

OPUS solution : 401289225S.14O OP1408549947599

opus <opus@ngs.noaa.gov>

Wed 8/20/2014 9:55 AM

To:Chad Mozol <Chad.Mozol@neciusa.com>;

FILE: 401289225S.14O OP1408549947599

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 20, 2014
RINEX FILE: 4012225s.14o TIME: 15:54:53 UTC

SOFTWARE: page5 1209.04 master53.pl 022814 START: 2014/08/13 18:40:00
EPHEMERIS: igr18053.eph [rapid] STOP: 2014/08/13 20:42:30
NAV FILE: brdc2250.14n OBS USED: 4517 / 5127 : 88%
ANT NAME: CHCX91R NONE # FIXED AMB: 32 / 34 : 94%
ARP HEIGHT: 1.722 OVERALL RMS: 0.012(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2014.6160)

X: -1393383.352(m) 0.002(m) -1393384.227(m) 0.002(m)
Y: -4032789.325(m) 0.006(m) -4032788.102(m) 0.006(m)
Z: 4726345.611(m) 0.008(m) 4726345.602(m) 0.008(m)

LAT: 48 7 1.54707 0.001(m) 48 7 1.56785 0.001(m)
E LON: 250 56 21.39116 0.001(m) 250 56 21.33187 0.001(m)
W LON: 109 3 38.60884 0.001(m) 109 3 38.66813 0.001(m)
EL HGT: 1030.224(m) 0.009(m) 1029.637(m) 0.009(m)
ORTHO HGT: 1045.331(m) 0.018(m) [NAVD88 (Computed using GEOID12A)]

| | UTM COORDINATES | STATE PLANE COORDINATES |
|-----------------------|-----------------|-------------------------|
| | UTM (Zone 12) | SPC (2500 MT) |
| Northing (Y) [meters] | 5331133.979 | 429801.976 |
| Easting (X) [meters] | 644330.593 | 632692.887 |
| Convergence [degrees] | 1.44405937 | 0.32133174 |
| Point Scale | 0.99985596 | 0.99957907 |
| Combined Factor | 0.99969454 | 0.99941770 |

US NATIONAL GRID DESIGNATOR: 12UXU4433031133(NAD 83)

BASE STATIONS USED

| PID | DESIGNATION | LATITUDE | LONGITUDE | DISTANCE(m) |
|--------|-----------------------|----------|--------------------------|-------------|
| DI3425 | P052 LRRNCHJRDnMT2006 | CORS ARP | N472229.026 W1070107.185 | 173976.7 |
| DL7731 | P053 WHITEWATERMT2007 | CORS ARP | N484333.865 W1074331.456 | 119820.3 |
| DM7133 | MTLW LEWISTOWN | CORS ARP | N470314.929 W1092633.764 | 121643.5 |

NEAREST NGS PUBLISHED CONTROL POINT

| | | | | |
|--------|--------|-------------|--------------|--------|
| TK0470 | MARTEN | N480917.660 | W1090141.197 | 4856.5 |
|--------|--------|-------------|--------------|--------|

BASE STATION INFORMATION

STATION NAME: p052 a 2 (LRRnchJrdnMT2006; Jordan, MT United States)

MONUMENT: NO DOMES NUMBER

| | | | | |
|-----|----------------|-----------------|--------------|----------------------------|
| XYZ | -1266648.1846 | -4138194.5676 | 4670709.5484 | MON @ 2005.0000 (M) |
| XYZ | -0.0158 | 0.0003 | -0.0057 | 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 | -0.1520 | 0.0031 | -0.0551 | VEL TIMES 9.6150 YRS |
| XYZ | -0.0016 | -0.0054 | 0.0061 | MON TO ARP |
| XYZ | -0.0161 | -0.0551 | 0.0641 | ARP TO L1 PHASE CENTER |
| XYZ | -1266648.3544 | -4138194.6249 | 4670709.5635 | L1 PHS CEN @ 2014.6159 |
| XYZ | 0.0000 | 0.0000 | 0.0000 | + XYZ ADJUSTMENTS |
| XYZ | -1266648.3544 | -4138194.6249 | 4670709.5635 | NEW L1 PHS CEN @ 2014.6159 |
| XYZ | -1266648.3383 | -4138194.5698 | 4670709.4995 | NEW ARP @ 2014.6159 |
| XYZ | -1266648.3366 | -4138194.5645 | 4670709.4933 | NEW MON @ 2014.6159 |
| LLH | 47 22 29.04864 | 252 58 52.75787 | 858.7208 | NEW L1 PHS CEN @ 2014.6159 |
| LLH | 47 22 29.04860 | 252 58 52.75784 | 858.6348 | NEW ARP @ 2014.6159 |
| LLH | 47 22 29.04860 | 252 58 52.75784 | 858.6265 | NEW MON @ 2014.6159 |

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 | 0.1184 | ARP TO L2 PHASE CENTER (M) |
| XYZ | -0.1579 | -0.0037 | -0.0453 | VEL TIMES 9.6150 YRS |
| XYZ | -0.0017 | -0.0052 | 0.0062 | MON TO ARP |
| XYZ | -0.0163 | -0.0534 | 0.0654 | ARP TO L1 PHASE CENTER |
| XYZ | -1283559.2757 | -4015770.3811 | 4771131.6766 | L1 PHS CEN @ 2014.6159 |
| XYZ | 0.0000 | 0.0000 | 0.0000 | + XYZ ADJUSTMENTS |
| XYZ | -1283559.2757 | -4015770.3811 | 4771131.6766 | NEW L1 PHS CEN @ 2014.6159 |
| XYZ | -1283559.2594 | -4015770.3277 | 4771131.6112 | NEW ARP @ 2014.6159 |
| XYZ | -1283559.2577 | -4015770.3225 | 4771131.6050 | NEW MON @ 2014.6159 |
| LLH | 48 43 33.88708 | 252 16 28.48429 | 815.0921 | NEW L1 PHS CEN @ 2014.6159 |
| LLH | 48 43 33.88705 | 252 16 28.48425 | 815.0061 | NEW ARP @ 2014.6159 |
| LLH | 48 43 33.88705 | 252 16 28.48425 | 814.9978 | NEW MON @ 2014.6159 |

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 -0.1543 -0.0033 -0.0507 VEL TIMES 9.6150 YRS
 XYZ 0.0000 0.0000 0.0000 MON TO ARP
 XYZ -0.0152 -0.0420 0.0496 ARP TO L1 PHASE CENTER
 XYZ -1449333.4962 -4105829.8728 4646773.5569 L1 PHS CEN @ 2014.6159
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS
 XYZ -1449333.4962 -4105829.8728 4646773.5569 NEW L1 PHS CEN @ 2014.6159
 XYZ -1449333.4811 -4105829.8307 4646773.5073 NEW ARP @ 2014.6159
 XYZ -1449333.4811 -4105829.8307 4646773.5073 NEW MON @ 2014.6159
 LLH 47 3 14.94991 250 33 26.17773 1236.4224 NEW L1 PHS CEN @ 2014.6159
 LLH 47 3 14.94987 250 33 26.17775 1236.3556 NEW ARP @ 2014.6159
 LLH 47 3 14.94987 250 33 26.17775 1236.3556 NEW MON @ 2014.6159

REMOTE STATION INFORMATION

STATION NAME: 4012 1

MONUMENT: NO DOMES NUMBER

XYZ -1393384.0247 -4032788.0301 4726345.1155 MON @ 2014.6158 (M)
 NEU -0.0018 -0.0004 1.7220 MON TO ARP (M)
 NEU 0.0018 0.0004 0.0838 ARP TO L1 PHASE CENTER (M)
 NEU 0.0002 -0.0006 0.0960 ARP TO L2 PHASE CENTER (M)
 XYZ -0.3763 -1.0877 1.2808 MON TO ARP
 XYZ -0.0174 -0.0518 0.0636 ARP TO L1 PHASE CENTER
 XYZ -1393384.4184 -4032789.1696 4726346.4599 L1 PHS CEN @ 2014.6159

BASELINE NAME: p052 4012

XYZ -0.2022 -0.0739 0.4891 + XYZ ADJUSTMENTS
 XYZ -1393384.6206 -4032789.2435 4726346.9490 NEW L1 PHS CEN @ 2014.6159
 XYZ -1393384.6032 -4032789.1917 4726346.8854 NEW ARP @ 2014.6159
 XYZ -1393384.2269 -4032788.1040 4726345.6046 NEW MON @ 2014.6159
 LLH 48 7 1.56786 250 56 21.33190 1031.4456 NEW L1 PHS CEN @ 2014.6159
 LLH 48 7 1.56780 250 56 21.33188 1031.3617 NEW ARP @ 2014.6159
 LLH 48 7 1.56786 250 56 21.33190 1029.6398 NEW MON @ 2014.6159

BASELINE NAME: p053 4012

XYZ -0.2030 -0.0731 0.4895 + XYZ ADJUSTMENTS
 XYZ -1393384.6214 -4032789.2427 4726346.9494 NEW L1 PHS CEN @ 2014.6159
 XYZ -1393384.6040 -4032789.1909 4726346.8858 NEW ARP @ 2014.6159
 XYZ -1393384.2277 -4032788.1032 4726345.6050 NEW MON @ 2014.6159
 LLH 48 7 1.56788 250 56 21.33186 1031.4455 NEW L1 PHS CEN @ 2014.6159
 LLH 48 7 1.56782 250 56 21.33184 1031.3617 NEW ARP @ 2014.6159
 LLH 48 7 1.56788 250 56 21.33186 1029.6397 NEW MON @ 2014.6159

BASELINE NAME: mtlw 4012

XYZ -0.2005 -0.0680 0.4819 + XYZ ADJUSTMENTS
 XYZ -1393384.6189 -4032789.2376 4726346.9418 NEW L1 PHS CEN @ 2014.6159
 XYZ -1393384.6015 -4032789.1858 4726346.8782 NEW ARP @ 2014.6159
 XYZ -1393384.2252 -4032788.0981 4726345.5974 NEW MON @ 2014.6159

LLH 48 7 1.56785 250 56 21.33189 1031.4361 NEW L1 PHS CEN @ 2014.6159
 LLH 48 7 1.56780 250 56 21.33187 1031.3523 NEW ARP @ 2014.6159
 LLH 48 7 1.56785 250 56 21.33189 1029.6303 NEW MON @ 2014.6159

G-FILES

Axx2014 813 14 813

B2014 8131840 14 8132042 1 page5 v1209.04IGS 126 1 2 27NGS 2014 820IFDDPX
 IIGS08_1804 IGS 20140803
 C00090005 1267358903 12-1054064604 26 -556361113 28 X2254A4012X2254AP052
 D 1 2 7565722 1 3 -8210223 2 3 -9508430

Axx2014 813 14 813

B2014 8131840 14 8132042 1 page5 v1209.04IGS 126 1 2 27NGS 2014 820IFDDPX
 IIGS08_1804 IGS 20140803
 C00090004 1098249700 12 170177807 21 447860000 27 X2254A4012X2254AP053
 D 1 2 7361244 1 3 -6016279 2 3 -9435888

Axx2014 813 14 813

B2014 8131840 14 8132042 1 page5 v1209.04IGS 126 1 2 27NGS 2014 820IFDDPX
 IIGS08_1804 IGS 20140803
 C00090003 -559492558 14 -730417326 28 -795720901 35 X2254A4012X2254AMTLW
 D 1 2 8950357 1 3 -7766595 2 3 -9290681

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 01 02 04 06 10 12 15 17
 p052-4012| 0.013 0.016 0.015 0.008 0.010 0.024 0.013 0.017 ...
 20 24 25 26 28 30
 p052-4012| 0.020 0.008 0.010 ...

OVERALL 01 02 04 06 10 12 15 17
 p053-4012| 0.012 0.016 0.014 0.007 0.009 0.022 0.011
 20 24 25 26 28 30
 p053-4012| 0.021 0.008 0.013 ...

OVERALL 01 02 04 06 10 12 15 17
 mtlw-4012| 0.012 0.026 0.012 0.008 0.009 ... 0.012
 20 24 25 26 28 30
 mtlw-4012| 0.021 0.008 0.011 ...

OBS BY SATELLITE VS. BASELINE

OVERALL 01 02 04 06 10 12 15 17
 p052-4012| 1578 47 170 244 244 25 189 19 ...
 20 24 25 26 28 30
 p052-4012| 192 244 204 ...

OVERALL 01 02 04 06 10 12 15 17
 p053-4012| 1490 50 174 244 244 28 155
 20 24 25 26 28 30
 p053-4012| 147 244 204 ...

OVERALL 01 02 04 06 10 12 15 17
 mtlw-4012| 1449 63 164 244 244 ... 176

| | | | | | | |
|-----------|-----|-----|-----|-----|-----|-----|
| | 20 | 24 | 25 | 26 | 28 | 30 |
| mtlw-4012 | 117 | 244 | ... | ... | 197 | ... |

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

| | | |
|---------------|---------------|---------------|
| 0.0000015911 | 0.0000002742 | -0.0000003054 |
| 0.0000002742 | 0.0000066244 | -0.0000007193 |
| -0.0000003054 | -0.0000007193 | 0.0000089178 |

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

| | | |
|---------------|---------------|--------------|
| 0.0000019586 | -0.0000010291 | 0.0000008566 |
| -0.0000010291 | 0.0000066761 | 0.0000012440 |
| 0.0000008566 | 0.0000012440 | 0.0000084986 |

Horizontal network accuracy = 0.00535 meters.

Vertical network accuracy = 0.00572 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) | |
|------|----------------|----------------|---------------|---------|
| P052 | -1266647.47169 | -4138195.81057 | 4670709.52375 | 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) | |
|------|----------------|----------------|---------------|---------|
| P052 | -1266647.47009 | -4138195.80517 | 4670709.51765 | 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) |
|------|-----------|-----------|-----------|
| P052 | -0.01580 | 0.00030 | -0.00570 |
| 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) | |
|------|--------------|---------------|--------------|---------|
| P052 | 126735.88191 | -105406.48017 | -55636.09335 | 2010.00 |
| P053 | 109824.97034 | 17017.77897 | 44785.99768 | 2010.00 |
| MTLW | -55949.25970 | -73041.73662 | -79572.08580 | 2010.00 |

STATE PLANE COORDINATES - International Foot

| | SPC (2500 MT) |
|-----------------------|----------------|
| Northing (Y) [feet] | 1410111.470 |
| Easting (X) [feet] | 2075764.065 |
| Convergence [degrees] | 0.32133174 |
| Point Scale | 0.99957907 |
| Combined Factor | 0.99941770 |

** 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: 1044.331 (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.