



MEMORANDUM

NOTE DE SERVICE

To
A

M.T. Swanson
Chief
Data Services Section

From
De

J.P. Henderson
Chief,
Data Analysis and Adjustment Section

Subject
Objet

BELLEVILLE, ONTARIO - Calibration Baseline - ADOPTED VALUES - 1991

Security Classification - Classification de sécurité
Our File - Notre référence C-28
Your file - Votre référence
Date FEB 12 1992

We have processed the 1990 and 1991 measurement of the BELLEVILLE baseline using the EDM program and procedures.

The piers of this baseline are considered stable since the pier positions remained within the tolerances of our pier stability criterion between 1983/84, 1990 and 1991. The 1989 data is poor due to degradation in the ME3000 operating capabilities in that epoch and is not used in the final analysis of this baseline.

A table of "ADOPTED VALUES" in EDM format and copies of the report on data processing, conclusions and recommendations are attached.

Please ensure this information is forwarded to the controlling agency.

J.P. Henderson

LH/cmg

cc. L. Nabe
N. Beck

**BELLEVILLE, ONTARIO
CALIBRATION BASELINE
ADOPTED VALUES 1991**

MEASUREMENTS

YEAR	MONTH	DAYS	
1983	May	27-31	
1984	August	06-08	
1989	July	20-24	Not used
1990	May	24-28] Combined 1990/91 Adopted Values
1991	June	15-18	

For the adjustments and analyses of the measurements for 1983 and 1984, the reader is referred to the reports issued for those years.

A complete determination of a baseline consists of at least three (3) double measurements (forward and backward) on all lines with the Geomensor.

The MEKOMETER ME3000, (serial no. 218024) was used to make the 1983, 1984 and 1989 complete determinations on this five-pier baseline.

The GEOMENSOR CR204, (serial no. 013) was used to make the 1990 and 1991 complete determinations.

COMPUTATIONS AND ANALYSIS

Observation Data

The 1990 and 1991 observation data was processed using the adjustment program EDM. A standard deviation of +/- (0.2mm + 1.0 ppm) was assigned to each GEOMENSOR length.

All NGBL calibration scale parameters were also determined using program EDM.

Minimum Constraint Adjustment

1989 Observations

The 1989 observations were not used to determine final values because the precision of the ME3000 was outside of normal standards. The unusually high variance factor of 2.585 indicated poorer than expected internal consistency for this data set. The ME3000 precision degraded in this and subsequent baseline measurements and eventually failed.

1990 Observations

The NGBL calibration parameters of constant and scale were (+1.6 mm, -0.3 ppm), with standard deviations of 0.2 mm and 0.3 ppm respectively, from May 14-22, and (+1.4 mm, +0.2 ppm), with standard deviations of 0.1 mm and 0.2 ppm respectively, from July 12-16. A -0.2 ppm scale parameter, determined by a linear interpolation by time, was applied to the observations. The instrument constant computed for the minimum constraint adjustment of the 1990 data was +1.3 mm, with a standard deviation of 0.1 mm. This is consistent with the calibration values.

The EDM listing was examined to detect outliers. One was flagged on the initial run. This distance appeared to be a blunder, as it was outside the expected statistical limits as computed from the instrument resolution. The outlier was on line 5-4 (250 meters) on May 25. After its removal, one new outlier was detected on line 4-5 on May 25. This was left in the adjustment since it did not appear to be a blunder and its inclusion had little effect on the results.

The variance factor after adjustment of 0.755, with 78 degrees of freedom, passes the Chi-square test on the variance factor based on an a priori estimate of 1.0. The Chi-square test for normal distribution of the residuals passes at the 95 percent level.

1991 Observations

The NGBL calibration parameters of constant and scale were (+1.5 mm, -0.5 ppm), with standard deviations of 0.1 mm and 0.3 ppm respectively, from June 12-14, and (+1.5 mm, -0.6 ppm), with standard deviations of 0.1 mm and 0.2 ppm respectively, from August 5-7. A -0.5 ppm scale parameter, determined by a linear interpolation by time, was applied to the observations. The instrument constant computed for the minimum constraint adjustment of the 1991 data was +1.4 mm, with a standard deviation of 0.1 mm. This is consistent with the calibration values.

The EDM listing was examined to detect outliers. None were found.

The variance factor after adjustment of 0.653, with 55 degrees of freedom, fails the Chi-square test on the variance factor based on an a priori estimate of 1.0. The variance factor is low indicating better than expected internal consistency for this data set. The Chi-square test for normal distribution of the residuals passes at the 95 percent level.

Pier Movement Analysis

The pier movement analysis option on EDM is used to detect systematic displacements between observing periods. Each epoch's adjustment results are used as input coordinates in the adjustment of another epoch's measurements.

The 1983/84 Adopted Values, scaled by the January, 1989 -5.0 ppm NGBL scale factor, were used as input coordinates in the 1990 and 1991 EDM minimum constraint adjustments. The pier movements in both comparisons as shown on the attached table (at piers 2 and 4) are statistically significant, but are not considered physically significant since movements of up to a millimeter are possible due to diurnal and/or seasonal factors in piers which are stable from epoch to epoch. The average scale differences were -1.6 ppm and -1.7 ppm for the 1990 and 1991 comparisons, respectively. These scale differences are small even though the 1983 and 1984 data has less

rigorous meteorological measurements and methodology, and larger differences are possible.

The 1990 adjustment results were used as input coordinates in the 1991 data adjustment. No significant pier movements were detected by EDM.

Combined Adjustment

The 1990 and 1991 observations were combined to compute best estimates of the interpier distances and corresponding accuracies. The appropriate instrument parameters for constant and scale from each year were used as input in the combined adjustment. These are (+1.3 mm, -0.2 ppm) for 1990 and (+1.4 mm, -0.5 ppm) for 1991.

The variance factor after adjustment of 0.739, with 136 degrees of freedom, fails the Chi-square test on the variance factor based on an a priori estimate of 1.0. The low variance factor indicates better than expected internal consistency for the combined data sets. The Chi-square goodness-of-fit test passes at the 95 percent level.

Tabulation of Results

The attached table summarizes the parameters and statistics from each adjustment.

BASELINE SITE

The BELLEVILLE baseline is located on the northside of Highway 401. For safety reasons care has to be taken while measuring this baseline due to the heavy traffic flow on the 401.

All pillars are built to Geodetic Survey Division specifications.

CONCLUSION AND RECOMMENDATION

The results from the combined adjustment of the 1990 and 1991 data sets should be issued as "ADOPTED VALUES".

All the piers of the Belleville baseline appear to be stable. Remeasurement of this baseline should only be done at the request of the controlling agency.

Hennessey/Bresee
December 1991

MINIMUM CONSTRAINT ADJUSTMENT ANALYSIS

BASELINE NAME: BELLEVILLE, ONTARIO

* PASSES
X FAILS

VARIANCE FACTOR V.F.
GOODNESS-OF-FIT G.F.

Observation Period	Variance Factor	Degrees of Freedom	Statistical Tests		Inst. Constant mm [S.D.]	Calibration Constant mm [S.D.]	Calibration Scale ppm [S.D.]	Input Coordinates	Pier Movement		Average Scale Difference ppm
			V.F.	G.F.					At	Amount mm	
May 24-28 1990	0.755	77	*	*	+1.3 [0.1]	+1.6 [0.2] +1.4 [0.1]	-0.2 [0.3]	1983/84 (Rev. -5 ppm)	2	-0.3 [0.1]	-1.6 [0.3]
									4	-0.8 [0.1]	
June 15-18 1991	0.653	55	X	*	+1.4 [0.1]	+1.5 [0.1] +1.5 [0.1]	-0.5 [0.3]	1983/84 (Rev. -5 ppm)	2	-0.5 [0.1]	-1.7 [0.4]
									4	-0.6 [0.1]	
1990	0.755	77	*	*	+1.3 [0.1]	+1.6 [0.2] +1.4 [0.1]	-0.2 [0.3]	1991 Computed	2	+0.2 [0.1]	+0.2 [0.3]
1991	0.653	55	X	*	+1.4 [0.1]	+1.5 [0.1] +1.5 [0.1]	-0.5 [0.3]	1990 Provisional	Nil	Nil	+0.1 [0.7]
1990/91 Combined	0.739	136	X	*	+1.3 [0.1] +1.4 [0.1]		-0.2 [0.3] -0.5 [0.3]	N/A	N/A	N/A	N/A

BELLEVILLE, ONT. 1990/91 ADOPTED VALUES

STATION TO	STATION	ELEVATION FR (METRES)	ELEVATION TO (METRES)	ELEV DIFF (METRES)	SEA LEVEL DIST (METRES)	SLOPE DIST (METRES)	STD DEV (MM)
1	2	97.780	98.610	0.830	100.2162	100.2211	0.08
	3	97.780	100.710	2.930	301.6371	301.6561	0.15
	4	97.780	109.250	11.470	1050.1679	1050.2476	0.26
	5	97.780	112.660	14.880	1308.3579	1308.4641	0.34
2	1	98.610	97.780	-0.830	100.2162	100.2211	0.08
	3	98.610	100.710	2.100	201.4210	201.4351	0.08
	4	98.610	109.250	10.640	949.9517	950.0268	0.21
	5	98.610	112.660	14.050	1208.1417	1208.2434	0.28
3	1	100.710	97.780	-2.930	301.6371	301.6561	0.15
	2	100.710	98.610	-2.100	201.4210	201.4351	0.08
	4	100.710	109.250	8.540	748.5308	748.5918	0.17
	5	100.710	112.660	11.950	1006.7207	1006.8085	0.23
4	1	109.250	97.780	-11.470	1050.1679	1050.2476	0.26
	2	109.250	98.610	-10.640	949.9517	950.0268	0.21
	3	109.250	100.710	-8.540	748.5308	748.5918	0.17
	5	109.250	112.660	3.410	258.1900	258.2170	0.11
5	1	112.660	97.780	-14.880	1308.3579	1308.4641	0.34
	2	112.660	98.610	-14.050	1208.1417	1208.2434	0.28
	3	112.660	100.710	-11.950	1006.7207	1006.8085	0.23
	4	112.660	109.250	-3.410	258.1900	258.2170	0.11