Porter's Survey

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LOTS, ACREAGE, SUB-DIVISION
CONSTRUCTION LAYOUT

November 7, 2016

Nelson Turcotte
Black River Limited Partnership
36 Kimberley Drive
Kapuskasing, ON P9N 1L5

RE: SUR#114-16 File #36R1031

Dear Mr. Tucker;
Per your request to verify the water levels at both the Alverno Facility gauge and the Black River Marina outside gauges, we have completed the requested work and find the following:

On November 2, 2016, we searched for the National Geodetic Survey (NGS) bench mark at the Alverno Facility location. This bench mark had an ID of QK0053 (see attached data sheets). The bench mark appears to have been destroyed. We then proceeded to locate the next available NGS bench mark being ID QK0050 (see attached data sheet) approximately 1 mile from the Alverno Facility and 6 miles from Black River Marina. We placed our survey grade Global Positioning System (GPS) upon this bench mark having a recorded elevation of 688.07' NAVD 88. We then transferred this elevation by GPS through Real Time Kinematic (RTK) shots to a 1/2" rod & cap at a convenient location on the grounds of both Alverno and Black River Marina. These positions were taken with a 10 minute RTK shots and measured on top of the rod and cap, being 616.04' NAVD 88 at the Alverno Facility and 613.52' NAVD 88 at the Black River Marina.

At 4:32 pm we transferred the elevation at the 1/2" rod & cap at the Black Lake Marina to the water and found it to be 611.80' NAVD 88 on the smooth glass like surface of the water. At 4:51pm we transferred the elevation at the 1/2" rod & cap at the Alverno Facility to the water and found it to be 611.35' NAVD 88 on the smooth glass like surface of the water.

We noted the current water level at the at the Black River Marina gauge being 612.10' NAVD 88.
And we noted the current water level at the Alverno Facility gauge being 611.5' NAVD 88.

To verify our work upon this project, we proceeded to complete a GPS static 2 hour plus positioning shot on both the NGS bench mark QK0050 and our 1/2" rod & cap at the Black River Marina. These positioned readings are post processed through the online positioning user service (OPUS) operated by

NGS and balances our readings with other online continuous operating core stations (see attached OPUS result pages). This process when completed resulting in the NGS bench QK0050 to be at an elevation of 688.20' NAVD 88 and Black Lake Marina to be at 613.53' NAVD 88 on top of the 1/2" rods and caps. Using these elevations to calibrate our GPS for higher accuracy we found the 1/2"rod & cap at Alverno to be at 616.15' NAVD 88, which translated to a water elevation of 611.81' NAVD 88 at the Black River Marina and 611.46' NAVD 88 at the Alverno Facility, again compared to the onsite gauges being 612.10' at the Black River Marina and 611.5' NAVD 88 at the Alverno Facility.

I hope this covers your request on this work. Should you have any questions please feel free to give us a call.

Sincerely,

Delmer E. Porter
Porter's Survey P.C.

p.s.
Benchmark Qk0050 recorded as 688.07', adjusted to 688.20'
Top of the ½" rod & cap at the Alverno Facility 616.04', adjusted to 616.15'
Top of the ½" rod & cap at the Black river Marina 613.52', adjusted to 613.53'
Water level at the Black River Marina direct reading of 611.80', adjusted to 611.81', gauge reading 612.10'
Water level at the Alverno Facility direct reading of 611.35', adjusted to 611.46', gauge reading 611.5'

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.10
1         National Geodetic Survey,   Retrieval Date = NOVEMBER  4, 2016
 QK0053 ***********************************************************************
 QK0053  DESIGNATION -  UPPER
 QK0053  PID         -  QK0053
 QK0053  STATE/COUNTY-  MI/CHEBOYGAN
 QK0053  COUNTRY     -  US
 QK0053  USGS QUAD   -  AFTON (1986)
 QK0053
 QK0053                          *CURRENT SURVEY CONTROL
 QK0053 ______________________________________________________________________
 QK0053* NAD 83(1986) POSITION- 45 33 05.      (N) 084 23 45.      (W)    SCALED
 QK0053* NAVD 88 ORTHO HEIGHT -   186.972 (meters)      613.42  (feet) ADJUSTED
 QK0053 ______________________________________________________________________
 QK0053  GEOID HEIGHT    -        -36.016 (meters)                      GEOID12B
 QK0053  DYNAMIC HEIGHT  -        186.968 (meters)      613.41  (feet) COMP
 QK0053  MODELED GRAVITY -    980,589.3   (mgal)                        NAVD 88
 QK0053
 QK0053  VERT ORDER      -  FIRST     CLASS I
 QK0053
 QK0053.The horizontal coordinates were scaled from a topographic map and have
 QK0053.an estimated accuracy of +/- 6 seconds.
 QK0053.
 QK0053.The orthometric height was determined by differential leveling and
 QK0053.adjusted by the NATIONAL GEODETIC SURVEY
 QK0053.in June 1991.
 QK0053
 QK0053.Significant digits in the geoid height do not necessarily reflect accuracy.
 QK0053.GEOID12B height accuracy estimate available here.
 QK0053
 QK0053.The dynamic height is computed by dividing the NAVD 88
 QK0053.geopotential number by the normal gravity value computed on the
 QK0053.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 QK0053.degrees latitude (g = 980.6199 gals.).
 QK0053
 QK0053.The modeled gravity was interpolated from observed gravity values.
 QK0053
 QK0053;                      North         East      Units  Estimated Accuracy
 QK0053;SPC MI C      -   248,330.    5,997,720.       MT  (+/- 180 meters Scaled)
 QK0053
 QK0053_U.S. NATIONAL GRID SPATIAL ADDRESS: 16TGR032475(NAD 83)
 QK0053
 QK0053                           SUPERSEDED SURVEY CONTROL
 QK0053
 QK0053.No superseded survey control is available for this station.
 QK0053
 QK0053_MARKER: Z = SEE DESCRIPTION
 QK0053_SETTING: 30 = SET IN A LIGHT STRUCTURE
 QK0053_SP_SET: WALL
 QK0053_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 QK0053
```

QK0053 HISTORY - Date Condition Report By
QK0053 HISTORY - 1996 MONUMENTED KRNF
QK0053 HISTORY - 2003 MKD KSLS
QK0053
QK0053 STATION DESCRIPTION
QK0053
QK0053'DESCRIBED BY US LAKE SURVEY 1973
QK0053'AT ALVERNO DAM.
QK0053'UPPER IS AT ALVERNO DAM, CHEBOYGAN COUNTY, MICHIGAN, 0.5 MILE SOUTH
QK0053'ALONG BLACK RIVER RD. FROM THE INTERSECTION OF ORCHARD BEACH AT
QK0053'BLACK RIVER RDS. IN ALVERNO, THENCE 0.2 MILE WEST ON GRAVEL ROAD
QK0053'LEADING TO BLACK RIVER HYDRO-ELECTRIC PLANT OWNED BY CONSUMERS
QK0053'POWER COMPANY, ON THE POOL OR EASTERLY END OF THE SPILLWAY CANAL,
QK0053'JUST WEST OF THE UPSTREAM END OF THE MAINE RAILWAY, ON LOWER
QK0053'CONCRETE WALL, BEING HIGHEST POINT IN A 2 IN X 3 IN RECTANGLE
QK0053'CHISELED IN THE CONCRETE TOP OF THE WALL. NOTE-- PREV. DESIG.
QK0053'UPPER 1962.

*** retrieval complete.
Elapsed Time = 00:00:01

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION =  8.18
1         National Geodetic Survey,   Retrieval Date = NOVEMBER  4, 2016
 QK0050 ***********************************************************************
 QK0050  DESIGNATION -  CEMETARY
 QK0050  PID         -  QK0050
 QK0050  STATE/COUNTY-  MI/CHEBOYGAN
 QK0050  COUNTRY     -  US
 QK0050  USGS QUAD   -  AFTON (1986)
 QK0050
 QK0050                          *CURRENT SURVEY CONTROL
 QK0050 ______________________________________________________________________
 QK0050* NAD 83(1986) POSITION- 45 33 30.      (N) 084 24 49.      (W)    SCALED
 QK0050* NAVD 88 ORTHO HEIGHT -    209.723 (meters)       688.07   (feet) ADJUSTED
 QK0050 ______________________________________________________________________
 QK0050  GEOID HEIGHT    -        -35.985 (meters)                       GEOID12B
 QK0050  DYNAMIC HEIGHT  -        209.718 (meters)       688.05   (feet) COMP
 QK0050  MODELED GRAVITY -    980,591.0   (mgal)                         NAVD 88
 QK0050
 QK0050  VERT ORDER      -  FIRST     CLASS I
 QK0050
 QK0050.The horizontal coordinates were scaled from a topographic map and have
 QK0050.an estimated accuracy of +/- 6 seconds.
 QK0050.
 QK0050.The orthometric height was determined by differential leveling and
 QK0050.adjusted by the NATIONAL GEODETIC SURVEY
 QK0050.in June 1991.
 QK0050
 QK0050.Significant digits in the geoid height do not necessarily reflect accuracy.
 QK0050.GEOID12B height accuracy estimate available here.
 QK0050
 QK0050.The dynamic height is computed by dividing the NAVD 88
 QK0050.geopotential number by the normal gravity value computed on the
 QK0050.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 QK0050.degrees latitude (g = 980.6199 gals.).
 QK0050
 QK0050.The modeled gravity was interpolated from observed gravity values.
 QK0050
 QK0050;                      North         East     Units  Estimated Accuracy
 QK0050;SPC MI C      -   249,100.     5,996,340.      MT  (+/- 180 meters Scaled)
 QK0050
 QK0050_U.S. NATIONAL GRID SPATIAL ADDRESS: 16TGR018482(NAD 83)
 QK0050
 QK0050                           SUPERSEDED SURVEY CONTROL
 QK0050
 QK0050.No superseded survey control is available for this station.
 QK0050
 QK0050_MARKER: % = SEE DESCRIPTION
 QK0050_SETTING: 16 = (FASTENED TO) A METAL ROD WITH BASE PLATE BURIED/SCREWED
 QK0050+WITH SETTING: INTO GROUND
 QK0050_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
 QK0050+STABILITY: SURFACE MOTION
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```
QK0050
QK0050  [illegible]
QK0056  [illegible]
QK0050  [illegible]
QK0050
QK0050                              STATION DESCRIPTION
QK0050
QK0050'E [illegible] BY US LAKE SURVEY 1973
QK0050'3.0 [illegible] FROM CHEBOYGAN.
QK0050'STATION IS IN CHEBOYGAN COUNTY, MICHIGAN, 3.0 MILES SOUTHERLY ALONG
QK0050'M-27 AND M-33 (MAIN ST.) FROM THE POST OFFICE IN CHEBOYGAN,
QK0050'THENCE 30.1 MILES SOUTH ALONG HIGHWAY M-33 FROM THE JUNCTION OF
QK0050'M-27 AND M-33, THENCE 2.0 MILES EAST OF INTERSECTION OF
QK0050'M-33 AND ORCHARD BEACH ROAD, ON THE NORTHEAST CORNER OF THE
QK0050'INTERSECTION OF ORCHARD BEACH ROAD AND SOUTH RIVER ROAD, 29.4
QK0050'FEET EAST OF EAST CORNER OF NORTHERLY OF TWO STONE PILLARS AT
QK0050'ENTRANCE TO ST. FRANCIS CEMETARY, 22.0 FEET SOUTHWEST OF WEST
QK0050'CORNER OF STONE BUILDING, 13.2 FEET NORTHEAST OF NORTHEASTERLY
QK0050'FACE OF SOUTHERLY STONE PILLAR, 4.4 FEET SOUTHEAST OF TRIANGULAR
QK0050'BLAZE IN A 4-INCH CEDAR, 1.9 FEET SOUTHWEST OF SOUTH CORNER AND
QK0050'IN LINE WITH SOUTHEAST FACE OF THE STONE BUILDING, 1/4 FOOT
QK0050'BELOW THE GROUND SURFACE, BEING HIGHEST POINT ON TOP OF 5/8-INCH
QK0050'DIAMETER COPPER-COATED STEEL ROD, 8 FEET LONG.  NOTE-- PREV.
QK0050'DESIG. CEMETARY 1962.

*** retrieval complete.
Elapsed Time = 00:00:02
```

Beach Water 0k 0c 50
Century 21

Porter's Survey

From: opus <opus@ngs.noaa.gov>
Sent: Friday, November 04, 2016 2:24 PM
To: ps@portersurvey.com
Subject: OPUS solution : 65413070.dat OP1478283762033

FILE: 65413070.dat OP1478283762033

NGS OPUS SOLUTION REPORT
==========

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy

USER: ps@portersurvey.com DATE: November 04, 2016
RINEX FILE: 6541307t.16o TIME: 18:23:10 UTC

SOFTWARE: page5 1209.04 master53.pl 160321 START: 2016/11/02 19:12:00
EPHEMERIS: igr19213.eph [rapid] STOP: 2016/11/02 21:27:00
NAV FILE: brdc3070.16n OBS USED: 4425 / 4695 : 94%
ANT NAME: TRM22020.00+GP NONE # FIXED AMB: 34 / 34 : 100%
ARP HEIGHT: 2.000 OVERALL RMS: 0.018(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.8384)

X:	435348.330(m)	0.013(m)	435347.442(m)	0.013(m)
Y:	-4452305.012(m)	0.012(m)	-4452303.675(m)	0.012(m)
Z:	4531217.195(m)	0.008(m)	4531217.161(m)	0.008(m)

LAT:	45 33 33.79660	0.002(m)	45 33 33.82860	0.002(m)
E LON:	275 35 4.75152	0.014(m)	275 35 4.71677	0.014(m)
W LON:	84 24 55.24848	0.014(m)	84 24 55.28323	0.014(m)
EL HGT:	173.782(m)	0.013(m)	172.766(m)	0.013(m)
ORTHO HGT:	209.765(m)	0.027(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES (UTM (Zone 16))	STATE PLANE COORDINATES (SPC (2112 MI C))
Northing (Y) [meters]	5048343.915	249217.719
Easting (X) [meters]	701717.043	5996199.369
Convergence [degrees]	1.84600170	-0.03438801
Point Scale	1.00010029	0.99997052
Combined Factor	1.00007304	0.99994328

US NATIONAL GRID DESIGNATOR: 16TGR0171748343(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DN2580	MIMC MACKINAW CITY CORS ARP	N454638.775	W0844315.475	33978.8
DL7802	MIND INDIAN RIVER CORS ARP	N452305.384	W0843747.682	25650.2
DI1840	MISI ST. IGNACE CORS ARP	N455113.059	W0844210.850	39640.9

NEAREST NGS PUBLISHED CONTROL POINT

QK0050	CEMETARY	N453330.	W0842449.	179.2

BASE STATION INFORMATION

STATION NAME: mimc a 1 (Mackinaw City; Mackinaw City, Michigan USA)
MONUMENT: NO DOMES NUMBER

XYZ	409996.0919	-4437282.3846	4548135.1683	MON @ 2005.0000 (M)
XYZ	-0.0166	-0.0008	0.0007	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	0.0004	0.0012	0.0871	ARP TO L1 PHASE CENTER (M)
NEU	0.0001	-0.0003	0.1175	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1965	-0.0095	0.0083	VEL TIMES 11.8383 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	0.0067	-0.0601	0.0627	ARP TO L1 PHASE CENTER
XYZ	409995.9021	-4437282.4541	4548135.2393	L1 PHS CEN @ 2016.8384
XYZ	0.0000	-0.0000	-0.0000	+ XYZ ADJUSTMENTS
XYZ	409995.9021	-4437282.4541	4548135.2393	NEW L1 PHS CEN @ 2016.8384
XYZ	409995.8954	-4437282.3941	4548135.1766	NEW ARP @ 2016.8384
XYZ	409995.8954	-4437282.3941	4548135.1766	NEW MON @ 2016.8384
LLH	45 46 38.80807	275 16 44.48959	147.5045	NEW L1 PHS CEN @ 2016.8384
LLH	45 46 38.80806	275 16 44.48953	147.4174	NEW ARP @ 2016.8384
LLH	45 46 38.80806	275 16 44.48953	147.4174	NEW MON @ 2016.8384

STATION NAME: mind a 1 (Indian River; Indian River, Michigan USA)
MONUMENT: NO DOMES NUMBER

XYZ	419966.4839	-4467680.7677	4517619.5090	MON @ 2005.0000 (M)
XYZ	-0.0165	-0.0008	0.0007	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	0.0004	0.0012	0.0871	ARP TO L1 PHASE CENTER (M)
NEU	0.0001	-0.0003	0.1175	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1953	-0.0094	0.0085	VEL TIMES 11.8383 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	0.0069	-0.0605	0.0623	ARP TO L1 PHASE CENTER
XYZ	419966.2954	-4467680.8375	4517619.5798	L1 PHS CEN @ 2016.8384
XYZ	-0.0000	-0.0000	-0.0000	+ XYZ ADJUSTMENTS
XYZ	419966.2954	-4467680.8375	4517619.5797	NEW L1 PHS CEN @ 2016.8384
XYZ	419966.2886	-4467680.7770	4517619.5175	NEW ARP @ 2016.8384
XYZ	419966.2886	-4467680.7770	4517619.5175	NEW MON @ 2016.8384
LLH	45 23 5.41604	275 22 12.28253	183.4740	NEW L1 PHS CEN @ 2016.8384
LLH	45 23 5.41603	275 22 12.28248	183.3869	NEW ARP @ 2016.8384
LLH	45 23 5.41603	275 22 12.28248	183.3869	NEW MON @ 2016.8384

STATION NAME: misi a 2 (St. Ignace; St. Ignace, Michigan USA)

MONUMENT: NO DOMES NUMBER
XYZ 410825.8746 -4431109.1073 4554039.7909 MON @ 2005.0000 (M)
XYZ -0.0139 -0.0010 0.0008 VEL (M/YR)
NEU 0.0000 0.0000 0.0000 MON TO ARP (M)
NEU 0.0004 0.0012 0.0871 ARP TO L1 PHASE CENTER (M)
NEU 0.0001 -0.0003 0.1175 ARP TO L2 PHASE CENTER (M)
XYZ -0.1643 -0.0118 0.0094 VEL TIMES 11.8383 YRS
XYZ 0.0000 0.0000 0.0000 MON TO ARP
XYZ 0.0067 -0.0600 0.0627 ARP TO L1 PHASE CENTER
XYZ 410825.7170 -4431109.1790 4554039.8631 L1 PHS CEN @ 2016.8384
XYZ 0.0000 0.0000 0.0000 + XYZ ADJUSTMENTS
XYZ 410825.7170 -4431109.1790 4554039.8631 NEW L1 PHS CEN @ 2016.8384
XYZ 410825.7103 -4431109.1190 4554039.8003 NEW ARP @ 2016.8384
XYZ 410825.7103 -4431109.1190 4554039.8003 NEW MON @ 2016.8384
LLH 45 51 13.09137 275 17 49.11483 150.7312 NEW L1 PHS CEN @ 2016.8384
LLH 45 51 13.09136 275 17 49.11478 150.6442 NEW ARP @ 2016.8384
LLH 45 51 13.09136 275 17 49.11478 150.6442 NEW MON @ 2016.8384

REMOTE STATION INFORMATION

STATION NAME: 6541 1
MONUMENT: NO DOMES NUMBER
XYZ 435347.6946 -4452303.0093 4531216.8641 MON @ 2016.8383 (M)
NEU -0.0012 0.0014 2.0000 MON TO ARP (M)
NEU 0.0012 -0.0014 0.0706 ARP TO L1 PHASE CENTER (M)
NEU -0.0015 0.0014 0.0630 ARP TO L2 PHASE CENTER (M)
XYZ 0.1378 -1.3945 1.4271 MON TO ARP
XYZ 0.0033 -0.0484 0.0513 ARP TO L1 PHASE CENTER
XYZ 435347.8357 -4452304.4522 4531218.3425 L1 PHS CEN @ 2016.8384

BASELINE NAME: mimc 6541
XYZ -0.2540 -0.6685 0.2987 + XYZ ADJUSTMENTS
XYZ 435347.5817 -4452305.1207 4531218.6412 NEW L1 PHS CEN @ 2016.8384
XYZ 435347.5784 -4452305.0723 4531218.5899 NEW ARP @ 2016.8384
XYZ 435347.4406 -4452303.6778 4531217.1628 NEW MON @ 2016.8384
LLH 45 33 33.82858 275 35 4.71669 174.8396 NEW L1 PHS CEN @ 2016.8384
LLH 45 33 33.82854 275 35 4.71676 174.7690 NEW ARP @ 2016.8384
LLH 45 33 33.82858 275 35 4.71669 172.7690 NEW MON @ 2016.8384

BASELINE NAME: mind 6541
XYZ -0.2580 -0.6699 0.2996 + XYZ ADJUSTMENTS
XYZ 435347.5777 -4452305.1221 4531218.6421 NEW L1 PHS CEN @ 2016.8384
XYZ 435347.5744 -4452305.0737 4531218.5908 NEW ARP @ 2016.8384
XYZ 435347.4366 -4452303.6792 4531217.1637 NEW MON @ 2016.8384
LLH 45 33 33.82858 275 35 4.71650 174.8409 NEW L1 PHS CEN @ 2016.8384
LLH 45 33 33.82854 275 35 4.71657 174.7703 NEW ARP @ 2016.8384
LLH 45 33 33.82858 275 35 4.71650 172.7703 NEW MON @ 2016.8384

BASELINE NAME: misi 6541
XYZ -0.2450 -0.6577 0.2917 + XYZ ADJUSTMENTS
XYZ 435347.5907 -4452305.1099 4531218.6341 NEW L1 PHS CEN @ 2016.8384
XYZ 435347.5874 -4452305.0614 4531218.5829 NEW ARP @ 2016.8384

XYZ 435347.4496 -4452303.6670 4531217.1558 NEW MON @ 2016.8384
LLH 45 33 33.82865 275 35 4.71715 174.8276 NEW L1 PHS CEN @ 2016.8384
LLH 45 33 33.82861 275 35 4.71722 174.7570 NEW ARP @ 2016.8384
LLH 45 33 33.82865 275 35 4.71715 172.7570 NEW MON @ 2016.8384

G-FILES

Axx201611 2 1611 2
B201611 21912 1611 22127 1 page5 v1209.04IGS 126 1 2 27NGS 201611 4IFDDPX
IIGS08_1915 IGS 20160918
C00090002 -253515452 17 150212838 66 169180138 72 X3076A6541X3076AMIMC
D 1 2 -6484742 1 3 4977695 2 3 -9471359

Axx201611 2 1611 2
B201611 21912 1611 22127 1 page5 v1209.04IGS 126 1 2 27NGS 201611 4IFDDPX
IIGS08_1915 IGS 20160918
C00090005 -153811481 14 -153770978 61 -135976462 62 X3076A6541X3076AMIND
D 1 2 -2735998 1 3 4733896 2 3 -9379712

Axx201611 2 1611 2
B201611 21912 1611 22127 1 page5 v1209.04IGS 126 1 2 27NGS 201611 4IFDDPX
IIGS08_1915 IGS 20160918
C00090003 -245217393 15 211945480 56 228226446 62 X3076A6541X3076AMISI
D 1 2 -5663039 1 3 3243021 2 3 -9053092

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 05 08 10 13 15 18 20 21
mimc-6541| 0.017 0.018 ... 0.016 0.022 0.016 0.013 0.015 ...
24 27 29 32
mimc-6541| 0.021 0.020 0.019 0.035

OVERALL 05 08 10 13 15 18 20 21
mind-6541| 0.017 0.020 ... 0.017 0.020 0.016 0.012 0.014 ...
24 27 29 32
mind-6541| 0.020 0.023 0.020 0.028

OVERALL 05 08 10 13 15 18 20 21
misi-6541| 0.018 0.020 ... 0.017 0.021 0.016 0.013 0.015 ...
24 27 29 32
misi-6541| 0.022 0.022 0.016 0.035

OBS BY SATELLITE VS. BASELINE

OVERALL 05 08 10 13 15 18 20 21
mimc-6541| 1453 40 ... 163 69 240 267 267 ...
24 27 29 32
mimc-6541| 225 41 80 61
OVERALL 05 08 10 13 15 18 20 21
mind-6541| 1507 38 ... 206 69 239 267 267 ...
24 27 29 32
mind-6541| 225 43 94 59

```
       OVERALL   05   08   10   13   15   18   20   21
misi-6541|  1465   30   ..  206   69  239  267  267  ..
         24   27   29   32
misi-6541|  224   41   49   60
```

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

```
  0.0000015778  -0.0000003243   0.0000002926
 -0.0000003243   0.0000249178  -0.0000025509
  0.0000002926  -0.0000025509   0.0000297422
```

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

```
  0.0000017360   0.0000014125  -0.0000013341
  0.0000014125   0.0000246519   0.0000024582
 -0.0000013341   0.0000024582   0.0000298498
```

Horizontal network accuracy = 0.00983 meters.
Vertical network accuracy = 0.01071 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)	
MIMC	409996.78680	-4437283.73261	4548135.20490	2010.00
MIND	419967.17772	-4467682.12022	4517619.54947	2010.00
MISI	410826.58346	-4431110.45549	4554039.82731	2010.00

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

	Xr(m)	Yr(m)	Zr(m)	
MIMC	409996.78680	-4437283.73261	4548135.20490	2010.00
MIND	419967.17772	-4467682.12022	4517619.54947	2010.00
MISI	410826.58346	-4431110.45549	4554039.82731	2010.00

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

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
MIMC	-0.01650	-0.00110	-0.00070
MIND	-0.01650	-0.00080	0.00070
MISI	-0.01390	-0.00100	0.00080

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)	
MIMC	-25351.54320	15021.27939	16918.00990	2010.00
MIND	-15381.15228	-15377.10822	-13597.64553	2010.00
MISI	-24521.74654	21194.55651	22822.63231	2010.00

STATE PLANE COORDINATES - International Foot
SPC (2112 MI C)
Northing (Y) [feet] 817643.435
Easting (X) [feet] 19672570.108

Convergence [degrees] -0.03[illegible]
Point Scale 0.9999705
Combined Factor 0.9999[illegible]

********** New Reference Frame Preview **********

We are replacing the nation's NAD 83 and NAVD 88 datums, to improve access and accuracy of the National Spatial Reference System. More at http://geodesy.noaa.gov/datums/newdatums/

Below are approximate coordinates for this solution in the new frames:

APPROX ORTHO HGT: 209.205 (m) [PROTOTYPE (Computed using xGeoid16B,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.

Porter's Survey

From: opus <opus@ngs.noaa.gov>
Sent: Friday, November 04, 2016 [illegible] PM
To: ps@portersurvey.com
Subject: OPUS solution : 61403080.dat : OP1478284209176

FILE: 61403080.dat OP1478284209176

NGS OPUS SOLUTION REPORT
==========

All computed coordinate accuracies are listed as peak-to-peak values.
For additional information: http://www.ngs.noaa.gov/OPUS/about.jsp#accuracy

USER: ps@portersurvey.com DATE: November 04, 2016
RINEX FILE: 6140308n.16o TIME: 18:30:46 UTC

SOFTWARE: page5 1209.04 master53.pl 160321 START: 2016/11/03 13:04:00
EPHEMERIS: igr19214.eph [rapid] STOP: 2016/11/03 15:16:00
NAV FILE: brdc3080.16n OBS USED: 4516 / 4798 : 94%
ANT NAME: TRM22020.00+GP NONE # FIXED AMB: 30 / 30 : 100%
ARP HEIGHT: 2.000 OVERALL RMS: 0.009(m)

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2016.8404)

X:	442567.718(m)	0.012(m)	442566.830(m)	0.012(m)
Y:	-4456267.930(m)	0.008(m)	-4456266.592(m)	0.008(m)
Z:	4526618.555(m)	0.006(m)	4526618.520(m)	0.006(m)

LAT:	45 30 1.92818	0.006(m)	45 30 1.96017	0.006(m)
E LON:	275 40 17.93399	0.012(m)	275 40 17.89938	0.012(m)
W LON:	84 19 42.06601	0.012(m)	84 19 42.10062	0.012(m)
EL HGT:	150.893(m)	0.007(m)	149.874(m)	0.007(m)
ORTHO HGT:	187.005(m)	0.019(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES (UTM (Zone 16))	STATE PLANE COORDINATES (SPC (2112 MI C))
Northing (Y) [meters]	5042028.189	242676.539
Easting (X) [meters]	708724.133	6002994.478
Convergence [degrees]	1.90625724	0.02706600
Point Scale	1.00013566	0.99995998
Combined Factor	1.00011200	0.99993632

US NATIONAL GRID DESIGNATOR: 16TGR0872442028(NAD 83)

BASE STATIONS USED

PID	DESIGNATION	LATITUDE	LONGITUDE	DISTANCE(m)
DJ8891	MIGD GAYLORD CORS ARP	N450135.671	W0843840.997	582 [illegible]
DI1840	MISI ST. IGNACE CORS ARP	N455113.059	W0844210.850	4891 [illegible]
DN2580	MIMC MACKINAW CITY CORS ARP	N454638.775	W0844315.475	[illegible]107.7

NEAREST NGS PUBLISHED CONTROL POINT

QK0628	BLACK	N452934.667	W0842101.900	1926.9

BASE STATION INFORMATION

STATION NAME: migd a 1 (Gaylord; Gaylord, Michigan USA)
MONUMENT: NO DOMES NUMBER

XYZ	421460.9201	-4496050.6856	4489697.2877	MON @ 2005.0000 (M)
XYZ	-0.0165	-0.0007	-0.0009	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	0.0004	0.0012	0.0871	ARP TO L1 PHASE CENTER (M)
NEU	0.0001	-0.0003	0.1175	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1951	-0.0081	-0.0105	VEL TIMES 11.8403 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	0.0069	-0.0609	0.0619	ARP TO L1 PHASE CENTER
XYZ	421460.7319	-4496050.7546	4489697.3391	L1 PHS CEN @ 2016.8404
XYZ	0.0000	-0.0000	-0.0000	+ XYZ ADJUSTMENTS
XYZ	421460.7319	-4496050.7546	4489697.3391	NEW L1 PHS CEN @ 2016.8404
XYZ	421460.7250	-4496050.6937	4489697.2772	NEW ARP @ 2016.8404
XYZ	421460.7250	-4496050.6937	4489697.2772	NEW MON @ 2016.8404
LLH	45 1 35.70358	275 21 18.96796	368.0334	NEW L1 PHS CEN @ 2016.8404
LLH	45 1 35.70357	275 21 18.96791	367.9463	NEW ARP @ 2016.8404
LLH	45 1 35.70357	275 21 18.96791	367.9463	NEW MON @ 2016.8404

STATION NAME: misi a 2 (St. Ignace; St. Ignace, Michigan USA)
MONUMENT: NO DOMES NUMBER

XYZ	410825.8746	-4431109.1073	4554039.7909	MON @ 2005.0000 (M)
XYZ	-0.0139	-0.0010	0.0008	VEL (M/YR)
NEU	0.0000	0.0000	0.0000	MON TO ARP (M)
NEU	0.0004	0.0012	0.0871	ARP TO L1 PHASE CENTER (M)
NEU	0.0001	-0.0003	0.1175	ARP TO L2 PHASE CENTER (M)
XYZ	-0.1643	-0.0118	0.0094	VEL TIMES 11.8403 YRS
XYZ	0.0000	0.0000	0.0000	MON TO ARP
XYZ	0.0067	-0.0600	0.0627	ARP TO L1 PHASE CENTER
XYZ	410825.7170	-4431109.1790	4554039.8631	L1 PHS CEN @ 2016.8404
XYZ	0.0000	0.0000	0.0000	+ XYZ ADJUSTMENTS
XYZ	410825.7170	-4431109.1790	4554039.8631	NEW L1 PHS CEN @ 2016.8404
XYZ	410825.7103	-4431109.1190	4554039.8003	NEW ARP @ 2016.8404
XYZ	410825.7103	-4431109.1190	4554039.8003	NEW MON @ 2016.8404
LLH	45 51 13.09137	275 17 49.11483	150.7312	NEW L1 PHS CEN @ 2016.8404
LLH	45 51 13.09136	275 17 49.11478	150.6442	NEW ARP @ 2016.8404
LLH	45 51 13.09136	275 17 49.11478	150.6442	NEW MON @ 2016.8404

STATION NAME: mimc a 1 (Mackinaw City; Mackinaw City, Michigan USA)

MONUMENT: NO DOMES NUMBER

XYZ 409996.0919 -4437282.3835 4548135.1683 MON @ 2005.0000 (M)
XYZ -0.0166 -0.0008 0.0007 VEL (M/YR)
NEU 0.0000 0.0000 0.0000 MON TO ARP (M)
NEU 0.0004 0.0012 0.0871 ARP TO L1 PHASE CENTER (M)
NEU 0.0001 -0.0003 0.1175 ARP TO L2 PHASE CENTER (M)
XYZ -0.1965 -0.0095 0.0083 VEL TIMES 11.8403 YRS
XYZ 0.0000 0.0000 0.0000 MON TO ARP
XYZ 0.0067 -0.0601 0.0627 ARP TO L1 PHASE CENTER
XYZ 409995.9021 -4437282.4541 4548135.2393 L1 PHS CEN @ 2016.8404
XYZ 0.0000 -0.0000 0.0000 + XYZ ADJUSTMENTS
XYZ 409995.9021 -4437282.4541 4548135.2393 NEW L1 PHS CEN @ 2016.8404
XYZ 409995.8954 -4437282.3941 4548135.1766 NEW ARP @ 2016.8404
XYZ 409995.8954 -4437282.3941 4548135.1766 NEW MON @ 2016.8404
LLH 45 46 38.80807 275 16 44.48959 147.5045 NEW L1 PHS CEN @ 2016.8404
LLH 45 46 38.80806 275 16 44.48953 147.4174 NEW ARP @ 2016.8404
LLH 45 46 38.80806 275 16 44.48953 147.4174 NEW MON @ 2016.8404

REMOTE STATION INFORMATION

STATION NAME: 6140 1
MONUMENT: NO DOMES NUMBER
XYZ 442566.9894 -4456267.2066 4526618.9681 MON @ 2016.8403 (M)
NEU -0.0012 0.0014 2.0000 MON TO ARP (M)
NEU 0.0012 -0.0014 0.0706 ARP TO L1 PHASE CENTER (M)
NEU -0.0015 0.0014 0.0630 ARP TO L2 PHASE CENTER (M)
XYZ 0.1401 -1.3957 1.4257 MON TO ARP
XYZ 0.0034 -0.0485 0.0512 ARP TO L1 PHASE CENTER
XYZ 442567.1328 -4456268.6508 4526620.4450 L1 PHS CEN @ 2016.8404

BASELINE NAME: migd 6140
XYZ -0.1579 0.6113 -0.4509 + XYZ ADJUSTMENTS
XYZ 442566.9749 -4456268.0395 4526619.9941 NEW L1 PHS CEN @ 2016.8404
XYZ 442566.9715 -4456267.9910 4526619.9429 NEW ARP @ 2016.8404
XYZ 442566.8315 -4456266.5953 4526618.5172 NEW MON @ 2016.8404
LLH 45 30 1.96003 275 40 17.89944 151.9448 NEW L1 PHS CEN @ 2016.8404
LLH 45 30 1.95999 275 40 17.89950 151.8742 NEW ARP @ 2016.8404
LLH 45 30 1.96003 275 40 17.89944 149.8742 NEW MON @ 2016.8404

BASELINE NAME: misi 6140
XYZ -0.1541 0.6191 -0.4494 + XYZ ADJUSTMENTS
XYZ 442566.9788 -4456268.0317 4526619.9955 NEW L1 PHS CEN @ 2016.8404
XYZ 442566.9754 -4456267.9832 4526619.9443 NEW ARP @ 2016.8404
XYZ 442566.8353 -4456266.5875 4526618.5187 NEW MON @ 2016.8404
LLH 45 30 1.96023 275 40 17.89965 151.9406 NEW L1 PHS CEN @ 2016.8404
LLH 45 30 1.96019 275 40 17.89972 151.8700 NEW ARP @ 2016.8404
LLH 45 30 1.96023 275 40 17.89965 149.8700 NEW MON @ 2016.8404

BASELINE NAME: mimc 6140
XYZ -0.1657 0.6121 -0.4452 + XYZ ADJUSTMENTS
XYZ 442566.9671 -4456268.0387 4526619.9997 NEW L1 PHS CEN @ 2016.8404
XYZ 442566.9638 -4456267.9902 4526619.9485 NEW ARP @ 2016.8404

XYZ 442566.8237 -4456266.5945 4526[illegible] NEW MON @ 2016.84[illegible]
LLH 45 30 1.96019 275 40 17.89908 151.917 NEW LL PHS CEN @ 201[illegible].8404
LLH 45 30 1.96015 275 40 17.89915 151.827 NEW ARP @ 2016.8404
LLH 45 30 1.96019 275 40 17.89908 14[illegible].827 NEW MON @ 2016.840[illegible]

G-FILES

Axx201611 3 1611 3
B201611 313 3 1611 31515 1 page5 v1209.04IGS 126 1 2 27NGS 201611 IIFDDPX
IIGS08_1915 IGS 20160918
C00090004 -211061064 4 -397840984 19 -3[illegible]12400 20 X3086A6140X3086AMIGD
D 1 2 -2310181 1 3 4897632 2 3 -7856247

Axx201611 3 1611 3
B201611 313 3 1611 31515 1 page5 v1209.04IGS 126 1 2 27NGS 201611 IIFDDPX
IIGS08_1915 IGS 20160918
C00090003 -317411251 5 251574684 19 274212817 16 X3086A6140X3086AMISI
D 1 2 -4715357 1 3 2005237 2 3 -8504874

Axx201611 3 1611 3
B201611 313 3 1611 31515 1 page5 v1209.04IGS 126 1 2 27NGS 201611 4IFDDPX
IIGS08_1915 IGS 20160918
C00090002 -325709284 8 189842004 25 215166537 20 X3086A6140X3086AMIMC
D 1 2 -6186062 1 3 3639118 2 3 -8739160

POST-FIT RMS BY SATELLITE VS. BASELINE

OVERALL 02 03 05 06 09 12 17 19
migd-6140| 0.009 0.005 0.015 0.009 ... 0.013 0.007 0.008 0.007
23 24 25 28 29
migd-6140| ... 0.019 0.009 0.024 ...

OVERALL 02 03 05 06 09 12 17 19
misi-6140| 0.008 0.005 0.016 0.009 ... 0.010 0.006 0.008 0.006
23 24 25 28 29
misi-6140| ... 0.014 0.009 ... ...

OVERALL 02 03 05 06 09 12 17 19
mimc-6140| 0.010 0.006 0.017 0.011 ... 0.011 0.009 0.011 0.008
23 24 25 28 29
mimc-6140| ... 0.021 0.011 0.016 ...

OBS BY SATELLITE VS. BASELINE

OVERALL 02 03 05 06 09 12 17 19
migd-6140| 1461 245 41 139 ... 114 245 206 245
23 24 25 28 29
migd-6140| ... 50 155 21 ...
OVERALL 02 03 05 06 09 12 17 19
misi-6140| 1516 263 63 103 ... 122 263 220 263
23 24 25 28 29
misi-6140| ... 52 167 ... ...

```
        OVERALL   02   03   04   06   09   12   17   19
mimc-6140|  1539  263   63  147  ...  120  263  228  263
          23   24   25   28   29
mimc-6140|  ...   38  134   30  ...
```

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

```
 0.0000002533  0.0000000444  0.0000000272
-0.0000000444  0.0000029933 -0.0000002257
 0.0000000272 -0.0000002257  0.0000022600
```

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

```
 0.0000002714  0.0000001639 -0.0000001555
 0.0000001639  0.0000023942 -0.0000003601
-0.0000001555 -0.0000003601  0.0000028411
```

Horizontal network accuracy = 0.00308 meters.
Vertical network accuracy = 0.00331 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)	
MIGD	421461.61229	-4496052.04145	4489697.32386	2010.00
MISI	410826.58346	-4431110.45549	4554039.82731	2010.00
MIMC	409996.78680	-4437283.73261	4548135.20490	2010.00

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

	Xr(m)	Yr(m)	Zr(m)	
MIGD	421461.61229	-4496052.04145	4489697.32386	2010.00
MISI	410826.58346	-4431110.45549	4554039.82731	2010.00
MIMC	409996.78680	-4437283.73261	4548135.20490	2010.00

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

	Vx (m/yr)	Vy (m/yr)	Vz (m/yr)
MIGD	-0.01650	-0.00070	-0.00090
MISI	-0.01390	-0.00100	0.00080
MIMC	-0.01650	-0.00110	-0.00070

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)	
MIGD	-21106.10571	-39784.11145	-36921.23114	2010.00
MISI	-31741.13454	25157.47451	27421.27231	2010.00
MIMC	-32570.93120	18984.19739	21516.64990	2010.00

STATE PLANE COORDINATES - International Foot
SPC (2112 MI C)
Northing (Y) [feet] 796182.871
Easting (X) [feet] 19694863.773

Convergence [deg -s] 0.02706600
Point Scale 0.99995993
Combined Factor 0.99993632

********** New Reference Frame Preview **********

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APPROX ORTHO HGT 186.459 (m) [PROTOTYPE (Computed using xGeoid16B,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.