

OPUS solution : 018772_14_239_A1.14O OP1409695925608

opus <opus@ngs.noaa.gov>

Tue 9/2/2014 4:15 PM

To: John Freetly <John.Freetly@neciusa.com>;

FILE: 018772_14_239_A1.14O OP1409695925608

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: john.freetly@neciusa.com
RINEX FILE: 0187239w.14oDATE: September 02, 2014
TIME: 22:15:03 UTCSOFTWARE: page5 1209.04 master90.pl 022814 START: 2014/08/27 22:42:00
EPHEMERIS: igr18073.eph [rapid] STOP: 2014/08/28 00:51:00
NAV FILE: brdc2390.14n OBS USED: 4377 / 4852 : 90%
ANT NAME: CHCX90D-OPUS NONE # FIXED AMB: 38 / 42 : 90%
ARP HEIGHT: 1.8000 OVERALL RMS: 0.015(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2014.6548)

X: -1337561.030(m) 0.021(m) -1337561.889(m) 0.021(m)
Y: -4287206.683(m) 0.028(m) -4287205.429(m) 0.028(m)
Z: 4515364.423(m) 0.013(m) 4515364.382(m) 0.013(m)LAT: 45 20 50.24145 0.013(m) 45 20 50.26220 0.013(m)
E LON: 252 40 21.56222 0.017(m) 252 40 21.50740 0.017(m)
W LON: 107 19 38.43778 0.017(m) 107 19 38.49260 0.017(m)
EL HGT: 1134.923(m) 0.029(m) 1134.233(m) 0.029(m)
ORTHO HGT: 1149.345(m) 0.050(m) [NAVD88 (Computed using GEOID12A)]

UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 13) SPC (2500 MT)

Northing (Y) [meters] 5024165.886 124317.556
Easting (X) [meters] 317681.730 770214.736
Convergence [degrees] -1.65607969 1.58930712
Point Scale 1.00000871 0.99980929
Combined Factor 0.99983081 0.99963142

US NATIONAL GRID DESIGNATOR: 13TCL1768124165(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DM7161	WYSH SHERIDAN CORS ARP	N444801.769	W1070035.715	65719.1
DI3062	BIL5 BILLINGS 5 CORS ARP	N455816.237	W1075947.298	86776.3
DG9745	MTEI ENGINC CORS ARP	N454447.035	W1083600.736	108865.2

NEAREST NGS PUBLISHED CONTROL POINT

QV0182	F 486	N452015.	W1072224.	3759.7
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BASE STATION INFORMATION

STATION NAME: wysh a 1 (Sheridan; Sheridan, Wyoming USA)

MONUMENT: NO DOMES NUMBER

XYZ	-1326396.2772	-4335757.8813	4472504.2552	MON @ 2005.0000 (M)
XYZ	-0.0156	-0.0003	-0.0049	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	0.0013	-0.0002	0.0667	ARP TO L1 PHASE CENTER (M)
NEU	0.0004	0.0006	0.0577	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1502	-0.0032	-0.0474	VEL TIMES 9.6538 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	-0.0138	-0.0444	0.0479	ARP TO L1 PHASE CENTER
XYZ	-1326396.4412	-4335757.9288	4472504.2557	L1 PHS CEN @ 2014.6548
XYZ	0.0000	-0.0000	-0.0000	+ XYZ ADJUSTMENTS
XYZ	-1326396.4411	-4335757.9288	4472504.2557	NEW L1 PHS CEN @ 2014.6548
XYZ	-1326396.4274	-4335757.8845	4472504.2078	NEW ARP @ 2014.6548
XYZ	-1326396.4274	-4335757.8845	4472504.2078	NEW MON @ 2014.6548
LLH	44 48 1.79015	252 59 24.23032	1220.7140	NEW L1 PHS CEN @ 2014.6548
LLH	44 48 1.79011	252 59 24.23033	1220.6472	NEW ARP @ 2014.6548
LLH	44 48 1.79011	252 59 24.23033	1220.6472	NEW MON @ 2014.6548

STATION NAME: bil5 a 1 (Billings 5; Billings, Montana USA)

MONUMENT: NO DOMES NUMBER

XYZ	-1372156.7413	-4223945.7929	4563650.2922	MON @ 2005.0000 (M)
XYZ	-0.0154	0.0005	-0.0072	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	-0.0028	-0.0023	0.0632	ARP TO L1 PHASE CENTER (M)
NEU	-0.0038	-0.0021	0.0612	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1484	0.0046	-0.0694	VEL TIMES 9.6538 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	-0.0163	-0.0430	0.0434	ARP TO L1 PHASE CENTER
XYZ	-1372156.9061	-4223945.8313	4563650.2663	L1 PHS CEN @ 2014.6548
XYZ	-0.0000	0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	-1372156.9061	-4223945.8313	4563650.2663	NEW L1 PHS CEN @ 2014.6548
XYZ	-1372156.8897	-4223945.7883	4563650.2228	NEW ARP @ 2014.6548
XYZ	-1372156.8897	-4223945.7883	4563650.2228	NEW MON @ 2014.6548
LLH	45 58 16.25826	252 0 12.64546	873.9125	NEW L1 PHS CEN @ 2014.6548

LLH 45 58 16.25835 252 0 12.64557 873.8493 NEW ARP @ 2014.6548
 LLH 45 58 16.25835 252 0 12.64557 873.8493 NEW MON @ 2014.6548

STATION NAME: mtei a 1 (ENGINC; Billings, Montana, U.S.A.)
 MONUMENT: NO DOMES NUMBER

XYZ -1422328.9082 -4226311.5606 4546317.4839 MON @ 2005.0000 (M)
 XYZ -0.0155 0.0003 -0.0078 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 -0.1492 0.0025 -0.0751 VEL TIMES 9.6538 YRS
 XYZ 0.0000 0.0000 0.0000 MON TO ARP
 XYZ -0.0149 -0.0433 0.0486 ARP TO L1 PHASE CENTER
 XYZ -1422329.0722 -4226311.6014 4546317.4574 L1 PHS CEN @ 2014.6548
 XYZ -0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS
 XYZ -1422329.0722 -4226311.6014 4546317.4574 NEW L1 PHS CEN @ 2014.6548
 XYZ -1422329.0573 -4226311.5581 4546317.4088 NEW ARP @ 2014.6548
 XYZ -1422329.0573 -4226311.5581 4546317.4088 NEW MON @ 2014.6548
 LLH 45 44 47.05575 251 23 59.20745 970.2674 NEW L1 PHS CEN @ 2014.6548
 LLH 45 44 47.05571 251 23 59.20747 970.2006 NEW ARP @ 2014.6548
 LLH 45 44 47.05571 251 23 59.20747 970.2006 NEW MON @ 2014.6548

REMOTE STATION INFORMATION

STATION NAME: 0187 1

MONUMENT: NO DOMES NUMBER

XYZ -1337562.0375 -4287205.0218 4515364.5019 MON @ 2014.6546 (M)
 NEU -0.0011 0.0007 1.8000 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 -0.3764 -1.2086 1.2798 MON TO ARP
 XYZ -0.0191 -0.0589 0.0642 ARP TO L1 PHASE CENTER
 XYZ -1337562.4330 -4287206.2894 4515365.8459 L1 PHS CEN @ 2014.6548

BASELINE NAME: wysh 0187

XYZ 0.1449 -0.3956 -0.1220 + XYZ ADJUSTMENTS
 XYZ -1337562.2881 -4287206.6850 4515365.7239 NEW L1 PHS CEN @ 2014.6548
 XYZ -1337562.2690 -4287206.6260 4515365.6597 NEW ARP @ 2014.6548
 XYZ -1337561.8926 -4287205.4174 4515364.3799 NEW MON @ 2014.6548
 LLH 45 20 50.26239 252 40 21.50709 1136.1134 NEW L1 PHS CEN @ 2014.6548
 LLH 45 20 50.26235 252 40 21.50712 1136.0242 NEW ARP @ 2014.6548
 LLH 45 20 50.26239 252 40 21.50709 1134.2241 NEW MON @ 2014.6548

BASELINE NAME: bil5 0187

XYZ 0.1606 -0.4013 -0.1251 + XYZ ADJUSTMENTS
 XYZ -1337562.2723 -4287206.6907 4515365.7208 NEW L1 PHS CEN @ 2014.6548
 XYZ -1337562.2533 -4287206.6317 4515365.6566 NEW ARP @ 2014.6548
 XYZ -1337561.8769 -4287205.4231 4515364.3768 NEW MON @ 2014.6548
 LLH 45 20 50.26230 252 40 21.50785 1136.1117 NEW L1 PHS CEN @ 2014.6548
 LLH 45 20 50.26226 252 40 21.50789 1136.0225 NEW ARP @ 2014.6548
 LLH 45 20 50.26230 252 40 21.50785 1134.2224 NEW MON @ 2014.6548

BASELINE NAME: mtei 0187
 XYZ 0.1400 -0.4237 -0.1118 + XYZ ADJUSTMENTS
 XYZ -1337562.2929 -4287206.7130 4515365.7341 NEW L1 PHS CEN @ 2014.6548
 XYZ -1337562.2738 -4287206.6541 4515365.6698 NEW ARP @ 2014.6548
 XYZ -1337561.8975 -4287205.4455 4515364.3901 NEW MON @ 2014.6548
 LLH 45 20 50.26197 252 40 21.50726 1136.1405 NEW L1 PHS CEN @ 2014.6548
 LLH 45 20 50.26193 252 40 21.50729 1136.0512 NEW ARP @ 2014.6548
 LLH 45 20 50.26197 252 40 21.50726 1134.2512 NEW MON @ 2014.6548

G-FILES

Axx2014 827 14 828
 B2014 8272241 14 828 050 1 page5 v1209.04IGS 126 1 2 27NGS 2014 9 2IFDDPX
 IIGS08_1805 IGS 20140810
 C00090005 111654653 9 -485524671 31 -428601721 26 X2394A0187X2394AWYSH
 D 1 2 6645451 1 3 -8336271 2 3 -7581404

Axx2014 827 14 828
 B2014 8272241 14 828 050 1 page5 v1209.04IGS 126 1 2 27NGS 2014 9 2IFDDPX
 IIGS08_1805 IGS 20140810
 C00090003 -345950128 14 632596348 46 482858460 39 X2394A0187X2394ABIL5
 D 1 2 6274496 1 3 -8349091 2 3 -8568279

Axx2014 827 14 828
 B2014 8272241 14 828 050 1 page5 v1209.04IGS 126 1 2 27NGS 2014 9 2IFDDPX
 IIGS08_1805 IGS 20140810
 C00090001 -847671599 12 608938873 30 309530187 30 X2394A0187X2394AMTEI
 D 1 2 5109206 1 3 -7674934 2 3 -8485842

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 02 05 10 12 15 16 18 21
 wysh-0187| 0.015 0.018 0.009 0.020 0.018 0.017 0.024 0.011 0.017
 25 26 29
 wysh-0187| 0.009 0.016 ...

OVERALL 02 05 10 12 15 16 18 21
 bil5-0187| 0.016 0.021 0.010 0.023 0.012 0.011 0.023 0.016 0.019
 25 26 29
 bil5-0187| 0.016 0.017 ...

OVERALL 02 05 10 12 15 16 18 21
 mtei-0187| 0.015 0.017 0.009 0.020 0.012 0.017 0.023 0.013 0.015
 25 26 29
 mtei-0187| 0.011 0.016 ...

OBS BY SATELLITE VS. BASELINE

OVERALL 02 05 10 12 15 16 18 21
 wysh-0187| 1504 150 257 100 102 141 71 99 214

```

    25  26  29
wysh-0187| 199 171 ...
    OVERALL  02  05  10  12  15  16  18  21
bil5-0187| 1389 163 257  59  77 129  42 101 196
    25  26  29
bil5-0187| 191 174 ...
    OVERALL  02  05  10  12  15  16  18  21
mtei-0187| 1484 162 257  73  87 137  75 113 221
    25  26  29
mtei-0187| 189 170 ...

```

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

```

0.0000020356  0.0000001957  -0.0000002854
0.0000001957  0.0000089778  -0.0000006978
-0.0000002854 -0.0000006978  0.0000076556

```

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

```

0.0000025401  -0.0000013308  0.0000012325
-0.0000013308  0.0000073155  -0.0000004129
0.0000012325  -0.0000004129  0.0000088133

```

Horizontal network accuracy = 0.00568 meters.

Vertical network accuracy = 0.00582 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)
WYSH -1326395.57266 -4335759.14462 4472504.25410 2010.00
BIL5 -1372156.02966 -4223947.03790 4563650.26522 2010.00
MTEI -1422328.19717 -4226312.80615 4546317.45438 2010.00

```

Position of reference station monument in NAD_83(2011)(EPOCH:2010.0000).

```

    Xr(m)    Yr(m)    Zr(m)
WYSH -1326395.57266 -4335759.14462 4472504.25410 2010.00
BIL5 -1372156.02966 -4223947.03790 4563650.26522 2010.00
MTEI -1422328.19717 -4226312.80615 4546317.45438 2010.00

```

Velocity of reference station monument in NAD_83(2011)(EPOCH:2010.0000).

```

    Vx (m/yr)  Vy (m/yr)  Vz (m/yr)
WYSH   -0.01560   -0.00030   -0.00490
BIL5   -0.01540    0.00050   -0.00720
MTEI   -0.01550    0.00030   -0.00780

```

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)
WYSH  11165.45734 -48552.46162 -42860.16890 2010.00

```

BIL5	-34594.99966	63259.64510	48285.84222	2010.00
MTEI	-84767.16717	60893.87685	30953.03138	2010.00

STATE PLANE COORDINATES - International Foot

SPC (2500 MT)

Northing (Y) [feet]	407865.997
Easting (X) [feet]	2526951.234
Convergence [degrees]	1.58930712
Point Scale	0.99980929
Combined Factor	0.99963142

** 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: 1148.490 (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.