

OPUS solution : 018697_14_243_A0.14O OP1409698414742

opus <opus@ngs.noaa.gov>

Tue 9/2/2014 4:56 PM

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

FILE: 018697_14_243_A0.14O OP1409698414742

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

DATE: September 02, 2014

RINEX FILE: 0186243x.14o

TIME: 22:56:13 UTC

SOFTWARE: page5 1209.04 master51.pl 022814 START: 2014/08/31 23:07:00

EPHEMERIS: igr18080.eph [rapid]

STOP: 2014/09/01 01:25:00

NAV FILE: brdc2430.14n

OBS USED: 4878 / 5262 : 93%

ANT NAME: CHCX90D-OPUS NONE

FIXED AMB: 34 / 38 : 89%

ARP HEIGHT: 1.8000

OVERALL RMS: 0.017(m)

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

IGS08 (EPOCH:2014.6658)

X: -1326018.383(m) 0.019(m) -1326019.247(m) 0.019(m)

Y: -4224969.079(m) 0.036(m) -4224967.833(m) 0.036(m)

Z: 4576237.058(m) 0.044(m) 4576237.025(m) 0.044(m)

LAT: 46 8 3.66118 0.024(m) 46 8 3.68215 0.024(m)

E LON: 252 34 31.39912 0.008(m) 252 34 31.34334 0.008(m)

W LON: 107 25 28.60088 0.008(m) 107 25 28.65666 0.008(m)

EL HGT: 871.767(m) 0.049(m) 871.099(m) 0.049(m)

ORTHO HGT: 886.584(m) 0.084(m) [NAVD88 (Computed using GEOID12A)]

UTM COORDINATES STATE PLANE COORDINATES

UTM (Zone 13) SPC (2500 MT)

Northing (Y) [meters] 5111832.753 211527.943

Easting (X) [meters] 312713.788 760279.412

Convergence [degrees] -1.74857007 1.51815552

Point Scale 1.00003121 0.99950906

Combined Factor 0.99989456 0.99937248

US NATIONAL GRID DESIGNATOR: 13TCM1271311832(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DM7161	WYSH SHERIDAN CORS ARP	N444801.769	W1070035.715	151773.1
DG9745	MTEI ENGINC CORS ARP	N454447.035	W1083600.736	100859.1
DI3062	BIL5 BILLINGS 5 CORS ARP	N455816.237	W1075947.298	47834.7

NEAREST NGS PUBLISHED CONTROL POINT

RU0425	N 554	N460916.	W1072544.	2261.1
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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	-0.1504	-0.0032	-0.0475	VEL TIMES 9.6649 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	-0.0138	-0.0444	0.0479	ARP TO L1 PHASE CENTER
XYZ	-1326396.4413	-4335757.9288	4472504.2557	L1 PHS CEN @ 2014.6658
XYZ	0.0000	-0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	-1326396.4413	-4335757.9288	4472504.2557	NEW L1 PHS CEN @ 2014.6658
XYZ	-1326396.4275	-4335757.8845	4472504.2077	NEW ARP @ 2014.6658
XYZ	-1326396.4275	-4335757.8845	4472504.2077	NEW MON @ 2014.6658
LLH	44 48 1.79015	252 59 24.23031	1220.7140	NEW L1 PHS CEN @ 2014.6658
LLH	44 48 1.79011	252 59 24.23032	1220.6472	NEW ARP @ 2014.6658
LLH	44 48 1.79011	252 59 24.23032	1220.6472	NEW MON @ 2014.6658

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	-0.1493	0.0025	-0.0752	VEL TIMES 9.6649 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	-0.0149	-0.0433	0.0486	ARP TO L1 PHASE CENTER
XYZ	-1422329.0724	-4226311.6014	4546317.4573	L1 PHS CEN @ 2014.6658
XYZ	0.0000	0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	-1422329.0724	-4226311.6014	4546317.4573	NEW L1 PHS CEN @ 2014.6658
XYZ	-1422329.0575	-4226311.5581	4546317.4087	NEW ARP @ 2014.6658
XYZ	-1422329.0575	-4226311.5581	4546317.4087	NEW MON @ 2014.6658
LLH	45 44 47.05575	251 23 59.20745	970.2674	NEW L1 PHS CEN @ 2014.6658

LLH 45 44 47.05571 251 23 59.20746 970.2006 NEW ARP @ 2014.6658
 LLH 45 44 47.05571 251 23 59.20746 970.2006 NEW MON @ 2014.6658

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 0.0631 ARP TO L1 PHASE CENTER (M)
 NEU -0.0038 -0.0021 0.0612 ARP TO L2 PHASE CENTER (M)
 XYZ -0.1486 0.0046 -0.0695 VEL TIMES 9.6649 YRS
 XYZ 0.0000 0.0000 0.0000 MON TO ARP
 XYZ -0.0163 -0.0430 0.0434 ARP TO L1 PHASE CENTER
 XYZ -1372156.9062 -4223945.8313 4563650.2662 L1 PHS CEN @ 2014.6658
 XYZ 0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS
 XYZ -1372156.9062 -4223945.8313 4563650.2662 NEW L1 PHS CEN @ 2014.6658
 XYZ -1372156.8899 -4223945.7883 4563650.2228 NEW ARP @ 2014.6658
 XYZ -1372156.8899 -4223945.7883 4563650.2228 NEW MON @ 2014.6658
 LLH 45 58 16.25826 252 0 12.64546 873.9125 NEW L1 PHS CEN @ 2014.6658
 LLH 45 58 16.25835 252 0 12.64556 873.8493 NEW ARP @ 2014.6658
 LLH 45 58 16.25835 252 0 12.64556 873.8493 NEW MON @ 2014.6658

REMOTE STATION INFORMATION

STATION NAME: 0186 1

MONUMENT: NO DOMES NUMBER

XYZ -1326019.0712 -4224967.8066 4576236.9988 MON @ 2014.6657 (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 0.1016 ARP TO L2 PHASE CENTER (M)
 XYZ -0.3731 -1.1911 1.2970 MON TO ARP
 XYZ -0.0189 -0.0581 0.0651 ARP TO L1 PHASE CENTER
 XYZ -1326019.4632 -4224969.0557 4576238.3609 L1 PHS CEN @ 2014.6658

BASELINE NAME: wysh 0186

XYZ -0.1778 -0.0257 0.0457 + XYZ ADJUSTMENTS
 XYZ -1326019.6411 -4224969.0815 4576238.4067 NEW L1 PHS CEN @ 2014.6658
 XYZ -1326019.6222 -4224969.0234 4576238.3416 NEW ARP @ 2014.6658
 XYZ -1326019.2490 -4224967.8323 4576237.0445 NEW MON @ 2014.6658
 LLH 46 8 3.68259 252 34 31.34324 873.0025 NEW L1 PHS CEN @ 2014.6658
 LLH 46 8 3.68256 252 34 31.34327 872.9133 NEW ARP @ 2014.6658
 LLH 46 8 3.68259 252 34 31.34324 871.1132 NEW MON @ 2014.6658

BASELINE NAME: mtei 0186

XYZ -0.1839 -0.0444 0.0322 + XYZ ADJUSTMENTS
 XYZ -1326019.6472 -4224969.1001 4576238.3931 NEW L1 PHS CEN @ 2014.6658
 XYZ -1326019.6283 -4224969.0421 4576238.3280 NEW ARP @ 2014.6658
 XYZ -1326019.2551 -4224967.8510 4576237.0310 NEW MON @ 2014.6658
 LLH 46 8 3.68183 252 34 31.34323 873.0063 NEW L1 PHS CEN @ 2014.6658
 LLH 46 8 3.68180 252 34 31.34326 872.9171 NEW ARP @ 2014.6658
 LLH 46 8 3.68183 252 34 31.34323 871.1170 NEW MON @ 2014.6658

BASELINE NAME: bil5 0186
 XYZ -0.1644 -0.0089 0.0021 + XYZ ADJUSTMENTS
 XYZ -1326019.6277 -4224969.0646 4576238.3630 NEW L1 PHS CEN @ 2014.6658
 XYZ -1326019.6088 -4224969.0066 4576238.2979 NEW ARP @ 2014.6658
 XYZ -1326019.2356 -4224967.8155 4576237.0009 NEW MON @ 2014.6658
 LLH 46 8 3.68208 252 34 31.34360 872.9571 NEW L1 PHS CEN @ 2014.6658
 LLH 46 8 3.68205 252 34 31.34363 872.8678 NEW ARP @ 2014.6658
 LLH 46 8 3.68208 252 34 31.34360 871.0678 NEW MON @ 2014.6658

G-FILES

Axx2014 831 14 9 1
 B2014 83123 7 14 9 1 124 1 page5 v1209.04IGS 126 1 2 27NGS 2014 9 2IFDDPX
 IIGS08_1805 IGS 20140810
 C00090005 -3771785 10-1107900521 33-1037328368 34 X2434A0186X2434AWYSH
 D 1 2 8488430 1 3 -8315092 2 3 -8302993

Axx2014 831 14 9 1
 B2014 83123 7 14 9 1 124 1 page5 v1209.04IGS 126 1 2 27NGS 2014 9 2IFDDPX
 IIGS08_1805 IGS 20140810
 C00090001 -963098024 16 -13437072 40 -299196223 40 X2434A0186X2434AMTEI
 D 1 2 6971758 1 3 -6163532 2 3 -9194853

Axx2014 831 14 9 1
 B2014 83123 7 14 9 1 124 1 page5 v1209.04IGS 126 1 2 27NGS 2014 9 2IFDDPX
 IIGS08_1805 IGS 20140810
 C00090003 -461376542 10 10220272 30 -125867781 29 X2434A0186X2434ABIL5
 D 1 2 6278348 1 3 -5646544 2 3 -9272492

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 02 05 10 12 15 16 18 21
 wysh-0186| 0.015 0.019 0.014 0.014 0.021 0.012 0.011
 22 25 26 27 29
 wysh-0186| 0.023 0.020 0.017

OVERALL 02 05 10 12 15 16 18 21
 mtei-0186| 0.020 0.030 0.018 0.018 0.025 0.018 0.017
 22 25 26 27 29
 mtei-0186| 0.044 0.024 0.019 0.016 ...

OVERALL 02 05 10 12 15 16 18 21
 bil5-0186| 0.015 0.017 0.012 0.012 0.024 0.012 0.013
 22 25 26 27 29
 bil5-0186| 0.024 0.015 0.015 0.021 ...

OBS BY SATELLITE VS. BASELINE

OVERALL 02 05 10 12 15 16 18 21
 wysh-0186| 1647 77 256 238 171 205 275

```

    22  25  26  27  29
wysh-0186| 33 122 270 ... ..
    OVERALL 02 05 10 12 15 16 18 21
mtei-0186| 1615 67 243 ... .. 234 160 215 275
    22  25  26  27  29
mtei-0186| 19 109 273 20 ...
    OVERALL 02 05 10 12 15 16 18 21
bil5-0186| 1616 98 249 ... .. 232 159 188 274
    22  25  26  27  29
bil5-0186| 34 102 262 18 ...

```

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

```

0.0000014333  0.0000002495  -0.0000002154
0.0000002495  0.0000087644  -0.0000007880
-0.0000002154 -0.0000007880  0.0000083044

```

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

```

0.0000019481  -0.0000013369  0.0000013360
-0.0000013369  0.0000074603  0.0000000005
0.0000013360  0.0000000005  0.0000090938

```

Horizontal network accuracy = 0.00564 meters.

Vertical network accuracy = 0.00591 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
MTEI -1422328.19717 -4226312.80615 4546317.45438 2010.00
BIL5 -1372156.02966 -4223947.03790 4563650.26522 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
MTEI -1422328.19717 -4226312.80615 4546317.45438 2010.00
BIL5 -1372156.02966 -4223947.03790 4563650.26522 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
MTEI   -0.01550    0.00030   -0.00780
BIL5   -0.01540    0.00050   -0.00720

```

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   -377.18966 -110790.06562 -103732.80390 2010.00

```

MTEI	-96309.81417	-1343.72715	-29919.60362	2010.00
BIL5	-46137.64666	1022.04110	-12586.79278	2010.00

STATE PLANE COORDINATES - International Foot

SPC (2500 MT)

Northing (Y) [feet]	693989.314
Easting (X) [feet]	2494355.026
Convergence [degrees]	1.51815552
Point Scale	0.99950906
Combined Factor	0.99937248

** 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: 885.666 (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.