2002 NDOR PLANIMETRIC IMPERIAL MAPPING GUIDELINES

JAN 2002 IN-HOUSE

Upon Notice To Proceed, The Consultant Shall Provide All Of The Services As Outlined In These Guidelines.

These guidelines address aerial photogrammetry services as required for planimetric mapping. The work required includes determination of supplemental control points by aerial analytical triangulation and Digital Terrain Model (DTM) compilation.

(A) **DATA TRANSFER**

1. It shall be the Consultant's responsibility to obtain the necessary software to translate to and from the specified format for all electronic files supplied by the State and for all electronic files prepared by the Consultant and supplied to the State.
2. The State and the Consultant will supply all DTM survey files for photogrammetric or ground surveys, in a 3D MICROSTATION format. Random spots, break lines and obscure/void areas on levels specified by the Preliminary Survey CADD Levels (PCL) document. An ASCII file will also be supplied in Geopak DAT file format. (If both parties are using Geopak, only the TIN needs to be supplied). Both formats will be supplied on a CD or via electronic means.
3. The State and the Consultant shall transfer all other files in a 2D MICROSTATION format. A transmittal must accompany all CD's listing the file names and detailing the method of placement so the State will know how to restore the data in our system.
4. An electronic file of the alignment listing must be supplied. (If both parties are using Geopak, only the GPK file needs to be supplied).

(B) **PROJECT DATA SHEETS – IN-HOUSE**

Three types of project data plan sheets will be produced, for the project, as described below. The purpose of information given on the data sheets is to provide the construction survey party with sufficient data to stake centerline, Right-of-Way and to set blue tops, slope stakes, etc. Each sheet will have the project number placed in the title block the control number and where appropriate, the DAF value. See the PCL and Exhibit A(1-3).

CONTROL POINT, P.I., CURVE DATA SHEET The sheet will list all of the targeted horizontal control points (C.P.'s) that are within the mapping boundary, horizontal alignment P.I.'s with curve data, intersecting road tie stations and equation stations. Each

of these points will be assigned a number, consecutively through the length of the project, usually beginning with 10.

Data needed to complete this sheet include X, Y and Z coordinates of the C.P.'s (listings furnished) as well as computation of offset and azimuth to station. In addition, station and horizontal alignment definition based on the State Plane coordinate grid for the project control points.

CONTROL POINT TIES SHEET The sheet will have a drawing of the physical ties from the tiebook of each C.P. listed on the Control Point, P.I., Curve Data Sheet.

NOTE: The previously assigned code numbers will not necessarily be consecutive, but will be in ascending order AND the preferred method for entering text within the tie circle is the "place text on line" command so that lines are automatically clipped out to fit text. A copy of the C.P. ties notebook is provided as the source for this information. The field description and identification is to be shown for each point. See Exhibit A.

CONTROL POINT / BENCHMARK SHEET The sheet will list all of the benchmarks, which fall within the station range for the project. Each benchmark will be assigned a number "B__" consecutively through the length of the project, usually beginning with “B10”. Each benchmark horizontal location is to be computed to the nearest one-hundredth of a foot by station and offset from coordinate data provided. Elevation will be shown to one-hundredth of a foot. See Exhibit A.

(C) **MEASURING FOR ANALYTICAL TRIANGULATION – IN-HOUSE SINCE MARCH 2000**

The photogrammetric instruments employed shall be comparators or stereoscopic model measuring instruments. They must have sufficient accuracy and utility for measuring the x and y photographic coordinates of the fiducial or other photographic reference marks and of the targets, photographic images, and artificially marked points to the accuracy’s which will admit of achieving the x, y, and z accuracy’s stipulated for each point.

The supplemental control points must be drilled and identified on the diapositives in such a manner that there will be no doubt as to the point location and its respective identity. The locations of these points shall be outlined by a small circle and identified on the contact prints.

Location of the supplemental control points will be shown as indicated on Exhibit B of these guidelines.

A minimum of three pass points will be drilled in the triple overlap area. The two outside points shall be drilled 1 to 1 ½ inches from the photographic edge of the diapositives on opposite sides of the principal point and on or near a line which passes

through or near the principal point and is perpendicular to the flight line. The center point must be drilled at or near the principal point.

Whenever three points cannot be drilled as specified in the triple overlap area, points must be drilled at least 4 ½ inches apart. Preferably farther apart on each photograph and near enough if possible to a perpendicular to the flight line passing through the principal point so that these points will be control points in the adjacent and succeeding stereoscopic models.

The supplemental points drilled in the triple overlap area of each diapositive must be close enough to a perpendicular to the flight line passing through the principal point so that these pass points will be control points in the adjacent and succeeding stereoscopic models. Each pass point must be drilled only once within any one flight strip except the common supplemental control points between flight strips must be drilled once in each flight strip. Use of a mono comparator will require the point to be drilled on each plate.

The pre-marked basic control points and other premarked points do not need to be drilled on the diapositives except that if the panel should be partially destroyed or the exact point otherwise not visible. But the intended point can be closely estimated, then the point should be drilled for measuring purposes.

There must be common supplemental control points in the overlap between flight strips.

The Consultant shall assign an identifying number to each supplemental control point, for which the x, y, and z coordinates are to be determined by analytical triangulation, that relate to the diapositive on which the point is drilled and indicates the location of the point on the diapositive.

If identifying numbers other than those furnished by the State are used in the computer program for the premarked basic control and other premarked points, separate series numbers should be for this identity such as 100 series for premarked basic control and 400 series for other premarked points. Likewise 300 series could be used for the supplemental control points with other numbers in the 300 series indicating location on the diapositive. (See example F)

The Consultant will deliver a tabulation of each adjusted flight strip listing the pre-marked basic control points with their respective x, y, and z values held. The residual differences between coordinates furnished by the State for the basic control not held and coordinates computed analytically for these same points, other premarked points and the RMS error of each strip or block.

(D) DESCRIPTION OF SERVICES FOR PLANIMETRIC MAPPING

1. GENERAL

This item consists of planimetric maps at (1:50 Urban) or (1:100 Rural) English scale of the project area designated for mapping, and prepared by photogrammetric methods. The finished product must be a clean computer graphics files, MICROSTATION compatible.

2. INTRODUCTION

These specifications set forth the minimum standards to be met and the general procedures to be followed in the production of digital photogrammetric stereocompilation for the State. As used in these specifications, "stereocompilation" refers to the preparation of large scale, photogrammetrically prepared engineering maps and digital terrain model data which will generally be used in highway and structures design. The maps may or may not include contours.

The Consultant shall return the graphic files to the State in format compatible with the equipment it operates, namely MICROSTATION.

3. STEREOCOMPILATION EQUIPMENT

All stereoplotters used for stereocompilation must be in good calibration. Any analog stereoplotters must have proof of a manufacturer's calibration or equivalent which has been performed within two years of the contract date. Any analytical stereoplotters must be recalibrated within 30 days prior to the date of compilation.

4. MAPPING FILE REQUIREMENTS

(a) The center alignment furnished by the State of Nebraska or the Prime Consultant shall be mapped using the widths for the whole length of the project generally is **600'** (**300'** LEFT and **300'** RIGHT). County road coverage shall extend **1000'** (**500'** on either side of the existing mainline alignment and (**150**' LEFT and **150'** RIGHT).

(b) Coordinate values for all features must be based on the grid system indicated by the control data. The Global Origin (GO) must be Lower Left (LL).

(c) Files must be compiled with coordinate values to the nearest hundredth (1/100) of a foot. The working units must be:

(1) Master Units = 1 Ft

(2) Sub Units = 1000 Th

(3) Positional Units = 1

(d) The entire planimetric mapping for each project must be in one continuous file. This file must also contain the project data sheets, which should be placed in line at the end of the map

(e) The graphics files must be named with the state's five or six digit control number applicable for each project plus an identifier and have the extension. "DGN"

EXAMPLES: Use Control Number plus extensions.

PLAINIMETRIC MAPPING	**80123PPL.DGN**	**(use seed file Kernel.dgn)**
ALIGNMENTS	**80123PAL.DGN**	**(use seed file Kernel.dgn)**
DTM	**80123DTM.DGN**	**(use seed file seed3d.dgn**

OBSCURE/VOID AREAS = Level 57

RANDOM SPOTS = Level 58

BREAK LINES = Level 59

5. **MAP PRODUCTION TECHNIQUES**

(a) All features to be labeled and the labels to be used, must be as prescribed on the Preliminary Survey CADD Levels (PCL) (Exhibits C-1 through C-8), of these guidelines. Included for each feature will be the corresponding MICROSTATION level, feature description, line style, (Exhibit F, G, H of these guidelines), font (Exhibit H of these guidelines), and character (where applicable). Labels must be oriented along linear features or parallel to the roadway or survey baseline, as appropriate, so that project beginning will be at the left and project end will be at the right.

(b) Mapping must be continuous with all model limits separating stereomodels delineated on Level 2 (LC=2) (CO=0) (WT=0).

6. **MAP CONTENT**

The following list applies to all scales of mapping. Reference should be made to the appropriate PCL.

(a) The State of Nebraska will provide the control points and benchmarks in a 2D.DGN file.

(b) Control Points

(1) Surveyed horizontal points must be shown with the appropriate symbol and label. Coordinate values or elevations must not be shown.

(2) Surveyed vertical points must be shown with appropriate symbol and labeled as identified in the control survey notebook.

(3) Analytical control points marked on the diapositives must be shown with the appropriate symbol and labeled. Coordinate values or elevations must not be shown.

(c) Planimetric Details

(1) The Preliminary Survey Cell Library, Line Style Resource, NDOR Font Rescource file can be located on the NDOR Web Page under Roadway Design – edesign.exe. The topog.ma, (NDOR Pull Down Menu) which shall be used to produce, correct lines, codes, etc. in this mapping.

(2) The principal point or nadir (photo center) point of each photograph used in the mapping must be shown on the mapping file.

(3) The maps must contain all planimetric features which are visible or identifiable on, or are interpretable from the aerial photograph, including land use features, buildings, irrigation pivots and swing arm lengths, and any utility service to the center pivots, canals, irrigation reuse pits, ditches, reservoirs, trails, roads, highways, railroads, ferry slips, fords, quarries, borrow pits, cemeteries, orchards, boundaries of logged-off areas and wooded areas, and individual (lone) large trees that can be recognized as such, and telephone, telegraph, electric power poles and towers, underground cables, pipe lines and sewers, fence lines, billboards, rock and other walls, and similar details of land use. Structures such as bridges, trestles, tunnels, piers, retaining walls, dams, power plants, transformer and other substations, transportation terminals and airfields, oil, water and other storage tanks, and the like must also be shown. In addition to all other required land use features, curbs, foundations, steps, building entrances, sidewalks, driveways, hydrants, manholes, lamp posts, and similar features, if visible or identifiable on the photography, must be shown. All line-like features, such as highways, railroads, fence, curb and sidewalk lines, and so forth, must be drawn with the guidance of the straight line or curve capabilities of the Intergraph digital mapping software. In areas of abundant brush and timber, a note such as "Scattered brush and timber" may be used providing the area is properly delineated.

All utility poles, structures, (i.e. boxes, meters, or any utility either mapped or located by field survey) which is identifiable

underground or above ground must be referenced by "plus" and distance from the design centerline only.

Building and similar measurable objects must be correctly outlined and oriented, and must be to actual size, except that building dimensions smaller than representable by two tenths of an inch at map scale must be symbolized two tenths of an inch in size. Minor irregularities in building outlines not representable by one tenth of an inch at map scales must be ignored.

The names of cities, towns, villages, rivers, streams, railroads, and other features of importance shall be obtained by the Consultant and must be neatly and correctly lettered on the maps. The designations of State and Federal numbered highways, coordinate grid lines and station markers and township, range and sections numbers must be legible and clear in meaning and must not interfere with map features.

(4) Features must be compiled and labeled as prescribed on the PCL. Features not specifically included on the PCL must also be shown and symbolized using the most equivalent symbol and associated descriptor indicated on the cell list.

(5) Features that are visible but not readily identified must be outlined with dashed lines and placed on the most appropriate level. See the PCL.

(6) The widths of roads and streets must be shown as the separation between back of curb or hard surface edges.

(7) Drainage ditches must be individually symbolized. Roadway ditches must be shown with directional flow arrow (LC = DRAINAGE LV. = 63). All other drainage must be shown spot elevations by a beginning, ending and change of slope, whether or not water is visible in them on the aerial photography.

(8) Contours.

(a) Contours shall be generated by the consultant from the digital terrain model and used to verify the collected terrain data and ground control points.

Contour interval shall be 1.0 foot or less.

The contour file may be requested by NDOR as a confirmational check of the data to use as an overlay with our software's generation of topography and contours.

Check contours should be generated using the criteria given below for standard design contours.

(b) Contours must accurately portray the shape of the terrain within specified accuracy standards according to 8.(e) Accuracy of Mapping, in this Section I. Special attention must be given to contours at transportation-related features. Accuracy standards for contours not-with-standing, contours must clearly reflect the crown or cross slope of all paved areas, including roads, paved ditches, and curbs, and must truly depict all drainage ways and dikes.

(c) Every fifth contour must be compiled as an "INDEX CONTOUR". See the PCL.

(d) Label all index contour elevation in full feet. Orient labels to follow the contours and be readable from the same direction as other text. Exercise care in labeling contours so that the elevation of any contour is readily recognizable. The distance along a contour between labels shall not exceed 15 inches at designated map scale. There must be a break in the contour just wide enough to permit placement of contour label. Where possible, label contours in diagonal stacks one above another along the general line of slope.

(e) Intermediate contours may be omitted in areas where adjacent index contours are less than one-forth of an inch apart at designated map scale, provided that all contours nearest the top and bottom of slope changes are shown.

(f) In densely wooded areas where the ground is partially obscured by dense brush or tree cover, contours must be plotted as accurately as possible and delineated as shown on the PCL.

(g) In areas completely obscured by tree cover or shadows, contours must be omitted and the area labeled accordingly.

(h) Contour lines must be broken for buildings and other feature symbols. All such breaks must provide clean junctures between

the contours and the feature. Gaps and over-runs are not allowed.

(9) Spot Elevations.

(a) Spot elevations must be used to supplement elevation data provided by contours, where exact elevations are needed and in areas of relatively flat terrain where contours are widely spaced.

(b) Spot elevations must be shown on topographic and planimetric-only mapping for drainage (Level 6).

(b) All spot elevations must be labeled with decimal values giving their elevation to the nearest one-tenth of a foot. Labels must be positioned so that they do not obscure other map detail, and placed reading left to right, bottom to top progressing with alignment.

(10) The edge of shoulder on both insides and outside shall be shown by the correct symbology from NDOR Pull Down Menu.

(11) All drives, gravel or hard surface shall be shown by the correct NDOR Pull Down Menu symbology.

7. **DIGITAL TERRAIN MODELS**

(A) Digital terrain models consist of elevation data compiled using a regular RANDOM SPOTS of elevation points as well as intermediate or random spots, where appropriate, to accurately define the general terrain and BREAK LINES of elevation points used to define unique features of grade or change in grade.

(1) RANDOM SPOTS data shall consist of elevations taken at regularly spaced intervals in two horizontal coordinate directions coinciding with the easting and northing (X,Y) of the project coordinate system. The MAXIMUM grid spacing allowable for this project shall be defined at 30 feet. RANDOM SPOTS data shall not be placed on top of breaklines.

(2) BREAK LINE data shall consist of a line of elevations taken at unique elevation breaks such as drainage, centerline of roads, edge of roads, edge of shoulder, toe of slopes, bottom of ditches, ridge lines, saddles and other features. In addition, break line data that defines the terrain at the project perimeter and at the internal Steromodel boundaries shall be provided. The MAXIMUM break line point spacing allowable for this

project shall be defined at 30 feet. Curved break lines will require closer spacing so as not to distort the feature or the program computations related to the discontinuity. Break lines must not cross.

(3) OBSCURE/VOID AREAS BREAK LINES any object that cannot be seen through shall have a breakline drawn around it. The area is surrounded by the breakline so that it is not triangulated through by the software.

(4) Accuracy of the RANDOM SPOTS and BREAK LINE points will be equal to that of spot elevations for contour mapping using National Map Accuracy Standards.

(5) RANDOM SPOTS and BREAK LINE data shall be compiled at intervals such that when contours or cross-sections are generated by an accurate software program the contours or cross-sections will meet National Map Accuracy Standards. A check file using generated contour shall be supplied along with the DTM files for verification of DTM data integrity. The requested accuracies shall be in accordance with generally accepted principles for the photography, ground control, analytical procedures and compilation equipment available.

(B) STREAM CROSSING - Obtain information as follows, Roadway cross-sections or random spots and break line data for DTM must extend at least 400 feet left and right of the proposed project centerline. Give flow line elevations and meander at least to the route band limits upstream and downstream. Meander requirements will vary depending upon size and nature of the stream. The survey should be extensive enough to include all bends or other characteristics that may effect the stream crossing.

(1) Note any evidence of waterfalls downstream from the crossing and show them on the map. The depth and extent of scour should also be shown, if possible.

(C) Hydraulic Survey shall be accomplished on the basis of the "1994 Hydraulic Survey Guidelines for Consultants".

8. **ACCURACY OF MAPPING**

(a) Analytical Triangulation

As determined by analytical triangulation, horizontal position (x and y) and elevation (z) of all supplemental control points required, shall not be in error by more than the error tolerances listed below.

Absolute Error as a Fraction of Flight Height

Error Tolerance	Horizontal Position		Elevation
	X	Y	Z
Maximum (plus or minus)	1: 2,700	1: 2,700	1: 1,800
Average (algebraic mean)	1:18,000	1:18,000	1:12,000
Root Mean Square	1: 9,000	1: 9,000	1: 6,000

(b) Coordinate Grid Lines--The plotted position of each modified plane coordinate grid line or tick mark must be exact.

(c) Horizontal Control--Each horizontal control point must be computer plotted within the coordinate grid in which it should lie and be exact.

(d) Planimetric Features--Ninety percent of all planimetric features which are well defined on the photographs must be plotted. Their position on the finished maps must be accurate to within at least 2 tenths of a foot of their true coordinate position, as determined by the test surveys. None of the features tested must be misplaced on the finished map by more than 4 tenths of a foot from their true coordinate position. The true coordinate position must be determined by making accurate measurements originating and closing on station markers of the project basic control survey, which must have a closure accuracy conforming with the requirements for the basic control.

(e) (Contour--Ninety percent of the elevations determined from the solid line contours of the topographic maps must have an accuracy with respect to true elevation of one-half contour interval or better and the remaining ten percent of such elevations must not be in error by more than one contour interval. This accuracy applies only to the contours which are on each map. Thus, in each particular area where the intermediate contours have had to be omitted because of the steepness of the ground slopes and only the index contours are delineated on the maps, the accuracy stipulations apply to the contour interval of the index contours. Wherever the intermediate contours are not omitted, of course, the accuracy's are applicable to the contour interval specified for the topographic maps. In densely wooded areas where heavy brush or tree cover fully obscures the ground and the contours are shown as dashed lines, they must be plotted as accurately as possible from the stereoscopic model, while making full use of spot elevations obtained during ground control surveys and all spot elevations measured photogrammetrically in places where the ground is visible.

(f) Spot Elevations--Ninety percent of all spot elevations placed on the maps must have an accuracy as follows:

Flight Height 3,000' 0.5'

Flight Height 2,400' 0.4'

Flight Height 2,100' 0.35'

Flight Height 1,500' 0.25'

The remaining ten percent must not be in error by more than:

Flight Height 3,000' 1.0'

Flight Height 2,400' 0.8'

Flight Height 2,100' 0.7'

Flight Height 1,500' 0.5'

(E) **TESTS BY THE STATE FOR QUALITY CONTROL OF MAPS AND THEIR COMPLETION BY THE CONSULTANT**

The State will do whatever testing, editing, and checking deemed necessary and may, at any time, inspect any or all phases of the work being done by the Consultant. The Prime Consultant will run traverse lines and measurement profiles to test the position accuracy of planimetric and topographic features on the maps by ground survey methods or by stereo plotter.

Whenever inaccuracies occur, and adjustments and corrections are necessary, the Consultant shall make those corrections, and/or adjustments when requested to do so by the Prime Consultant.

The Prime Consultant shall create a “TIN” using the data provided by the mapping sub to do a direct comparison check of the culvert hard pavement, flow line shots, all spot elevations and the control points/ bench marks from the adjusted analytical output.

(F) **OWNERSHIP OF MATERIALS AND RESPONSIBILITY**

At the conclusion of the work, the Consultant shall deliver to the State all of the original materials on a CD developed and prepared to fulfill the agreement requirements including:

1. All materials the State furnished to the Consultant for use on this project.
2. Results of aerial analytical triangulation for all strip or block adjustments in softcopy and hardcopy.
3. Graphics files in softcopy and hardcopy.
    a. Planimetric mapping, including data sheets.
    b. DTM.dgn 3D file with all break lines, random spots and obscure/void areas.
    c. Alignments, including crossroad intersections.

While any resultant items of work are in the possession of the Consultant, either before or after completion of the work, the Consultant is responsible for their preservation. If they are lost, damaged, or destroyed while in the Consultant's possession, the Consultant shall replace them in the same quantity and quality as specified in the agreement at no cost to the State.

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