654.143	4727557.002

Covariance matrix of the stations:

1	3.1830E-07	6.5810E-07	-9.0770E-07	-4.4560E-08	-2.9550E-07	3.7500E-07	4.1420E-08	-1.1250E-07	1.0310E-07
	-6.4890E-08	-2.5030E-07	4.2960E-07	1.0630E-07	1.4790E-07	-2.1360E-07			
2	6.5810E-07	2.8370E-06	-3.8810E-06	-3.4470E-07	-1.2660E-06	1.6700E-06	9.3310E-08	-4.9370E-07	5.2110E-07
	-4.0540E-07	-8.2850E-07	1.6890E-06	2.4660E-07	9.2740E-07	-1.2640E-06			
3	-9.0770E-07	-3.8810E-06	6.2960E-06	3.8330E-07	1.5750E-06	-2.2780E-06	6.6450E-08	9.3480E-07	-1.3100E-06
	4.5620E-07	1.3730E-06	-2.4580E-06	-1.4390E-07	-5.1370E-07	7.8470E-07			
4	-4.4560E-08	-3.4470E-07	3.8330E-07	4.0670E-07	9.5820E-07	-1.1780E-06	-1.6910E-07	-3.2830E-07	5.8500E-07
	5.6580E-08	-2.8530E-07	2.0980E-07	-9.5130E-08	-5.4650E-07	8.0940E-07			
5	-2.9550E-07	-1.2660E-06	1.5750E-06	9.5820E-07	3.8500E-06	-4.8530E-06	-7.1480E-07	-1.3440E-06	2.3920E-06
	5.0400E-08	-9.9020E-07	8.8750E-07	-5.1770E-07	-1.7300E-06	2.6500E-06			
6	3.7500E-07	1.6700E-06	-2.2780E-06	-1.1780E-06	-4.8530E-06	7.1540E-06	6.4480E-07	1.6080E-06	-2.6600E-06
	1.6030E-07	1.5740E-06	-1.9670E-06	4.1930E-07	1.4620E-06	-2.0590E-06			
7	4.1420E-08	9.3310E-08	6.6450E-08	-1.6910E-07	-7.1480E-07	6.4480E-07	6.4560E-07	8.4840E-07	-1.5080E-06
	-2.6840E-07	-2.2540E-07	7.9590E-07	4.2580E-07	1.2270E-06	-1.8670E-06			
8	-1.1250E-07	-4.9370E-07	9.3480E-07	-3.2830E-07	-1.3440E-06	1.6080E-06	8.4840E-07	2.9010E-06	-4.2020E-06
	-4.1030E-07	-8.1120E-07	1.6620E-06	3.4210E-07	1.1150E-06	-1.6550E-06			
9	1.0310E-07	5.2110E-07	-1.3100E-06	5.8500E-07	2.3920E-06	-2.6600E-06	-1.5080E-06	-4.2020E-06	7.2680E-06
	8.2280E-07	1.2850E-06	-3.0520E-06	-8.3600E-07	-2.6990E-06	4.2350E-06			
10	-6.4890E-08	-4.0540E-07	4.5620E-07	5.6580E-08	5.0400E-08	1.6030E-07	-2.6840E-07	-4.1030E-07	8.2280E-07
	5.2740E-07	7.6400E-07	-1.4390E-06	-1.8700E-07	-8.2810E-07	1.2710E-06			
11	-2.5030E-07	-8.2850E-07	1.3730E-06	-2.8530E-07	-9.9020E-07	1.5740E-06	-2.2540E-07	-8.1120E-07	1.2850E-06
	7.6400E-07	2.8780E-06	-4.2350E-06	-7.0620E-08	-6.0970E-08	2.6800E-07			
12	4.2960E-07	1.6890E-06	-2.4580E-06	2.0980E-07	8.8750E-07	-1.9670E-06	7.9590E-07	1.6620E-06	-3.0520E-06

```
-1.4390E-06 -4.2350E-06 7.7290E-06 5.6040E-07 1.7510E-06 -2.7110E-06
 13 1.0630E-07 2.4660E-07 -1.4390E-07 -9.5130E-08 -5.1770E-07 4.1930E-07 4.2580E-07 3.4210E-07 -8.3600E-07
-1.8700E-07 -7.0620E-08 5.6040E-07 3.2480E-06 8.1390E-06 -1.1300E-05
 14 1.4790E-07 9.2740E-07 -5.1370E-07 -5.4650E-07 -1.7300E-06 1.4620E-06 1.2270E-06 1.1150E-06 -2.6990E-06
-8.2810E-07 -6.0970E-08 1.7510E-06 8.1390E-06 3.5870E-05 -5.1320E-05
 15 -2.1360E-07 -1.2640E-06 7.8470E-07 8.0940E-07 2.6500E-06 -2.0590E-06 -1.8670E-06 -1.6550E-06 4.2350E-
06 1.2710E-06 2.6800E-07 -2.7110E-06 -1.1300E-05 -5.1320E-05 8.2740E-05
```

Covariance Matrix for the xyz OPUS Rover Position (meters^2).

```
0.0000032480 0.0000081390 -0.0000113000
0.0000081390 0.0000358700 -0.0000513200
-0.0000113000 -0.0000513200 0.0000827400
```

Covariance Matrix for the enu OPUS Position (meters^2).

```
0.0000016808 0.0000013246 0.0000067799
0.0000013246 0.0000058267 0.0000171784
0.0000067799 0.0000171784 0.0001143506
```

Horizontal network accuracy = 0.00504 meters.

Vertical network accuracy = 0.02097 meters.

		Vectors		
To	From	X	Y	Z
mtms	0186	-44712.313	51640.939	29936.871
mtlw	0186	-68610.213	-70175.683	-80783.498
p052	0186	114074.939	-102540.426	-56847.506
p050	0186	-144756.921	112570.701	50028.198

Covariance matrix of the 4 vectors

```
1 3.3537E-06 8.4026E-06 -1.1850E-05 3.1923E-06 8.2133E-06 -1.1131E-05 2.7573E-06 7.5365E-06 -1.0147E-05
3.2638E-06 7.8114E-06 -1.1217E-05
 2 8.4026E-06 3.6852E-05 -5.3423E-05 8.0942E-06 3.5407E-05 -4.9848E-05 6.7587E-06 3.3334E-05 -4.6836E-
05 8.3151E-06 3.4175E-05 -5.0118E-05
 3 -1.1850E-05 -5.3423E-05 8.7467E-05 -1.1582E-05 -5.1881E-05 8.1736E-05 -9.2227E-06 -4.8217E-05 7.6410E-05
-1.1971E-05 -4.9701E-05 8.2208E-05
 4 3.1923E-06 8.0942E-06 -1.1582E-05 3.8450E-06 1.0161E-05 -1.3707E-05 2.7482E-06 8.0151E-06 -1.0688E-05
3.5867E-06 8.4708E-06 -1.2460E-05
 5 8.2133E-06 3.5407E-05 -5.1881E-05 1.0161E-05 4.3180E-05 -6.0285E-05 6.7149E-06 3.5141E-05 -4.8879E-05
9.5352E-06 3.6671E-05 -5.4834E-05
 6 -1.1131E-05 -4.9848E-05 8.1736E-05 -1.3707E-05 -6.0285E-05 9.4012E-05 -9.2075E-06 -4.9519E-05 7.7904E-05
-1.2830E-05 -5.1476E-05 8.5543E-05
 7 2.7573E-06 6.7587E-06 -9.2227E-06 2.7482E-06 6.7149E-06 -9.2075E-06 3.0420E-06 7.4183E-06 -1.0105E-05
2.7408E-06 6.7572E-06 -9.1975E-06
 8 7.5365E-06 3.3334E-05 -4.8217E-05 8.0151E-06 3.5141E-05 -4.9519E-05 7.4183E-06 3.6541E-05 -5.1168E-05
8.2147E-06 3.4005E-05 -4.9754E-05
 9 -1.0147E-05 -4.6836E-05 7.6410E-05 -1.0688E-05 -4.8879E-05 7.7904E-05 -1.0105E-05 -5.1168E-05 8.1538E-05
-1.0912E-05 -4.7604E-05 7.8164E-05
10 3.2638E-06 8.3151E-06 -1.1971E-05 3.5867E-06 9.5352E-06 -1.2830E-05 2.7408E-06 8.2147E-06 -1.0912E-05
4.1494E-06 9.8017E-06 -1.4570E-05
11 7.8114E-06 3.4175E-05 -4.9701E-05 8.4708E-06 3.6671E-05 -5.1476E-05 6.7572E-06 3.4005E-05 -4.7604E-05
```

9.8017E-06 3.8870E-05 -5.7574E-05

12 -1.1217E-05 -5.0118E-05 8.2208E-05 -1.2460E-05 -5.4834E-05 8.5543E-05 -9.1975E-06 -4.9754E-05 7.8164E-05  
-1.4570E-05 -5.7574E-05 9.5891E-05

Correlation matrix of the 4 vectors

1 1.0000E+00 7.5582E-01 -6.9190E-01 8.8898E-01 6.8252E-01 -6.2686E-01 8.6327E-01 6.8080E-01 -6.1363E-01  
8.7492E-01 6.8417E-01 -6.2551E-01

2 7.5582E-01 1.0000E+00 -9.4097E-01 6.7998E-01 8.8759E-01 -8.4688E-01 6.3834E-01 9.0837E-01 -8.5441E-01  
6.7242E-01 9.0296E-01 -8.4309E-01

3 -6.9190E-01 -9.4097E-01 1.0000E+00 -6.3157E-01 -8.4421E-01 9.0137E-01 -5.6540E-01 -8.5287E-01 9.0480E-01  
-6.2837E-01 -8.5239E-01 8.9765E-01

4 8.8898E-01 6.7998E-01 -6.3157E-01 1.0000E+00 7.8862E-01 -7.2093E-01 8.0358E-01 6.7620E-01 -6.0365E-01  
8.9796E-01 6.9290E-01 -6.4891E-01

5 6.8252E-01 8.8759E-01 -8.4421E-01 7.8862E-01 1.0000E+00 -9.4619E-01 5.8589E-01 8.8467E-01 -8.2376E-01  
7.1235E-01 8.9510E-01 -8.5215E-01

6 -6.2686E-01 -8.4688E-01 9.0137E-01 -7.2093E-01 -9.4619E-01 1.0000E+00 -5.4447E-01 -8.4487E-01 8.8979E-01  
-6.4959E-01 -8.5154E-01 9.0096E-01

7 8.6327E-01 6.3834E-01 -5.6540E-01 8.0358E-01 5.8589E-01 -5.4447E-01 1.0000E+00 7.0361E-01 -6.4162E-01  
7.7145E-01 6.2141E-01 -5.3852E-01

8 6.8080E-01 9.0837E-01 -8.5287E-01 6.7620E-01 8.8467E-01 -8.4487E-01 7.0361E-01 1.0000E+00 -9.3741E-01  
6.6713E-01 9.0228E-01 -8.4052E-01

9 -6.1363E-01 -8.5441E-01 9.0480E-01 -6.0365E-01 -8.2376E-01 8.8979E-01 -6.4162E-01 -9.3741E-01 1.0000E+00  
-5.9325E-01 -8.4558E-01 8.8397E-01

10 8.7492E-01 6.7242E-01 -6.2837E-01 8.9796E-01 7.1235E-01 -6.4959E-01 7.7145E-01 6.6713E-01 -5.9325E-01  
1.0000E+00 7.7180E-01 -7.3045E-01

11 6.8417E-01 9.0296E-01 -8.5239E-01 6.9290E-01 8.9510E-01 -8.5154E-01 6.2141E-01 9.0228E-01 -8.4558E-01  
7.7180E-01 1.0000E+00 -9.4304E-01

12 -6.2551E-01 -8.4309E-01 8.9765E-01 -6.4891E-01 -8.5215E-01 9.0096E-01 -5.3852E-01 -8.4052E-01 8.8397E-01  
-7.3045E-01 -9.4304E-01 1.0000E+00

G-FILE for the vectors

Axx2014 8152014 815

B201408152100201408152100 4 rsgps 1.37IGS

lant\_info.003 NGS

C00050001 -447123126 18 516409386 60 299368705 93

C00050002 -686102127 19 -701756833 65 -807834983 96

C00050003 1140749387 17 -1025404264 60 -568475064 90

C00050004 -1447569205 20 1125707005 62 500281983 97

D 1 2 7558226 1 3 -6918986 1 4 8889791 1 5 6825182 1 6 -6268573

D 1 7 8632676 1 8 6807966 1 9 -6136325 1 10 8749235 1 11 6841651

D 1 12 -6255088 2 3 -9409745 2 4 6799802 2 5 8875875 2 6 -8468848

D 2 7 6383406 2 8 9083729 2 9 -8544115 2 10 6724238 2 11 9029646

D 2 12 -8430883 3 4 -6315736 3 5 -8442059 3 6 9013681 3 7 -5653989

D 3 8 -8528729 3 9 9047961 3 10 -6283665 3 11 -8523926 3 12 8976470

D 4 5 7886173 4 6 -7209337 4 7 8035771 4 8 6761963 4 9 -6036521

D 4 10 8979614 4 11 6929032 4 12 -6489081 5 6 -9461855 5 7 5858934

D 5 8 8846726 5 9 -8237605 5 10 7123539 5 11 8951004 5 12 -8521493

D 6 7 -5444656 6 8 -8448702 6 9 8897911 6 10 -6495945 6 11 -8515422

D 6 12 9009566 7 8 7036141 7 9 -6416182 7 10 7714452 7 11 6214146

D 7 12 -5385192 8 9 -9374070 8 10 6671274 8 11 9022828 8 12 -8405215  
 D 9 10 -5932525 9 11 -8455834 9 12 8839706 10 11 7717963 10 12 -7304490  
 D 11 12 -9430409

ITRF position of 0186 as determined by individual baselines

	X	Y	Z
mtms	-1380723.270	-4035654.156	4727557.019
mtlw	-1380723.268	-4035654.146	4727557.013
p052	-1380723.279	-4035654.153	4727557.016
p050	-1380723.266	-4035654.144	4727557.008

Residuals of position determined by individual baselines from the final position

	X	Y	Z	East	North	Up
mtms	-0.000	-0.014	0.017	0.004	0.002	0.021
mtlw	0.002	-0.004	0.011	0.003	0.005	0.010
p052	-0.009	-0.010	0.014	-0.005	-0.000	0.019
p050	0.004	-0.001	0.006	0.004	0.004	0.004

STATE PLANE COORDINATES - International Foot

SPC (2500 MT )

Northing (Y) [feet]	1416480.305
Easting (X) [feet]	2118036.768
Convergence [degrees]	0.44811783
Point Scale	0.99958477
Combined Factor	0.99942914

\*\* Orthometric Heights Above Future Geopotential Datum.

Prototype orthometric heights are now being made available as a precursor to the completion of GRAV-D and the replacement of NAVD 88 with a new geopotential reference system. The following height reflects the current best estimate of the true orthometric height, based on the existing gravimetric geoid model. This height is subject to change as data and modeling for the gravimetric geoid change throughout the lifetime of the GRAV-D project, or as new realizations of the ITRF are adopted. However, at the completion of GRAV-D, these heights will supersede the NAVD 88 heights

APPROX ORTHO HGT: 1008.007 (m) [PROTOTYPE (Computed using USGG2012,GRS80,IGS08)]

dop from interpolation is	0.436
scatter (mean square distance from rover) is	21141.630
average edop for rover is	0.960
average ndop for rover is	1.220
average hdop for rover is	1.552
average vdop for rover is	2.240
average gdop for rover is	3.260

This position and the above vector components were computed without any knowledge by the National Geodetic Survey regarding the equipment or

field operating procedures used.