Helping Vermonters Visualize Choice

GUIDELINES FOR USE OF THE VERMONT COORDINATE SYSTEM

I. INTRODUCTION

These standards were developed by the **Vermont Geodetic Network Committee** of the **Vermont Society of Land Surveyors (VSLS)** for consideration by the VSLS membership. The Vermont Center for Geographic Information, Inc. (VCGI) is pleased to cooperate in offering this draft for review and comment by *VGIS Handbook* subscribers.

Written comments are invited prior to **April 19, 1993**, and should be addressed to the Committee Chairperson:

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II. PURPOSE

The objective is to provide a source document for any organization or political body wishing to regulate the use of the Vermont Coordinate System, and as such, the impact of these standards is dependent on the actions of those outside institutions. The reasons for utilizing the Vermont (state plane) Coordinate System are:

1. To describe on a common datum, the position of points on, above, or under the surface of the earth.
2. To perpetuate said positions in a convenient format.
3. To standardize the location of objects, points, and other entities, as recorded in geographic/ land information systems, (G/LIS) and other spatially related databases, for use in analytic and mapping applications.
4. To facilitate future survey retracement of land boundaries.

III. POSITIONAL STANDARDS

A. Control Requirements -- All coordinates that purport to define positions based on the Vermont Coordinate System shall be tied by direct survey measurement to at least one, and preferably two or more, control stations that are either presently included in the National Geodetic Reference System (NGRS), or have been established in accordance with standards published by the Federal Geodetic Control Subcommittee (FGCS), formerly the Federal Geodetic Control Committee (FGCC).

The order of accuracy of the control station(s) used or established shall be Second Order or higher in conformance with Title 1, Chapter 17, section 673(d) of the Vermont Statutes Annotated.

B. Accuracy of Coordinates -- The positional accuracy of coordinates based on the Vermont Coordinate System, for points other than control stations, shall be consistent with their intended use, subject to the following:

1. The positional tolerance for points relied upon for the location of land boundaries shall not exceed +/- 0.15 meter.

2. The positional tolerance for all other points shall not exceed +/- 1.0 meter.

For purposes of this document, positional tolerance is defined as the range of values, at 95% probability, of the difference between purported and true X and Y coordinates. (ie. For boundary points, the absolute error for either coordinate, at the 95% confidence level, shall not exceed +/- 0.15 meter.)

This value is roughly equivalent to the length of the major semi-axis of an error ellipse at the 95% confidence level.

IV. MEASUREMENTS

A. Using Conventional Surveying Instruments

1. Traverse: Traverse is a measurement system comprised of joined distance and angular observations.

Traverse methods shall be consistent with existing applicable standards and specifications, and shall include sufficient measurement redundancy to enable a statistically valid analysis and adjustment, giving a mathematical indication of the positional tolerance for each point.

2. Astronomic Observations: Reliance on astronomic azimuths alone provides no check on position and is discouraged except in areas of sparse control.

   a. Astronomic observations for azimuth are required at two or more different locations when measurements are tied to a single control station.

   b. Astronomic observations for azimuth are required on traverse between control stations when the number of instrument setups exceeds 25.

   c. Astronomic azimuths shall be corrected to geodetic by

applying the LaPlace correction, and corrected to grid (The Vermont Coordinate System) by applying the convergence/mapping angle. (Note: estimated LaPlace corrections +/- 1" are available using NGS software DEFLEC. Corrections for Vermont may approach 10".)

B. Using Global Positioning System (GPS) -- Where measurements are made using GPS, not for the establishment of new control, but as a substitute for conventional methods, the resulting positional accuracy of the points measured shall conform with the tolerances defined in section III B.

V. PROCESSING

The computations and adjustment will use models which account for the particular characteristics of the Vermont Coordinate System. For example, all measured distances may be corrected from horizontal to geodetic (ellipsoid) by the formula [20906000/20906000+H+N], where 20906000 = the average radius of the earth in feet, H = the mean elevation, in feet, of the survey, as long as the change in elevation is not more than about 500 feet for the entire survey, and N = mean geoid height of the survey (an average value of N = -95 feet may be used for the entire state). Correction to grid (The Vermont Coordinate System) may be made by multiplying all geodetic distances by the average grid scale factor for the survey area.

Least Squares is recognized as the best method for analyzing and adjusting survey measurements. It is the only method in common use that provides the statistical basis for computing positional tolerance. This statement should not be construed as precluding the use of other methods of adjustment, but rather as an indication of current trends in the surveying profession.

A minimally constrained least squares adjustment will be checked for blunders by examining the normalized residuals. The observation weights will be checked by inspecting the post-adjustment estimate of the variance of unit weight.

When using coordinates based on the Vermont Coordinate System, the surveyor should remember that the inversed quantities are grid distances, bearings, and areas. In most land surveying situations in Vermont, the difference between grid and ground will not be significant. However, there may be occasions when it is desirable to account for this discrepancy, particularly where large tracts of land at high elevations, and/or on the fringes of the grid zone, are involved.

VI. REPORTING IN

A. Any use of the Vermont Coordinate System shall abide by statute

THE VERMONT COORDINATE SYSTEM

law (Title 1, Chapter 17, sections 671-679)

B. Values of coordinates shall be given only to the number of significant figures which is indicative of their positional accuracy. While this precept may not apply to data which is transferred in electronic media, such data shall be documented as provided in 3 and 4, below.

C. The basis of coordinates must be included in the documentation supplied with the coordinate information, i.e. names of control station(s), reference datum and adjustment version used (e.g. NAD83 - 1988).

D. When coordinate values are purported to be based on the Vermont Coordinate System, they shall be accompanied by a certification to the effect that they have been generated in conformance with these standards.

E. Guidelines for depicting coordinates on map products:

1. Grid lines/ticks should cover the project area, at an appropriate interval, and should be annotated at the map's extremities.

2. When shown on the map, each coordinate value should be labeled either **X/Y** or **N/E**

   e.g. X 184560 or N 269380
   Y 269380 E 184560

It shall not be necessary, (or desirable), to show coordinates for all points as well as bearings and distances for all lines. A separate table of coordinate values may be appropriate. Care and judgement should be exercised in terms of clarity, content, and aesthetic appeal.

F. The surveyor should place emphasis on reporting information relative to the raw measurements rather than the computed coordinates, since the coordinate values are subject to change as more accurate measurements and/or adjustments are made.

It is recognized, however, that the practical use of spatial information requires the coordinate values themselves, and the surveyor is encouraged to make this information as readily available as possible.