

## OPUS solution : 018772\_14\_217\_A0.14O OP1407514211292

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

Fri 8/8/2014 10:12 AM

To:Chad Mozol &lt;Chad.Mozol@neciusa.com&gt;;

FILE: 018772\_14\_217\_A0.14O OP1407514211292

## NGS OPUS SOLUTION REPORT

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All computed coordinate accuracies are listed as peak-to-peak values.

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

USER: cmozol@neciusa.com                      DATE: August 08, 2014  
 RINEX FILE: 0187217s.14o                      TIME: 16:12:07 UTC

SOFTWARE: page5 1209.04 master93.pl 022814    START: 2014/08/05 18:30:00  
 EPHEMERIS: igr18042.eph [rapid]              STOP: 2014/08/05 22:40:00  
 NAV FILE: brdc2170.14n                      OBS USED: 9740 / 10623 : 92%  
 ANT NAME: CHCX90D-OPUS    NONE              # FIXED AMB: 65 / 86 : 76%  
 ARP HEIGHT: 2.1000                      OVERALL RMS: 0.027(m)

REF FRAME: NAD\_83(2011)(EPOCH:2010.0000)              IGS08 (EPOCH:2014.5941)

X: -1370393.154(m) 0.013(m)              -1370394.028(m) 0.013(m)  
 Y: -4052960.546(m) 0.022(m)              -4052959.320(m) 0.022(m)  
 Z: 4715958.024(m) 0.035(m)              4715958.013(m) 0.035(m)

LAT: 47 58 36.25884    0.034(m)              47 58 36.27979    0.034(m)  
 E LON: 251 19 6.59495    0.011(m)              251 19 6.53611    0.011(m)  
 W LON: 108 40 53.40505    0.011(m)              108 40 53.46389    0.011(m)  
 EL HGT: 1094.064(m) 0.028(m)              1093.466(m) 0.028(m)  
 ORTHO HGT: 1109.343(m) 0.047(m) [NAVD88 (Computed using GEOID12A)]

## UTM COORDINATES    STATE PLANE COORDINATES

UTM (Zone 12)              SPC (2500 MT )

Northing (Y) [meters]    5316316.081              414429.799  
 Easting (X) [meters]    673022.457              661078.647  
 Convergence [degrees]    1.72277542              0.59873517  
 Point Scale              0.99996786              0.99953456  
 Combined Factor              0.99979642              0.99936319

US NATIONAL GRID DESIGNATOR: 12TXU7302216316(NAD 83)

## BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DI2257	P049 ARMINGTON_MT2006	CORS ARP	N472059.850 W1105422.382	181064.2
DL7731	P053 WHITEWATERMT2007	CORS ARP	N484333.865 W1074331.456	109395.7
DM7133	MTLW LEWISTOWN	CORS ARP	N470314.929 W1092633.764	117529.7

## NEAREST NGS PUBLISHED CONTROL POINT

SR0247	P 135	N475837.	W1084023.	629.8
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## BASE STATION INFORMATION

STATION NAME: p049 a 1 (Armington\_MT2006; Belt, MT United States)

MONUMENT: NO DOMES NUMBER

XYZ -1545099.6822 -4044895.8653 4669084.6330 MON @ 2005.0000 (M)

XYZ -0.0157 -0.0002 -0.0067 VEL (M/YR)

NEU -0.0000 0.0000 0.0083 MON TO ARP (M)

NEU 0.0012 0.0008 0.0860 ARP TO L1 PHASE CENTER (M)

NEU 0.0006 -0.0006 0.1183 ARP TO L2 PHASE CENTER (M)

XYZ -0.1510 -0.0017 -0.0645 VEL TIMES 9.5932 YRS

XYZ -0.0020 -0.0053 0.0061 MON TO ARP

XYZ -0.0198 -0.0539 0.0640 ARP TO L1 PHASE CENTER

XYZ -1545099.8551 -4044895.9261 4669084.6386 L1 PHS CEN @ 2014.5941

XYZ 0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS

XYZ -1545099.8551 -4044895.9261 4669084.6386 NEW L1 PHS CEN @ 2014.5941

XYZ -1545099.8353 -4044895.8722 4669084.5746 NEW ARP @ 2014.5941

XYZ -1545099.8333 -4044895.8669 4669084.5684 NEW MON @ 2014.5941

LLH 47 20 59.87006 249 5 37.55750 1186.1535 NEW L1 PHS CEN @ 2014.5941

LLH 47 20 59.87003 249 5 37.55747 1186.0675 NEW ARP @ 2014.5941

LLH 47 20 59.87003 249 5 37.55747 1186.0592 NEW MON @ 2014.5941

STATION NAME: p053 a 1 (WhitewaterMT2007; Whitewater, Montana USA)

MONUMENT: NO DOMES NUMBER

XYZ -1283559.0999 -4015770.3187 4771131.6503 MON @ 2005.0000 (M)

XYZ -0.0164 -0.0004 -0.0047 VEL (M/YR)

NEU -0.0000 0.0000 0.0083 MON TO ARP (M)

NEU 0.0012 0.0008 0.0860 ARP TO L1 PHASE CENTER (M)

NEU 0.0006 -0.0006 0.1183 ARP TO L2 PHASE CENTER (M)

XYZ -0.1575 -0.0037 -0.0452 VEL TIMES 9.5932 YRS

XYZ -0.0017 -0.0052 0.0062 MON TO ARP

XYZ -0.0163 -0.0534 0.0654 ARP TO L1 PHASE CENTER

XYZ -1283559.2753 -4015770.3811 4771131.6767 L1 PHS CEN @ 2014.5941

XYZ -0.0001 0.0000 -0.0000 + XYZ ADJUSTMENTS

XYZ -1283559.2755 -4015770.3811 4771131.6767 NEW L1 PHS CEN @ 2014.5941

XYZ -1283559.2592 -4015770.3277 4771131.6113 NEW ARP @ 2014.5941

XYZ -1283559.2575 -4015770.3224 4771131.6051 NEW MON @ 2014.5941

LLH 48 43 33.88709 252 16 28.48430 815.0921 NEW L1 PHS CEN @ 2014.5941

LLH 48 43 33.88705 252 16 28.48426 815.0061 NEW ARP @ 2014.5941  
 LLH 48 43 33.88705 252 16 28.48426 814.9978 NEW MON @ 2014.5941

STATION NAME: mtlw a 1 (Lewistown; Lewistown, Montana USA)

MONUMENT: NO DOMES NUMBER

XYZ -1449333.3267 -4105829.8275 4646773.5579 MON @ 2005.0000 (M)  
 XYZ -0.0160 -0.0003 -0.0053 VEL (M/YR)  
 NEU 0.0000 0.0000 0.0000 MON TO ARP (M)  
 NEU 0.0011 -0.0003 0.0668 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0001 0.0007 0.0578 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.1540 -0.0033 -0.0506 VEL TIMES 9.5932 YRS  
 XYZ 0.0000 0.0000 0.0000 MON TO ARP  
 XYZ -0.0152 -0.0420 0.0496 ARP TO L1 PHASE CENTER  
 XYZ -1449333.4959 -4105829.8728 4646773.5570 L1 PHS CEN @ 2014.5941  
 XYZ 0.0002 -0.0000 0.0000 + XYZ ADJUSTMENTS  
 XYZ -1449333.4957 -4105829.8728 4646773.5571 NEW L1 PHS CEN @ 2014.5941  
 XYZ -1449333.4805 -4105829.8308 4646773.5074 NEW ARP @ 2014.5941  
 XYZ -1449333.4805 -4105829.8308 4646773.5074 NEW MON @ 2014.5941  
 LLH 47 3 14.94992 250 33 26.17776 1236.4224 NEW L1 PHS CEN @ 2014.5941  
 LLH 47 3 14.94988 250 33 26.17777 1236.3556 NEW ARP @ 2014.5941  
 LLH 47 3 14.94988 250 33 26.17777 1236.3556 NEW MON @ 2014.5941

#### REMOTE STATION INFORMATION

STATION NAME: 0187 1

MONUMENT: NO DOMES NUMBER

XYZ -1370393.7587 -4052959.1751 4715957.3065 MON @ 2014.5939 (M)  
 NEU -0.0011 0.0007 2.1000 MON TO ARP (M)  
 NEU 0.0011 -0.0007 0.0892 ARP TO L1 PHASE CENTER (M)  
 NEU 0.0007 -0.0031 0.1017 ARP TO L2 PHASE CENTER (M)  
 XYZ -0.4499 -1.3327 1.5593 MON TO ARP  
 XYZ -0.0195 -0.0556 0.0670 ARP TO L1 PHASE CENTER  
 XYZ -1370394.2281 -4052960.5634 4715958.9328 L1 PHS CEN @ 2014.5941

BASELINE NAME: p049 0187

XYZ -0.2722 -0.1376 0.7265 + XYZ ADJUSTMENTS  
 XYZ -1370394.5003 -4052960.7011 4715959.6593 NEW L1 PHS CEN @ 2014.5941  
 XYZ -1370394.4808 -4052960.6454 4715959.5922 NEW ARP @ 2014.5941  
 XYZ -1370394.0309 -4052959.3127 4715958.0330 NEW MON @ 2014.5941  
 LLH 47 58 36.28037 251 19 6.53586 1095.6662 NEW L1 PHS CEN @ 2014.5941  
 LLH 47 58 36.28034 251 19 6.53589 1095.5770 NEW ARP @ 2014.5941  
 LLH 47 58 36.28037 251 19 6.53586 1093.4770 NEW MON @ 2014.5941

BASELINE NAME: p053 0187

XYZ -0.2741 -0.1597 0.6999 + XYZ ADJUSTMENTS  
 XYZ -1370394.5023 -4052960.7231 4715959.6327 NEW L1 PHS CEN @ 2014.5941  
 XYZ -1370394.4827 -4052960.6675 4715959.5657 NEW ARP @ 2014.5941  
 XYZ -1370394.0328 -4052959.3348 4715958.0064 NEW MON @ 2014.5941  
 LLH 47 58 36.27928 251 19 6.53611 1095.6609 NEW L1 PHS CEN @ 2014.5941  
 LLH 47 58 36.27924 251 19 6.53615 1095.5717 NEW ARP @ 2014.5941  
 LLH 47 58 36.27928 251 19 6.53611 1093.4717 NEW MON @ 2014.5941

BASELINE NAME: mtlw 0187

XYZ -0.2609 -0.1384 0.6920 + XYZ ADJUSTMENTS  
 XYZ -1370394.4890 -4052960.7018 4715959.6248 NEW L1 PHS CEN @ 2014.5941  
 XYZ -1370394.4695 -4052960.6462 4715959.5578 NEW ARP @ 2014.5941  
 XYZ -1370394.0196 -4052959.3135 4715957.9985 NEW MON @ 2014.5941  
 LLH 47 58 36.27969 251 19 6.53639 1095.6387 NEW L1 PHS CEN @ 2014.5941  
 LLH 47 58 36.27966 251 19 6.53642 1095.5494 NEW ARP @ 2014.5941  
 LLH 47 58 36.27969 251 19 6.53639 1093.4495 NEW MON @ 2014.5941

G-FILES

Axx2014 8 5 14 8 5

B2014 8 51830 14 8 52239 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090001-1747058024 14 80634458 31 -468734645 37 X2174A0187X2174AP049  
 D 1 2 7471250 1 3 -6705485 2 3 -9261205

Axx2014 8 5 14 8 5

B2014 8 51830 14 8 52239 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090004 868347753 16 371890124 34 551735986 41 X2174A0187X2174AP053  
 D 1 2 8045253 1 3 -6622224 2 3 -9046980

Axx2014 8 5 14 8 5

B2014 8 51830 14 8 52239 1 page5 v1209.04IGS 126 1 2 27NGS 2014 8 8IFDDPX  
 IIGS08\_1804 IGS 20140803  
 C00090003 -789394609 15 -528705173 33 -691844911 39 X2174A0187X2174AMTLW  
 D 1 2 8328087 1 3 -6327520 2 3 -8812797

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 01 02 04 05 06 08 10 11  
 p049-0187| 0.025 0.020 0.033 0.019 0.044 0.014 ... 0.036 0.020  
 12 15 17 20 24 25 26 28 29  
 p049-0187| 0.023 0.020 0.022 0.027 0.021 0.030 0.022 0.018 0.089  
 30  
 p049-0187| 0.025

OVERALL 01 02 04 05 06 08 10 11  
 p053-0187| 0.027 0.017 0.036 0.015 0.058 0.019 ... 0.034 0.017  
 12 15 17 20 24 25 26 28 29  
 p053-0187| 0.026 0.028 0.031 0.025 0.023 0.048 0.024 0.018 0.054  
 30  
 p053-0187| 0.025

OVERALL 01 02 04 05 06 08 10 11  
 mtlw-0187| 0.030 0.017 0.036 0.015 0.053 0.023 ... 0.046 0.024  
 12 15 17 20 24 25 26 28 29  
 mtlw-0187| 0.036 0.021 0.029 0.026 0.028 0.044 0.021 0.014 0.076  
 30

mtlw-0187| 0.030

OBS BY SATELLITE VS. BASELINE

```

OVERALL 01 02 04 05 06 08 10 11
p049-0187| 3267 175 289 398 63 340 ... 199 51
          12 15 17 20 24 25 26 28 29
p049-0187| 361 42 86 209 428 180 85 259 31
          30
p049-0187| 71
OVERALL 01 02 04 05 06 08 10 11
p053-0187| 3227 178 285 405 62 335 ... 190 55
          12 15 17 20 24 25 26 28 29
p053-0187| 359 27 85 219 427 179 53 279 19
          30
p053-0187| 70
OVERALL 01 02 04 05 06 08 10 11
mtlw-0187| 3246 171 290 409 61 346 ... 199 22
          12 15 17 20 24 25 26 28 29
mtlw-0187| 361 31 86 199 451 180 78 271 20
          30
mtlw-0187| 71
    
```

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

```

0.0000013711 0.0000002329 -0.0000002516
0.0000002329 0.0000071244 -0.0000007448
-0.0000002516 -0.0000007448 0.0000099778
    
```

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

```

0.0000018200 -0.0000011557 0.0000010488
-0.0000011557 0.0000073839 0.0000015670
0.0000010488 0.0000015670 0.0000092694
    
```

Horizontal network accuracy = 0.00558 meters.

Vertical network accuracy = 0.00597 meters.

Derivation of NAD 83 vector components

Position of reference station ARP in NAD\_83(2011)(EPOCH:2010.0000).

```

Xa(m) Ya(m) Za(m)
P049 -1545098.96458 -4044897.09606 4669084.59181 2010.00
P053 -1283558.38336 -4015771.55123 4771131.61488 2010.00
MTLW -1449332.61170 -4105831.06162 4646773.52520 2010.00
    
```

Position of reference station monument in NAD\_83(2011)(EPOCH:2010.0000).

```

Xr(m) Yr(m) Zr(m)
P049 -1545098.96258 -4044897.09076 4669084.58571 2010.00
P053 -1283558.38166 -4015771.54603 4771131.60868 2010.00
    
```

MTLW -1449332.61170 -4105831.06162 4646773.52520 2010.00

Velocity of reference station monument in NAD\_83(2011)(EPOCH:2010.0000).

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
P049	-0.01570	-0.00020	-0.00670
P053	-0.01640	-0.00040	-0.00470
MTLW	-0.01600	-0.00030	-0.00530

Vectors from unknown station monument to reference station monument in NAD\_83(2011)(EPOCH:2010.0000).

	Xr-X= DX(m)	Yr-Y= DY(m)	Zr-Z= DZ(m)	
P049	-174705.80858	8063.45524	-46873.43829	2010.00
P053	86834.77234	37188.99997	55173.58468	2010.00
MTLW	-78939.45770	-52870.51562	-69184.49880	2010.00

STATE PLANE COORDINATES - International Foot

SPC (2500 MT )

Northing (Y) [feet]	1359677.818
Easting (X) [feet]	2168893.199
Convergence [degrees]	0.59873517
Point Scale	0.99953456
Combined Factor	0.99936319

\*\* 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: 1108.341 (m) [PROTOTYPE (Computed using USGG2012,GRS80,IGS08)]

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.