Guidelines

For

Electronic Distance Measurement

Calibration Baseline Surveys in Alberta

Geodetic Control Unit
Surveys and Technical Services Section
Land Dispositions Branch, Lands Division
Alberta Sustainable Resource Development

January 2007

INTRODUCTION

These guidelines describe the four Electronic Distance Measurement (EDM) calibration baselines in the province of Alberta as well as how to undertake an EDM calibration baseline survey. They have been developed to assist users in verifying that their EDM equipment is working within the EDM manufacturer's stated specification for scale error and constant error. The guidelines also include requirements for submission of EDM calibration survey data to the Geodetic Control Unit, Surveys and Technical Services Section for evaluation.

Those persons who require further information on Alberta's EDM calibration baselines can contact the Geodetic Control Unit, Surveys and Technical Services Section via:

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IMPORTANT NOTICE – All users of the Alberta EDM calibration baselines are responsible for any damages to any property (public or private) that may occur when using the baselines. In addition, users should exercise normal traffic safety precautions while conducting calibration surveys. Any damage or activities, which may result in damage to the baseline, must be reported to the Geodetic Control Unit, Surveys and Technical Services Section.

BACKGROUND

The Government of Alberta maintains four EDM calibration baselines within Alberta for the purposes of calibrating EDM equipment. There is one baseline each near the Cities of Lethbridge, Calgary, Edmonton, and Grande Prairie. Each baseline consists of a set of forced-centring concrete filled steel pillars with an inter-pillar spacing of approximately 100 m to over 2 km, depending on which baseline is being observed at. The Government of Alberta is responsible for general maintenance of the baselines as well as determining and publishing the baseline lengths. Re-observation of the baseline lengths is carried out approximately every five years in conjunction with Geodetic Survey Division (GSD - Earth Sciences Sector, Natural Resources Canada).

The Edmonton and Calgary baselines were originally established in 1976 as part of the recommendations made by the *Federal-Provincial Conference on Control Surveys* in order to detect systematic errors (scale and constant) in EDM systems. Subsequently, the Lethbridge and Grande Prairie baselines were established in 1985 in order to facilitate EDM users in the farther reaches of the province.

All of the baselines have been measured by GSD at regular intervals (epochs of observations) since their inception dates to verify the inter-pillar distances and pillar stability. In general, the re-measurement schedule has been between one and three years depending on the baseline. The current policy for re-observation of the baseline lengths is once every five years. **Baseline lengths for all of the baselines are published on the Director of Surveys web-site at** http://esrd.alberta.ca/lands-forests/director-of-surveys/default.aspx For further information regarding the various epochs of observations conducted by GSD and the corresponding results, please refer to the *Standards* section under the *Products and Services* area of the GSD web-site for reports on the Lethbridge, Calgary, Edmonton, and Grande Prairie EDM Calibration Baselines (see http://www.geod.nrcan.gc.ca/)

Note that complete marker descriptions for all of the various baseline pillars can be obtained by accessing the *Spatial Information System* (SPIN) at http://www.spin.gov.ab.ca. If further information is required, users should contact the Geodetic Control Unit, Surveys and Technical Services Section directly.

WHEN TO DO AN EDM CALIBRATION SURVEY

In general, there are three situations under which a Land Surveyor or other users of EDM equipment conduct EDM calibration surveys.

1 As a requirement for an Alberta Survey Control project for the establishment and/or maintenance of Alberta Survey Control Markers (ASCMs).

2 Statutory requirement under Part 1, Section 11(2),(b) of the *Surveys Act* which requires an Alberta Land Surveyor to verify *all electronic linear measuring devices used by him by comparison with calibration base lines established by the Minister for that purpose*.

3 Check the quality of the EDM in situations where it has been damaged during regular surveying operations or when the EDM is old and may no longer be operating within the manufacturer's specifications.

LETHBRIDGE EDM CALIBRATION BASELINE

A) Location Description

The Lethbridge EDM calibration baseline is located on the west side of a north-south road allowance near the NE 1/4 of S35-T7-R20-W4M. The baseline is within a ditch 9.1 m west of the centerline of the north-south road, 211.3 m south of the NE 1/4 of S35-T7-R20-W4M, and 1 m east of the east boundary of S35-T7-R20-W4M. See page 4 for a diagram showing the location of the baseline in relation to surrounding physical features.

B) Marker Type Description

This baseline consists of six pillars with stainless steel forced-centring plates. The pillars are 35-cm diameter steel pipes driven into the ground approximately 10.5 m with approximately 1.5 m above ground level, filled with concrete. All of the pillars are painted yellow and have concrete bases on which the observer can stand when conducting a calibration survey. Each pillar has a plaque (tablet) fixed to it identifying the pillar as an Alberta Survey Control Marker (ASCM) and showing the tablet marking.

C) Pillar Location and Instability Issues

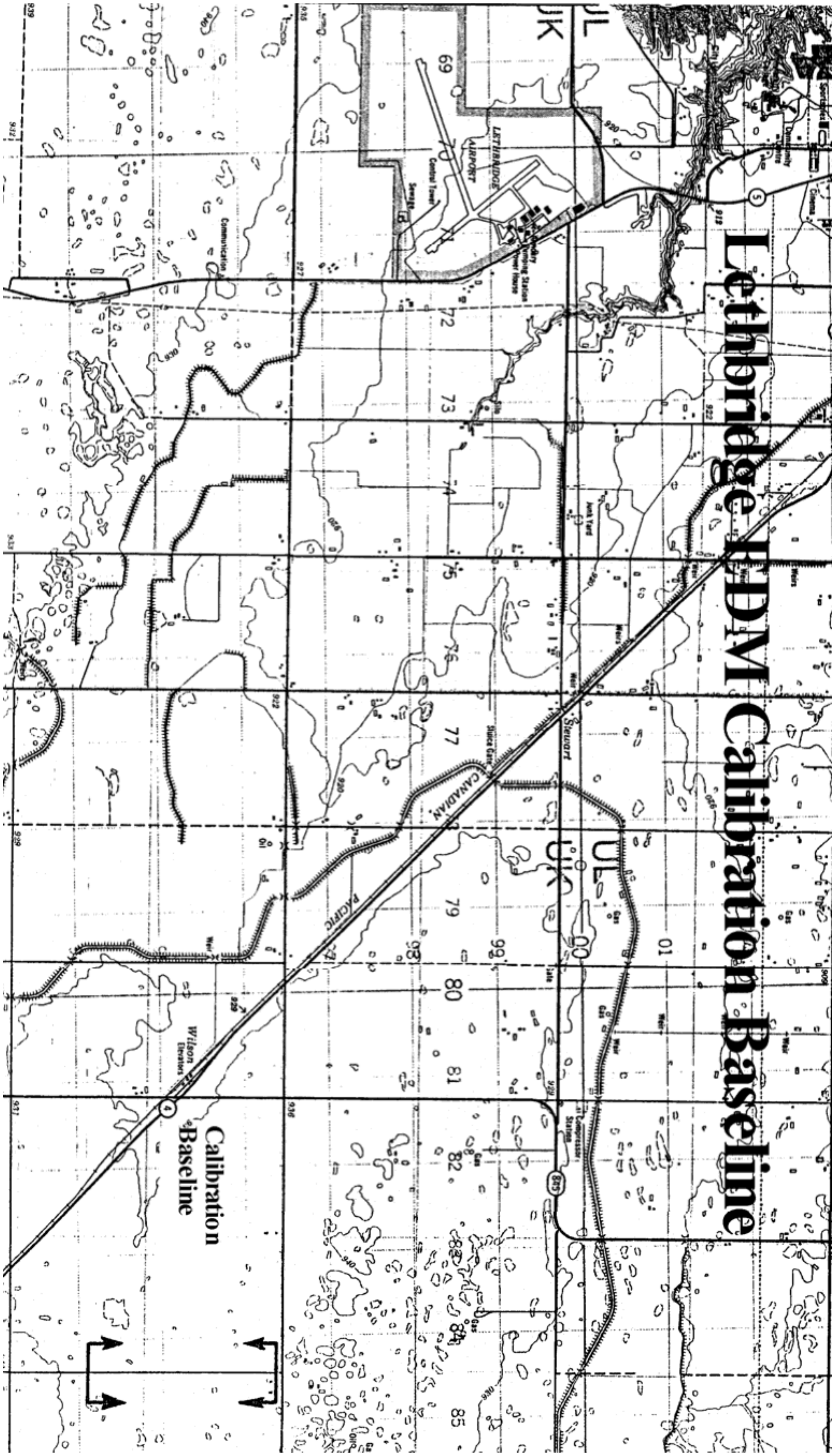
As of August 2001, the Lethbridge baseline was free of any obstructions that may inhibit the ability of users to conduct calibration surveys. Based on the 1998 baseline analysis from GSD, instability of the pillars is estimated at less than 1 mm for the baseline. See **Appendix A** for a listing of recommended baseline lengths to observe.

Update December 12, 2003:

The Lethbridge baseline was re-observed by GSD in July-August of 2003. The baseline continues to be free of obstructions.

Based on the 2003 epoch of observations, a statistically significant movement was detected at pillar 49112.99 of 1.1 mm. This level of movement is not considered to be practically significant since movements of up to 1 mm are possible due to diurnal and seasonal effects. The other pillars at the Lethbridge baseline are considered to be stable.

For further information, please contact the Geodetic Control Unit.


Lethbridge EDM Calibration Baseline
Calibration Baseline
LETHBRIDGE AIRPORT
CANADIAN PACIFIC
Stewart
Wilson

CALGARY EDM CALIBRATION BASELINE

A) Location Description

The Calgary EDM calibration baseline is located near the Calgary Springbank Airport on Old Banff Coach road, north of the Trans-Canada Hwy going west from Calgary. It is near the southwest corner of the SE 1/4 of S4-T25-R3-W5M and 27.8 m north of the centerline of Old Banff Coach road. Pillars 661-24.2, 661-24.3, 661-24.4, 661-24.5 and 661-24.6 are located on property owned by the Calgary Airport Authority (Springbank Airport). Pillars 661-24.7 and 661-24.8 are located in the road allowance and pillar 661-24.1 is located on private property. See page 7 for a diagram showing the location of the baseline.

B) Marker Type Description

The baseline is made up of eight pillars with stainless steel forced-centring plates on top. The pillars are concrete filled steel pipes approximately 25 cm in diameter and driven into the ground approximately 8 m with 1.5 m above ground level. The pillars are painted either orange or white and have *duck-boards* surrounding the base for users to stand on. Also, pillars 661-24.1, 661-24.2, 661-24.3, and 661-24.4 are all encased in aluminium-backed insulation in order to reduce pillar instability related to potential diurnal heating. Each pillar has a plaque attached identifying it as an ASCM and its corresponding tablet marking.

C) Pillar Instability and Location Issues

Movement has been identified at five of the eight Calgary EDM calibration baseline pillars based on the 1995 epoch and earlier observations by GSD. It was determined that pillars 661-24.3, 661-24.4, 661-24.5, 661-24.6, and 661-24.8 are all unstable at the millimetre level or worse. In particular, pillar 661-24.6 has shown movements of up to 7.3 mm during the 1988 to 1994 re-observational epochs. Further to this, GSD has concluded that instability at any pillar on this baseline is worse than one mm and that scale determination will only be at the three to four parts-per-million level.

The Calgary baseline also has pillar location problems that may contribute to the user not being able to obtain the best results possible. These problems include:

- Pillar 661-24.8 is located off-line from the other baseline pillars.
- Pillar 661-24.7 is only visible from pillars 661-24.1 and 661-24.6 due to changes in elevation.
- Baseline observations from pillars 661-24.4 to 661-24.5 and 661-24.4 to 661-24.6 are through a hole cut in a chain link fence, which may have an adverse impact on measurements.
- Baseline observation from pillars 661-24.2 to 661-24.8 goes under a high voltage electrical box, which may have an adverse impact on measurements.

- Pillars 661-24.2, 661-24.3, 661-24.4, 661-24.5, and 661-24.6 are all located on property owned by the Calgary Airport Authority (Springbank Airport). There is a strong potential for development in and around the baseline pillars.

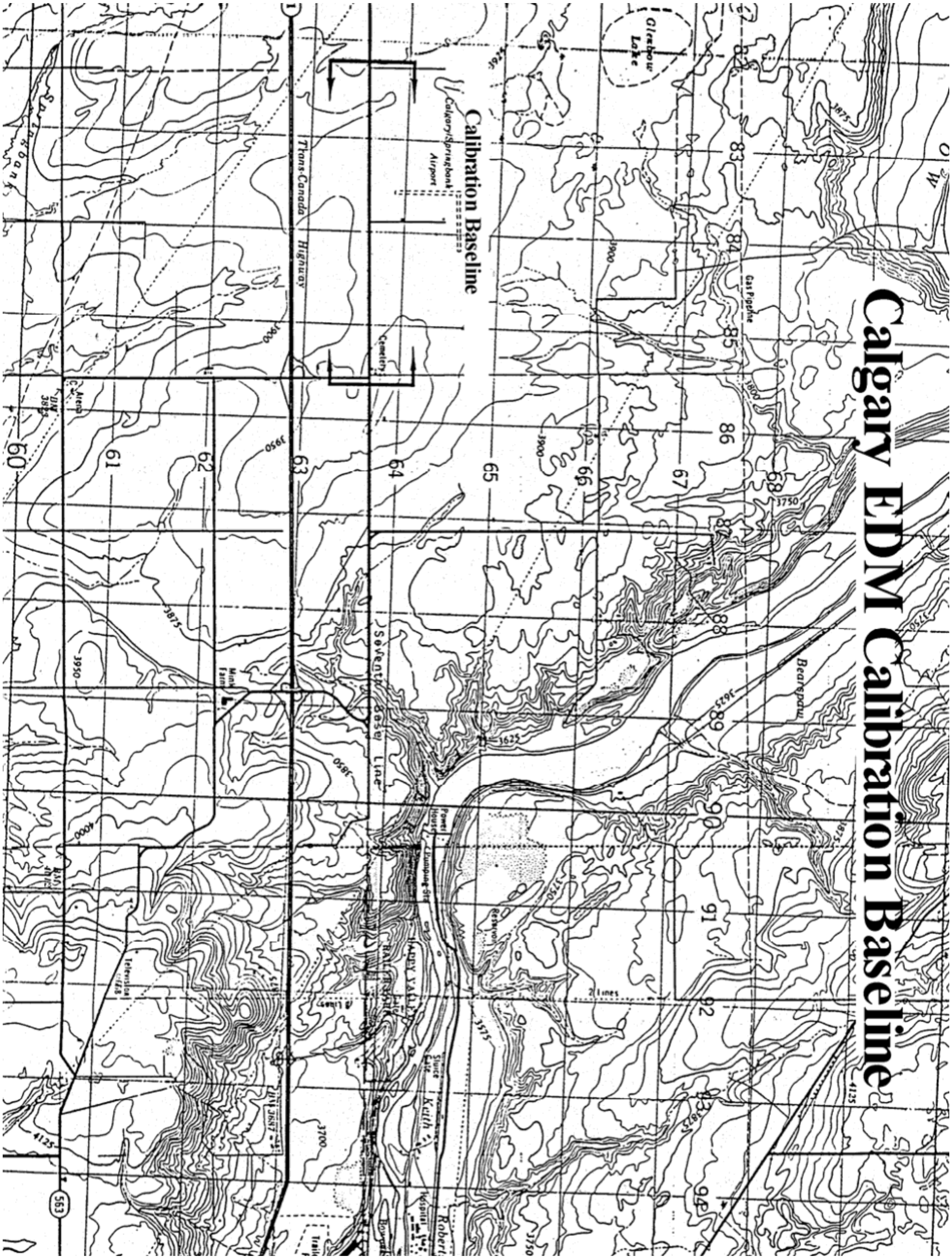
Users of the Calgary EDM calibration baseline are encouraged to use caution when calibrating on this baseline given the pillar instability and location issues. **Appendix A** includes a listing of recommended baseline distances to be observed in order to obtain the best possible results using this baseline.

Update December 9, 2003:

The Calgary baseline was re-observed by GSD in August of 2003. Based on the 2003 epoch of observations, statistically significant movements were detected at pillars 661-24.1, 661-24.3, 661-24.5, and 661-24.6. Similar to previous epochs of observations at this baseline, at least 50% of the pillars that make up this baseline are considered to be unstable. Note that no reliable estimate of the movement between the last epoch (1995) and the 2003 epoch has been made since over half of the pillars are moving. As a result, the baseline lengths between the various pillars are classified as **PROVISIONAL** as the lengths are only considered to reliable for the 2003 epoch of observations.

Caution must be exercised when using (and analyzing) any EDM calibration results based on this baseline.

For further information, please contact the Geodetic Control Unit.


Calgary EDM Calibration Baseline
Calibration Baseline
Calgary/Springbank Airport
Trans-Canada Highway
Seventh Base Line
Glenbow Lake
Bearspaw
Gas Pipeline
Cemetery
Keith

EDMONTON EDM CALIBRATION BASELINE

A) Location Description

The Edmonton EDM calibration baseline is situated on the north-side of Hwy #16, east of the City of Edmonton, and approximately between Range Roads 223 and 224. The five of the six pillars are located in the road allowance along the edge of a paved service road that runs parallel to Hwy #16. The sixth pillar is located on private land (cattle pasture) near the SE 1/4 of S17-T53-R22-W4M. See page 9 for a diagram showing the location of the baseline.

B) Marker Type Description

The Edmonton baseline has six pillars consisting of stainless steel forced-centring plates cemented to a 25-cm diameter, concrete filled steel pipe, driven approximately 8 m into the ground with approximately 1.5 m above ground level. All of the pillars are painted yellow and have a plaque attached identifying them as ASCMs along with their corresponding tablet markings.

C) Pillar Location and Stability Issues

Similar to the Lethbridge baseline, the Edmonton baseline (as of August 2001) is free of any obstructions other than minor tree vegetation that is trimmed appropriately each year. Based on the 1996 epoch of observations by GSD, movement of approximately 1.5 mm has been determined at pillar 937+56.14. However, the five other pillars have been deemed to be stable at less than 1-mm. The recommended baseline lengths to be observed for the Edmonton EDM calibration baseline are given in **Appendix A**.

Update April 5, 2002:

The Edmonton baseline was re-observed by GSD in July of 2001. the baseline continues to free of obstructions.

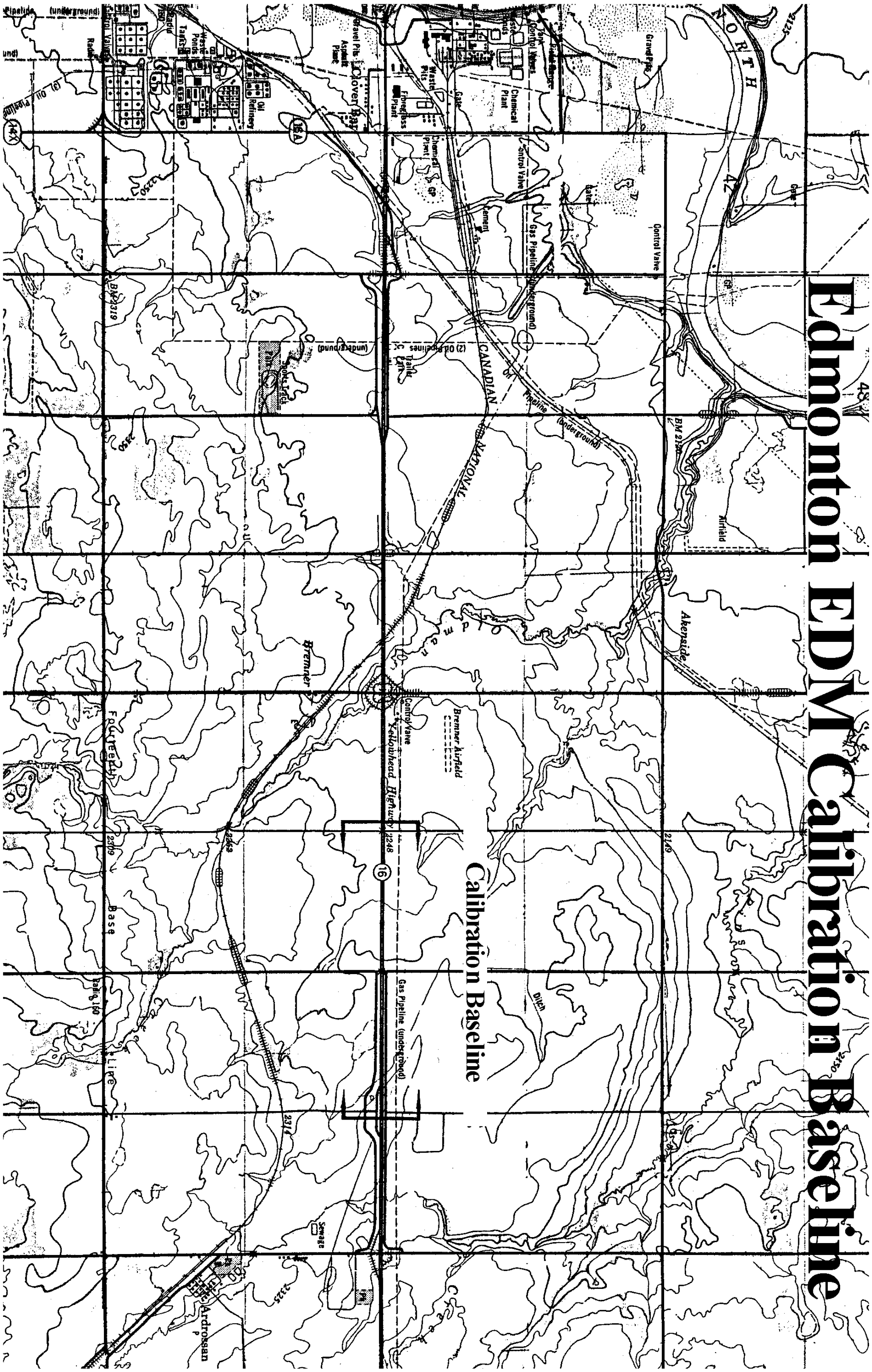
Based on the 2001 epoch of observations, statistically significant movements were detected at pillar 937+56.14 (-2.3 mm) and pillar 937+56.17 (-0.8 mm). It is noted that the 2.3 mm movement at pillar 937+56.14 is in the opposite direction when compared to the 1996 epoch of observations. Conversely, no statistically significant movement was detected at pillar 937+56.17 in the 1996 epoch. In reviewing the analysis for the last 10 years, pillar 937+56.14 has moved up to 2.7 mm while pillar 937+56.17 is quite stable at an overall movement of only 0.2 mm.

Update Jaunary 11, 2007:

The Edmonton baseline was re-observed by GSD in June of 2007. The baseline continues to be free of obstructions.

Based on the 2007 epoch of observations, no statistically significant movements were detected at any of the pillars that make up the Edmonton baseline. Only minor pier movements of less that 0.001 m were detected when comparing between the 2001 and 2006 epochs.

For further information, please contact the Geodetic Control Unit.


Edmonton EDM Calibration Baseline
Calibration Baseline
Bremner
Bremner Airfield
Akenside
Ardrossan
Yellowhead Highway
CANADIAN
NATIONAL
Airfield
Ditch
NORTH

GRANDE PRAIRIE EDM CALIBRATION BASELINE

A) Location Description

The Grande Prairie EDM calibration baseline is located approximately 16 km east of the City of Grande Prairie on Hwy # 670. The baseline is in the road allowance approximately 9 m west of a gravel road running north-south near the east boundary of the NE 1/4 of S33-T71-R4-W6M. The baseline runs south from this point to a point 293.5 m north of the east 1/4 corner of the NE1/4 of S28-T71-R4-W6M. See page 11 for a diagram showing the location of the baseline.

B) Marker Type Description

The Grande Prairie baseline consists of six pillars, 40 cm in diametre, filled with concrete, driven into the ground 10.4-m with stainless steel forced-centring plates on top. Each of the pillars stands approximately 1.6 m above ground level. All of the pillars are painted yellow and have identification plaques attached identifying them as ASCMs and displaying the corresponding tablet markings.

C) Pillar Location and Instability Issues

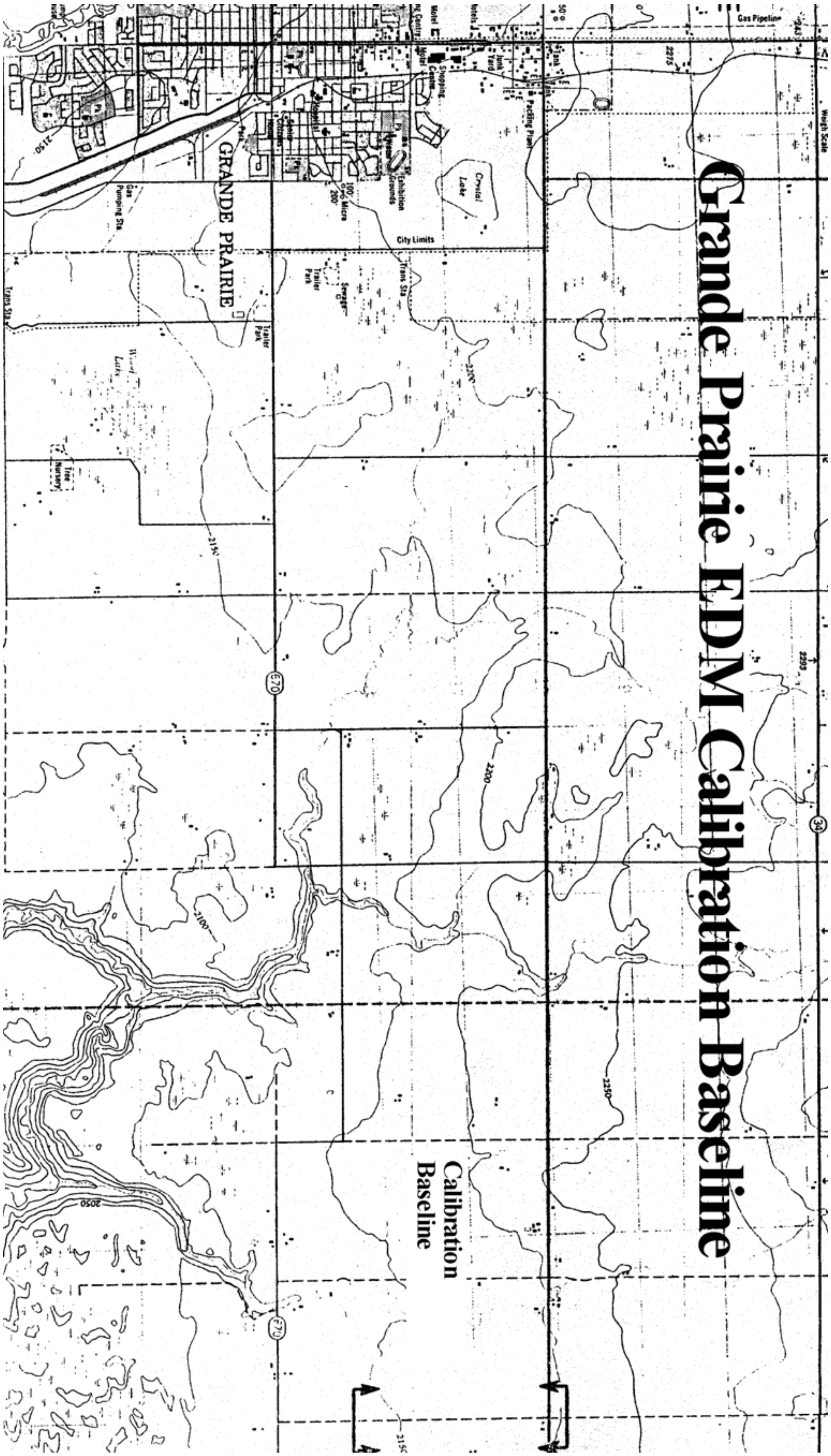
As of August of 2001, no obstructed baseline distances had been reported for the Grande Prairie baseline. GSD's analysis of the 1996 epoch of observations shows instability at pillar 55118.19 of the baseline of approximately 2.6-mm. However, the other five pillars are considered to be stable at less than one mm. The recommended baseline lengths to be observed at the Grande Prairie baseline are given in **Appendix A**.

Update December 12, 2003:

The Grande Prairie baseline was re-observed by GSD in August of 2003. The baseline continues to be free of obstructions.

Based on the 2003 epoch of observations, a statistically significant movement was detected at pillar 55118.18 of 3.5 mm. This level of movement is considered significant and caution should be exercised when including this pillar in any EDM calibration survey and subsequent analysis. Statistically significant movements were also detected at pillars 55118.15 and 55118.17, but are not considered to be practically significant as they are less than 1 mm in each case.

For further information, please contact the Geodetic Control Unit.


Grande Prairie EDM Calibration Baseline
Calibration
Baseline
GRANDE PRAIRIE
City Limits
Crystal Lake
Gas Pipeline
Weigh Scale
Exhibition Grounds
Trailer Park
Tree Nursery
Gas Pumping Sta
Trans Sta
2200
2150
2250
2100
2050

HOW TO DO AN EDM CALIBRATION SURVEY

EDM calibration surveys are conducted by measuring the pillar-to-pillar slope distance on baselines of known length to determine the scale and constant error associated with the EDM being evaluated. In order to do this accurately; users must also have compatible prisms as well as a good quality barometer and thermometer to measure the meteorological (MET) conditions at the time of calibration. The other issue to be considered is the correct *dialing out* of the EDM's MET corrections as required for evaluation of calibration survey results by the Geodetic Control Unit, Surveys and Technical Services Section.

In **Appendix B** are blank forms that may be used to record calibration baseline survey data. Included are forms for distance observations, EDM information, and barometer and thermometer calibration. Some users will recognize these forms as being similar to those used for conventionally surveyed Alberta Survey Control projects.

Observation Methodology

The Geodetic Control Unit, Surveys and Technical Services Section has recommended baseline lengths to be observed for each of the calibration baselines in Alberta (See **Appendix A**). However, the following general steps should be used to conduct an EDM calibration survey:

A. Users must fully understand the operating manual of the EDM being used.

B. All equipment should be correctly adjusted and in good working order.

C. All appropriate instrument self-checks as stated in the manufacturer's operating manual should be done.

D. Calibration surveys should only be conducted within the allowable range of weather conditions as defined by the manufacturer.

E. Slope distances for each pillar-to-pillar distance are measured twice (aim#1 and aim#2) with the average between the two distances used as the observed value.

F. Temperature and barometric pressure should be measured at both the instrument station and the target station (prism) for all distances. The temperature and pressure values are recorded as the correct value(s) in the field based on the known standards (see below).

Compatible Prisms

When conducting a calibration survey, it is preferred that users calibrate with prisms sets that are compatible with the EDM being evaluated. However, users may calibrate using prisms that are not specifically designed for use with the EDM in question, but have the same prism offset (*retro-ray prisms* for example). The reason for doing this is simply that when calibrating, the

desire is to accurately determine the constant error associated with the EDM system. This is not possible if different prism sets are used during the survey.

Barometer and Thermometer Equipment

Similar to compatible prisms, it is important to also have an accurate barometer and thermometer to measure the MET conditions at the time of measurement. EDM measurements require that the *absolute* or *station* pressure and temperature be recorded for each distance measurement. Inaccurate MET observations can contribute to as much as one to two parts-per-million error in the scale determination of an EDM. Also, the barometric (or atmospheric) pressure is not reduced to sea level. Contact the Geodetic Control Unit, Surveys and Technical Services Section for further information if required.

It is important to verify the accuracy of the MET equipment by comparing it against a known standard. It is not required to adjust the MET equipment to the standard values, but just note the amount of the correction to your equipment in order to be consistent with the standard values. Also, the barometer must be graduated to an interval of not greater than 2.5 mm and the thermometer must be graduated in intervals of 1^0 C or smaller. The pressure is recorded to the nearest mm or equivalent while the temperature is recorded to the nearest 1^0 C or equivalent value.

Users can contact Environment Canada in Edmonton or Calgary, or contact their local airport in order to compare their thermometer and barometer with a known standard. It is noted the users should contact the appropriate agency in advance of their visit to the baseline.

***Dialing Out* of EDM Met Corrections**

Most modern EDMs have the capability to automatically correct the distance observations based on the MET conditions at the time of observation. However, the mathematical model used to correct the observed distances is based on the manufacturer's specifications, which may or may not correctly reflect the true meteorological effects at the time of the calibration survey. Therefore, the operator of the EDM may wish to *dial out* the MET corrections so that the EDM is observing based on standard temperature and pressure (usually 20^0C and 760 mm HG). For further information, consult with the EDM manual and/or the Geodetic Control Unit, Surveys and Technical Services Section.

SUBMISSION REQUIREMENTS FOR EVALUATION OF EDM CALIBRATION SURVEYS BY THE SURVEYS AND TECHNICAL SERVICES SECTION

If desired, users of EDM equipment may submit their EDM calibration survey data to the Surveys and Technical Services Section in order to determine the scale and constant error for their EDM. This service is offered free of charge and usually takes one business day to complete, provided that all the pertinent information for the EDM and the survey has been provided.

When submitting an EDM calibration survey for evaluation by the Geodetic Control Unit, Surveys and Technical Services Section, the following information is required:

1. EDM make, model, and serial number.
2. Number and type of prisms employed in the calibration survey.
3. Barometer make, model, serial number.
4. Thermometer make, model, serial number.
5. Carrier wave-length of the EDM.
6. Modulated wave-length of the EDM.
7. Modulated frequency of the EDM.
8. Calibration survey data must be submitted using the forms in **Appendix B**.

The Carrier wave-length, Modulated wave-length and the Modulated frequency (items 5, 6, and 7 above) are used by the Surveys and Technical Services Section to derive the meteorological coefficient values used within the evaluation software. The Carrier wave-length, Modulated wave-length, and the Modulated frequency can be obtained by contacting the EDM equipment supplier or manufacturer directly.

EDM calibration baseline surveys that are to be submitted to the Geodetic Control Unit, Surveys and Technical Services Section for evaluation must have the MET correction values dialed out in order to not adversely impact the evaluation.

APPENDIX A

RECOMMENDED BASELINE LENGTHS TO BE OBSERVED FOR EDM CALIBRATION SURVEYS

A) Lethbridge

From Pillar		To Pillar	
Tablet Marking	ASCM-NO	Tablet Marking	ASCM-NO
49112.99	432344	49112.100	317057
49112.99	432344	49112.101	307900
49112.99	432344	49112.103	418640
49112.99	432344	49112.104	214221
49112.100	317057	49112.101	307900
49112.100	317057	49112.103	418640
49112.100	317057	49112.104	214221
49112.101	307900	49112.102	301978
49112.101	307900	49112.104	214221
49112.102	301978	49112.104	214221

B) Calgary

From Pillar		To Pillar	
Tablet Marking	ASCM-NO	Tablet Marking	ASCM-NO
661-24.1	151894	661-24.2	11718
661-24.1	151894	661-24.3	149203
661-24.1	151894	661-24.5	249060
661-24.2	11718	661-24.3	149203
661-24.2	11718	661-24.5	249060
661-24.2	11718	661-24.8*	453951
661-24.3	149203	661-24.5	249060
661-24.3	149203	661-24.8*	453951
661-24.5	249060	661-24.8*	453951

* Pillar 661-28.8 (ASCM 249060) was <u>not</u> included in the 2003 epoch of observations conducted by GSD.

C) Edmonton

From Pillar		To Pillar	
Tablet Marking	ASCM-NO	Tablet Marking	ASCM-NO
937+56.13	57364	937+56.14	265959
937+56.13	57364	937+56.18	208595
937+56.14	265959	937+56.15	117135
937+56.14	265959	937+56.16	47340
937+56.14	265959	937+56.17	227371
937+56.14	265959	937+56.18	208595
937+56.15	117135	937+56.16	47340
937+56.15	117135	937+56.18	208595
937+56.16	47340	937+56.17	227371
937+56.16	47340	937+56.18	208959

D) Grande Prairie

From Pillar		To Pillar	
Tablet Marking	ASCM-NO	Tablet Marking	ASCM-NO
55118.14	327726	55118.15	350926
55118.14	327726	55118.16	327601
55118.14	327726	55118.18	444414
55114.14	327726	55118.19	331702
55118.15	350926	55118.16	327601
55118.15	350926	55118.18	444414
55118.15	350926	55118.19	331702
55118.16	327601	55118.18	444414
55118.16	327601	55118.19	331702
55118.17	365700	55118.19	331702

APPENDIX B

Barometer and Thermometer Calibration Form

Date _____

Location of Known Standard (Weather Station) _____

Observer _____

BAROMETER CALIBRATION

User Barometer Make _____

User Barometer Model _____

Serial # (if applicable) _____

Weather Station Barometer Reading (include units) _____

User Barometer Pressure Reading (include units) _____

Pressure Reading Difference (include units) _____

THERMOMETER CALIBRATION

User Thermometer Make _____

User Thermometer Model _____

Serial # (if applicable) _____

Weather Station Thermometer Reading (include units) _____

User Thermometer Reading (include units) _____

Thermometer Reading Difference (include units) _____

EDM Information

Agency or Surveying Company _____

Contact Name _____

Contact Number (ph)_____ (fax) _____

EDM Make _____

EDM Model _____

EDM Serial Number _____

Measurement Units – Metres □ or Feet □

EDM Prism – Make_____Number of Prisms in Set _____

Distance Measurement Form

Observer_____ **Recorder**_____ **Date**_____ **Page**____ **of** ____

	EDM Station			**Prism Station**	
Station	ASCM # _____		**Station**	ASCM # _____	
H.I. _____		M ___ F ___	**H.T.** _____		M ____ F ____
Obs Pressure _____		MB ___ MM ___ IN. ____	**Obs Pressure**_____		MB ___ MM ___ IN. ___
Obs Dry Temp _____		^{0}C ____ ^{0}F ____	**Obs Dry Temp**_____		^{0}C ____ ^{0}F ____
Obs Wet Temp _____		^{0}C ____ ^{0}F ____	**Obs Wet Temp**_____		^{0}C ____ ^{0}F ____
Slope Distance	**AIM #1** _____		**MET Corrections Zeroed Out Yes**___ **No** ___		
	AIM #2 _____		**Obs Start Time** _____ **Obs Finish Time** _____		
	MEAN _____		**Weather**		

Remarks:

Notes:

- M - Metres
- F - Feet
- MB – Millibars
- MM – Millimetres
- IN - Inches
- ^{0}C - Degrees Centigrade
- ^{0}F - Degrees Fahrenheit