



# PHOTOGRAMMETRIC MAPPING STANDARDS

# GENERAL SPECIFICATIONS

## I Introduction

- A. The specifications set forth are standards to be met and the general procedures to be followed in the production of digital photogrammetric map compilation for the Nevada Department of Transportation (NDOT). As used in this document, compilation refers to the preparation of large scale, photogrammetrically prepared engineering maps to be used on NDOT's CADD system for highway and structure design.
- B. The Task Order provides specific details for each project and should be used in conjunction with this document. Specifications in the Task Order have precedence when a difference or a conflict occurs with this document.

## II Aerotriangulation

- A. Aerotriangulation must be performed with a minimum of six image pass points per model to adequately compute a simultaneous block adjustment with a final RMSE not to exceed bridging specifications for required mapping.
- B. Resulting aerotriangulation report shall be delivered to NDOT within 2 days of completion for review.
- C. Vendor shall provide a current USGS camera calibration report if NDOT camera is not used.
- D. If minimum standards are not met, a conference call shall be arranged with NDOT personnel to resolve conflicts before proceeding.
- E. Softcopy aerotriangulation methods will be acceptable and will be held to the same specifications.

## III Production Methods

- A. Digital planimetric features (.mfc) need to be delivered on CD-ROM or DVD in design file format. For specific details see the "File Requirements" section IV. If the vendor does not have MicroStation in-house, then the vendor may arrange for proper translation into MicroStation to provide NDOT with the specified file format. Enclosed in this manual is NDOT's Location Division "Tools" CD. For details about "Tools" CD please refer to page 57. The "sample mapping" incorporated on the "Tools" CD has several files to help clarify many of the situations which will occur during the collection phase.
- B. Compilation of adjacent data files shall edge match exactly.

- C.** Stereo compilation of large-scale engineering mapping shall show all required planimetric features that are visible, identifiable, or interpretable from the aerial photography. Features to be portrayed and their respective levels, colors, linestyles or cells are defined in the Map Feature Codes.
- D.** Shared cells are cells whose definitions are stored only once in the design file, regardless of how often the cell is placed. Any change made to one shared cell is reflected in all instances of that shared cell. Shared cells are unacceptable; only cells from the NDOT standard cell library included with the Tools CD are acceptable.
- E.** Surface files shall not be generated from contour data.
- F.** Surface files (.mtc) should only have line string and points collected. Arcs, cells, curve string, text or any other data in the raw surface data files are unacceptable.
- G.** Features not specified in the Map Feature Codes need to fit the strategy of the level, color and linestyle. If a situation arises that needs clarification please contact the consultant coordinator identified on the “Task Order”.
- H.** Orthophotos of the area mapped shall be delivered as untiled Geotiff version 6.0 with their accompanying world files (.tfw). Orthophotos shall not exceed 250MB in size. Please refer to “Task Order” for any special requirements.

**IV. File Requirements**

- A.** A diagram and/or description of required file limits for each stereo model pair or project will be provided to the vendor.
- B.** All stereo model pairs will be in MicroStation 3D Design file format utilizing NDOT’s seed file. The correct Global Origin is derived from the physical location of the project relative to the Nevada State Plane Zones provided by NDOT (page 66.)

The working units for the design files shall be:

English	Metric
Master Units .....= ‘	Master Units..... = m
Sub Units..... = tn	Sub Units..... = mm
Sub Units per Master..... = 10	Sub Units per Master..... = 1000
Positional Units per Sub = 100	Positional Units per Sub. = 10

Coordinate values for all features are based on the grid system indicated by the survey control data.

- C. Files shall be named using a unique number/letter designation with the appropriate extension. E.g.: .dgn .mfc .mTc .txt. Please refer to the “Task Order” for a Location Project number.

Example: 4381101.mfc  
          438... represents job number  
          11.... represents strip number  
          01.... represents model number

- D. Each grid file (grd.dgn) will encompass the entire project area. The grid file must be in a MicroStation 3D design file format. Coordinate grids for 1:500 design mapping shall be shown as:

<b>English</b>	<b>Metric</b>
Grid Ticks... = 1/4”	Grid Ticks... = 1cm
Grid Spacing = 250’	Grid Spacing = 100m

- E. Each contour (cnt.dgn) file will encompass the entire project area. The contour file for 1:500 or 1:1000 must be a MicroStation 3D design file format.

<b>English</b>	<b>Metric</b>
Intermediate = 2’	Intermediate = .5 m
Index ..... =10’	Index..... =3 m

Dashed lines will be used to portray the hidden intermediate and index contours when the ground is obscured by vegetation or cultural features to the degree that standard accuracies are not obtainable.

- F. Colors, levels, linestyles, and cells shall be submitted in accordance with the appropriate guidelines provided in the Map Feature Codes (pages 67-69). In addition, model borders and exterior borders must be submitted as closed shapes.
- G. It is the vendor’s responsibility to archive data sets for a minimum of ninety days following NDOT’s final acceptance of project.

## **V. MFC Files**

- A.** Each planimetric .mfc file shall be clean, edited and contain one stereo model. Mapping design file collection of features that are visible, identifiable, or interpretable from the aerial photography at NDOT have been provided to help answer “how to” questions on the “Tools” CD under the “sample map folder”. Also refer to the Map Feature Codes (pages 67-69).
- B.** All .mfc files shall be named in the standard naming convention. Please refer to section IV File Requirements part C.
- C.** NDOT will only allow feature collection as noted in the Map Feature Codes. Collection of elements such as arcs, curve string, patterns or shared cells are unacceptable. Please refer section III production methods parts E & F. (Page 51.)
- D.** Cell placement shall be at the proper scale and direction of the feature being collected. Also, take note of special instructions given on the Map Feature Codes (pages 67-69).
- E.** Area of special attention: Single post signs are collected with the “Sign” cell. Large signs with two or more posts, billboards and extreme signs such as hotel signs are collected without posts and with the custom linestyle of “BBD”. Note that lights associated with these signs must be collected. Also, any street names or names of water bodies must be identified and labeled.
- F.** All text shall be oriented parallel with the flight line or feature being labeled. Additionally, the text shall be placed on the same level, color and vertical placement as the feature. Text (font 10) should have a weight of zero. Text height standards are as follows: English tx = 5 or metric tx = 1. The view rotation for all stereo models in the same strip shall be set to the same flight line angle as the first model in the strip. Text shall be placed as close as possible to the feature being labeled and in accordance with the guidelines provided in the Map Feature Codes (pages 67-69).
- G.** Survey control essential to mapping the project area will be included in deliverables. This includes not only cadastral and construction control but also pipe surveys, utility surveys and any other surveys that pertain to mapping projects.

## **VI MTC Files**

- A.** Each surface .mTc file shall be clean, edited and contain one stereo model. Surface file (.mTc) limits must exceed the planimetric (.mfc) file border by 10 feet.

- B.** Surface files (.mTc) are separate from .mfc files and consist of 3D data measured along surface specific features in the form of lines along terrain changes and discrete points. The .mTc will contain elements that delineate both terrain and culture features. All 3D digital data shall be compiled directly using a softcopy or an approved analytical stereoplotter.
- C.** Surface files (.mfc) shall be named in the appropriate naming convention. Please refer to section IV file requirements part C.
- D.** NDOT will only accept collected features that adhere to the Map Feature Codes. Collection of elements such as arcs, curvestring, patterns or shared cells are unacceptable. Please refer to section III production methods parts E & F.

## **VII Triangulated Surface file**

- A.** Each .dtm file will encompass the entire project area. The .dtm file will be provided in a "INROADS" format. The .dtm files are a topological triangle network file that contains all the input terrain data and the resultant network generated by the software. The data includes information about each triangle and its neighboring triangles, the vertical scale, Z base, multiplier and other information.

## **VIII Cursory Model Review**

- A.** NDOT cartography section requires a cursory model review to make sure that vendors correctly set up their projects with NDOT standards at the beginning. The first stereo model completed shall be delivered to NDOT cartography section within 7 days for review. Mapping diapositives or scanned photo frames, contact prints, aerotriangulation report, georeferenced orthophotos and line work files (.mfc, .mTc) shall be included in the delivery.
- B.** Review of the initial .mfc, and .mTc files will include:
  - Data is clean and conforms to NDOT standards.
  - Proper feature representation using corresponding levels, colors, weight and linestyles (Map Feature Code).
  - Required view rotation angle (flight lines), global origin and working units.
  - A comparison of the field survey profile data and photogrammetrically collected EO's and centerlines.
  - Adequate density of data (English = 250 ft., metric = 76m).

- C. Vendor is notified of problems and corrections discussed.
- D. Significant problems will be communicated and vendor shall deliver revised files within seven calendar days. NDOT will review the revised files and notify vendor to proceed if required corrections were properly accomplished. If significant problems still remain, the vendor will be notified of the problems, the project will be withdrawn, the contract cancelled, and no payment made. The vendor will return all project materials originally supplied by NDOT.

## **IX Project Deliverable Review**

- A. Mapping shall be delivered as flight line strips are completed (and not at the end of the project.) They shall be delivered as individual models and adhere to the “Production Methods” and “File Requirements.”
- B. Orthophotos, when specified, will be delivered in strips (not to exceed a 250MB file size) at the same time as the associated .mfc and .mTc files.
- C. Point marked diapositives and annotated contact prints are to be packaged and delivered flat. When softcopy plotters are used, all stereomodel softcopy orientation files shall be delivered to NDOT at the completion of the job. File format of orientation files shall be PAT-B.ori. If SocetSet softcopy software is used, files required will be: \*.sup, \*.prj, and all files from the project data directory.
- D. A copy of the Positional Accuracy Report including point identification.

# **SURVEY AND MAPPING DELIVERABLES**

## **Check List**

Detailed list is itemized in the Task Order.

- Wet stamped attesting that the mapping or survey requirements have been met
- Survey raw data
- Construction control
- Cadastral survey
- Aerial control survey
- Topographic survey
- Reconnaissance report
- Traverse and survey report
- ASCII final coordinate report
- ASCII coordinate/alignment offset reports
- ASCII description for all monumentation
- Digital photograph (.jpeg) of monuments tied in the field
- Aerial negatives
- Aerial prints
- Aerial Diapositives
- Digital images of scanned frames (CD & DVD)
- Aerotriangulation reports (per project)
- MicroStation 3-D mfc files (stereo pair model data)
- MicroStation 3-D mTc files (stereo pair model data)
- MicroStation 3-D cnt files (per project)
- MicroStation 3-D grd.dgn files (per project)
- Field collected profiles ASCII file and MicroStation 3-D .dgn
- InRoads DTM files (per project)
- Orthophoto georeferenced in a tiff format, version 6.0 (file size not to exceed 250MB.)

# CONTENTS OF THE “TOOLS” CD

## Consultant 2007.pdf

Digital copy of “SPECIAL INSTRUCTIONS for SURVEY, MAPPING OR GIS Consultants” in .pdf format.

## MicroStation Seed Files

27ft\_C.dgn, 27ft\_E.dgn  
27ft\_W.dgn,

Blank MicroStation design files that are pre-set with NDOT standard working units, header information, etc. These files are for projects produced in an NAD27 datum. Project location determines which seed file to use; please refer to Work Zones map on page 66.

Ft\_C1.dgn, Ft\_C2.dgn,  
Ft\_E1.dgn, Ft\_E2.dgn,  
Ft\_W1\_W2.dgn

Blank MicroStation design files that are pre-set with NDOT standard English working units, header information, etc. These files are for projects produced with English working units and in an NAD83/94 datum. Project location determines which seed file to use; please refer to Work Zones map on page 66.

NV\_C1.dgn, NV\_C2.dgn,  
NV\_E1.dgn, NV\_E2.dgn,  
NV\_W1.dgn, NV\_W2.dgn

Blank MicroStation design files that are pre-set with NDOT standard metric working units, header information, etc. These files are for projects produced with metric working units and in an NAD83/94 datum. Project location determines which seed file to use; please refer to Work Zones map on page 66.

NVutm.dgn

A blank MicroStation design file that is pre-set with NDOT standard working units, header information, etc. This file is for projects produced in UTM projection, NAD83/94 datum, zone 11.

## Other MicroStation Resources

ndot_font.rsc	NDOT standard font selections.
ndotcolor.tbl	NDOT standard color table.
NDOTeng.cel	NDOT standard cells in English working units.
NDOTEURO.cel	NDOT standard cells in metric working units.
NDOTSTYL.res	NDOT standard line style selections.

## Sample Mapping

976.alg	InRoads alignment geometry files.
976.dtm	Digital Terrain Model generated with InRoads. It is a topological triangle network file of terrain coordinates.
976101.mfc - 976402.mfc	Map Feature Code file that shows the location of natural and man made objects within the model area.
976pat.xls	Spreadsheet file of Y, X, Z random points selected throughout the project area.
976meta.doc	NDOT-standardized metadata of the project.
9764SHT.dgn	Contract survey control sheet.
976cnt.dgn	Contour file: linear graphics that depict the terrain at points of equal elevation.
976ctl.txt	Text file of Y, X, Z survey control points for project.
976grd.dgn	Graphics file displaying "State Plane Ground Grid" of project area.
976mpck.dgn	Graphic display of random set of points collected within project to assist with the statistical check.
976pat.dgn	Graphic display of 976PAT.TXT file of random points collected throughout the project area.
976pipes.dgn	Labeled survey drainage point data associated with project.
976plss.dgn	Public Land Survey System (land section network grid projected to ground per project.)
976101.mTc - 976402.mTc	Surface terrain coordinates collected by photogrammetry and/or survey demonstrated with only break lines and points.
ALG976P2.TXT	Text file of alignments within the project.
CTL976.TXT	Text file listing coordinates of the location survey.
976pat.txt	Random points selected throughout project area for the statistical check.
OFF976P2.TXT	Text file of offsets to stationing.
PIP976.txt	Text file of surveyed drainage associated with project.
TAC976.TXT	Temporary Aerial Control panels with a surveyed location.
976_SHEET1.tfw - 976_SHEET4.tfw	Tif World File (orients .tif files into their geo-referenced world).
976_SHEET1.tif - 976_SHEET4.tif	Orthophoto saved as Tagged Image File format.

## Files that are not demonstrated in sample mapping

***STK.TXT	Survey stakeout report.
XSEC**.TXT	Text file of Y, X, Z cross sections collected by survey.
UTL***.TXT	Text file that lists coordinates of all utilities within the project area.
SOE***.TXT	Text file of topography; organized by station, offset and elevation.
RR****.TXT	Text file of railroad topographic Y, X, Z points.
LDR***.TXT	Text file of Y, X, Z points of LIDAR target locations.
PRO***.TXT	Text file of Y, X, Z points collected along edges of oil and centerline.
PRO***.dgn	Graphic display of the PRO***.TXT points collected along edges of oil and centerline.
E***.TXT	Text file of events associated with flight position to imagery.
TOP***.TXT	Text file of Y, X, Z points of requested topological features.

## Blank File Resources

NDOTDTMSeed.dtm

InRoads surface seed file pre-set with NDOT standards used in Design Division.

Positional Accuracy.xls

Microsoft Excel spreadsheet used to calculate positional accuracies of mapping projects.

Project Metadata.doc

NDOT Location Division standard metadata related to the project.

QA.xlt

Microsoft Excel spreadsheet with embedded Macro used to find duplicates and crossing breaklines in surface files.

## ACCURACY REQUIREMENTS

NDOT produces two types of maps: survey grade (large scale) and resource grade (small scale.) A survey grade topographic map produced using photogrammetric methods is performed under the direct supervision of Land Surveyors while resource grade mapping (i.e. 30' Atlas) is not. The distinction is made clearer by recognizing that surveyor maps are made from raw data that is collected, verified and is a primary data collection or database system. Resource grade digital data and resulting general use maps are secondary data collections or database systems that are compiled from existing photography, plans or maps. Absolute accuracy is not the highest priority for resource grade mapping.

The primary map testing technique used at NDOT for both types of maps is the NSSDA (National Standard for Spatial Data Accuracy) method. Previously used map accuracy standards such as NMAS (National Map Accuracy Standards) and ASPRS (American Society of Photogrammetry and Remote Sensing) fail because they apply only to paper maps compiled at a specific scale. Digital data may be collected at one scale and used (or misused) at various scales. The NSSDA method for reporting accuracy of digital geospatial data is not constrained by scale and was developed to replace those older standards. Primary documents used to establish NDOT standards are:

- FGDC “Geospatial Positioning Accuracy Standards” part 3.
- “Positional Accuracy Handbook” published by Minnesota Land Management Information Center

Generally we:

- Use a methodology that compares sample mapped points with independent measurements of their location to derive a statistical assessment that is valid for 95% of the points.
- Decide whether to test for horizontal or vertical accuracy or both.
- Independently collect a minimum of 20 representative, well-defined, random and identifiable ground survey points through our survey crew (map checks) and compare them with our mapped features or terrain model.
- Record the measurement values into the positional accuracy spread sheet.
- Calculate the sum of all error radius measurements, then calculate the average, and then take the square root to yield the root mean square (RMS) error.
- Multiply the RMS error by 1.7308 for horizontal error and 1.96 for vertical error.
- Prepare a accuracy statement assuring the data or map user to expect locational errors no worse than “XX feet” 95% of the time, regardless of the scale at which the map is displayed.

This well defined statistic and testing methodology tests only the positional accuracy of spatial data. There are other components of data quality such as attribute accuracy, logical consistency, completeness and lineage, which may be of more critical importance. The NSSDA testing standard does not define a “pass-fail” accuracy value but has allowed this agency to define its own minimum standards. NDOT accuracy standards were developed using traditional technical methods and then correlated to NSSDA. Please note that different features may require different minimum accuracies. This is easily accomplished in a digital dataset while a traditional map may be rated at no better than its worst map layers accuracy

## ACCURACY TESTING

- A. Map checks are not restricted to specific models. The mathematical surface must be completed before any analysis of a photogrammetric .mTc can begin. Analysis of mapping terrain model data is the relationship between the final .dtm surface and survey points collected by a qualified surveyor in the field.
- B. Following NDOT written procedures, the vendor shall prepare a checkpoint file using NDOT Location Division's standardized spreadsheet (PositionlAcrcy.XLS, included on the "Tools CD".) We require a minimum of 20 points for statistical comparison of elevation values taken from the compiled surface and checkpoint file. For mapping projects, please refer to pages 63 through 65 for designated accuracies at a given map scale.
- C. Vertical accuracy standards vary depending on mapping scale requirements. Please refer to the complete chart on page 70, "NDOT Map Checks". For example in large scale (1:500) mapping, Vertical NMAS Feet 95% SPOTS accuracies may not exceed elevations higher or lower than .30 feet on transportation surfaces. If vertical surface results exceed this limitation, we will require a recompilation of the check file. Another analysis must be performed and the same criteria are applied. If the results are high or low again, the subject model will be checked by field methods to determine the cause of the problem. If the results show differences between the surfaces occurring only along the road, then the entire roadway (EO, centerline, shoulders) must be recompiled, including but not limited to the areas where bad points are detected. The same procedure must be followed if problems are occurring off the road surface. The quality of the entire project will be questioned if check errors exceed our standard.

## MAPPING CRITERIA

The primary intent of this manual is to provide NDOT consultants with a definitive guideline in performing or acquiring design mapping that will meet or exceed NDOT standards. A secondary intent of this manual is to provide guidance in determining an optimal map scale required by those who request mapping or survey products. During the planning phase of a project, consideration should be given to the “highest and best” use to which a map will be put. Designers who determine the optimal map scale required for their project need to know that accuracy requirements have a great impact on cost. NDOT consultants will be notified which classification of mapping is required and are expected to meet or exceed the control factors in producing their product.

**For those requesting mapping the following suggestions may be used for assistance.**

Three questions are used to determine which map to request:

- What is the required target mapping scale? NDOT uses 1:500, 1:600, 1:1000, 1:1200, 1:1700 and 1:2000 specific scale mapping for their design projects.
- What is the vertical relief accuracy required? Expected accuracies are in the chart following under the heading “Elevation”.
- What is the horizontal or planimetric accuracy required? Expected accuracies are in the chart following under the heading “Features”.

Map Scale	Elevation	Features	Typical Applications
1:500 (Large Scale)	.58 ft topo .30 ft hard surface	1.0 ft	Determination of pay quantities, site development, roadbed modifications.
1:600 (Large Scale)	.70 ft topo .34 ft hard surface	1.2 ft	(Same as 1:500.)
1:1000 (Intermediate Scale)	1.16 ft topo .58 ft hard surface	2.0 ft	Overlays, easements, grading, excavation, drainage.
1:1200 (Intermediate Scale)	1.40 ft topo .70 ft hard surface	2.5 ft	(Same as 1:1000.)
1:1700 (Small Scale)	2.0 ft (.6m) topo 1.0 ft (.3m) hard surface	3.5 ft (1.0m)	Planning, natural resources, R/W condemnation.
1:2000 (Small Scale)	2.0 ft (.6m) topo 1.0 ft (.3m) hard surface	3.5 ft (1.0m)	(Same as 1:1700.)

Survey or mapping projects invariably involve problems peculiar only to that project, and the solution to those problems may not necessarily conform to the procedures outlined in this manual. If you find this to be the case, please contact us for specific recommendations.





# ACCURACY STANDARDS

## For Common NDOT Small Scale Digital Photogrammetry

**English Control Factors** 1:1700 or 1"=142ft.

Max Flying Height <i>6000 ft.</i>	Camera <i>6"</i>	Minimum Contour Interval <i>3.0 ft.</i>	Minimum Photo Scale <i>1"=1000 ft.</i>
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<b>Aerotriangulation (RMSE)</b> Horizontal =.6ft. max = 1.8 ft. Vertical = .67ft. max = 2.0 ft.	<b>Grid/Survey Control</b> All at true Value	<b>Elevations (95%)</b> Spots/dtm = 1.0 ft. Topo = 2.0 ft.	<b>Features (95%)</b> Horizontal = 3.5 ft.
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The maximum image point residual for any point shall not exceed 25 microns.

**Contours**  
Display Interval =5ft.      **Note: If surface elevations are derived from solid line contours, 95% will be within 2/3 of the maximum contour display interval.**

Final Orthophoto Ground Pixel Resolution = 1.0ft.

**Metric Control Factors** 1:1700

Max Flying Height <i>1830m</i>	Camera <i>153mm</i>	Minimum Contour Interval <i>.92 m</i>	Minimum Photo Scale <i>1:12000</i>
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<b>Aerotriangulation (RMSE)</b> Horizontal =.18m max = .55m Vertical =.20m max = .60m	<b>Grid/Survey Control</b> All at true Value	<b>Elevations (95%)</b> Spots/dtm = 0.3m Topo =0.6m	<b>Features (95%)</b> Horizontal =1.0m
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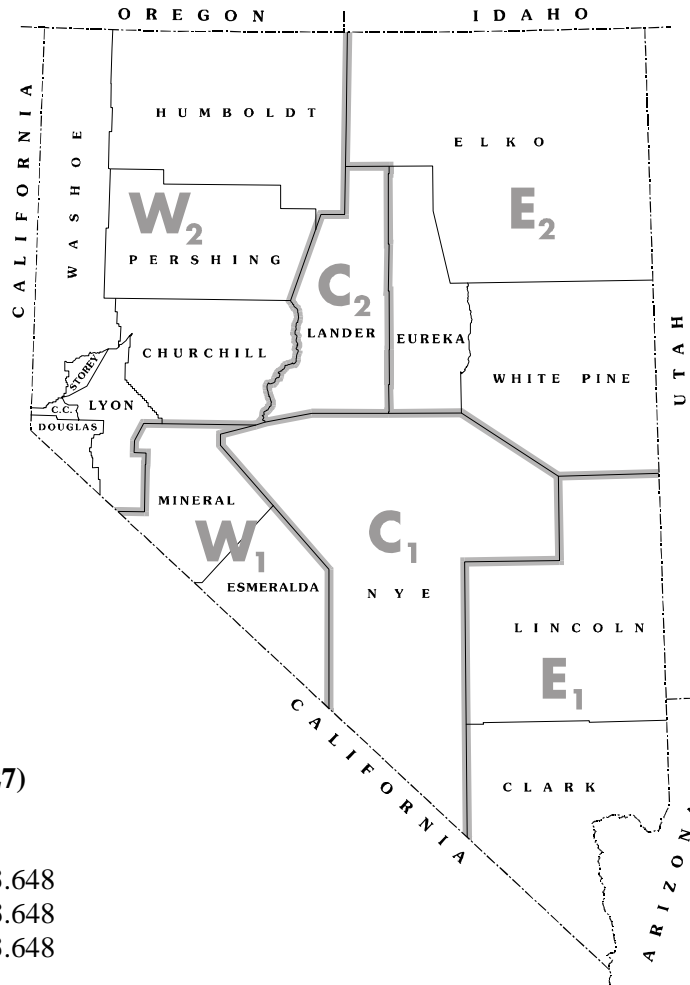
The maximum image point residual for any point shall not exceed 25 microns.

**Contours**  
Display Interval =2m      **Note: If surface elevations are derived from solid line contours, 95% will be within 2/3 of the maximum contour display interval.**

Final Orthophoto Ground Pixel Resolution = 0.30m

Survey checkpoints are a requirement for consultants performing work for NDOT. We require a large enough data set (>20) to assure compliance of the Elevation and Feature standards listed above. Check Points should be restricted to well-defined points (spots & features) distributed throughout the project. If the finished map elevation surface is to be checked without using well-defined points, the Elevation Topo standard is held. A spreadsheet program is available to evaluate checkpoints. Calculations are based on an analytical plotter with a "C" factor of 1980 and capable of 7X enlargement.

# NDOT MICROSTATION WORK ZONES



## Global Origins (NAD27)

	X	Y	Z
E	0	0	-2,147,483.648
C	0	0	-2,147,483.648
W	0	0	-2,147,483.648

## English State Plane

### Global Origins (NAD83/94)

	X	Y	Z
E1	0	26,000,000	-2,147,483.648
E2	0	27,000,000	-2,147,483.648
C1	0	19,000,000	-2,147,483.648
C2	0	21,000,000	-2,147,483.648
W1, W2	0	14,000,000	-2,147,483.648

## Metric State Plane

### Global Origins (NAD83/94)

	X	Y	Z
E1	0	8,000,000	-214,748.365
E2	0	8,400,000	-214,748.365
C1	300000	6,000,000	-214,748.365
C2	300000	6,400,000	-214,748.365
W1	600000	4,000,000	-214,748.365
W2	600000	4,400,000	-214,748.365

## NV UTM (Zone 11)

X	Y	Z
1650000.0000	-2120000.0000	2147483.648

**Note:** Type in values located here to achieve the global origin needed to map in each specified zone. Notice that these values are multiplied by a (-1) in MicroStation.

MAP FEATURE CODES

LV	SYMB	DESCRIPTION	CO	LC	WT	AC	CLASS
7		DIRT ROADS - TRAILS	4	5	2		LINESTRING
8		RAILROAD	6	RR	0		CUSTOM LS
8		RAILROAD GATE ARM	6		0	RRGT	SYM ROTATE SCALE
8		RAILROAD SWITCH	6		0	RRSW	SYM ROTATE SCALE
12		ROCK - BOULDERS	126		0	ROCK	SYM ROTATE SCALE
12		MINING ACTIVITY	126		0	DIG	SYM ROTATED
12		ROCK LINE - RIPRAP	126	RCKL	0		CUSTOM LS
13		CONCRETE	3	0	0		LINESTRING
17		CHEMICAL TANK	215		0	LAP	SYM ROTATE SCALE
19		STREET/STOP SIGN	4		0	STSGN	SYMBOL
19		SIGNS WITH 2+ POSTS	4	BBD	0		CUSTOM LS
19		POST	3		0	P	SYMBOL
19		SIGN	4		0	SIGN	SYMBOL
20		GUARD RAIL	6	GRL	0		CUSTOM LS
20		JERSEY BARRIER	3	JB	0		CUSTOM LS
21		CATTLE GUARD	3		0	CTX	SYM ROTATE SCALE
21		FENCE	5	FENCE	0		CUSTOM LS
21		GATE	5		0	G	SYM ROTATE SCALE
22		RETAINING WALL	5	RW	0		CUSTOM LS
22		FREE STANDING WALL	5	WALL	0		CUSTOM LS
24		WATER CHECK GATE	126		0	CG	SYM ROTATE SCALE
25		FLAG POLE	168		0	FL	SYM ROTATED
25		SATELLITE DISH	0		0	TV	SYM ROTATE SCALE
26		FIRE HYDRANTS	126		0	FH	SYM ROTATED
26		LIGHT	4		0	LITE	SYM ROTATED
26		LIGHT ON ARM	4		0	LITEX	SYM ROTATED

LV	SYMB	DESCRIPTION	CO	LC	WT	AC	CLASS
1		CONTROL POINT W/NAME	6		0	CP	SYMBOL
2		BRIDGE DECK SEAM	4	5	1		LINESTRING
2		EDGE OF PAVEMENT	4	0	1		LINESTRING
5		BUILDING	5	0	2		SHAPE SQUARED
5		FOOT BRIDGE NON CONC STAIRS	126	0	2		SHAPE SQUARED
5		DECKS - CANOPY CARPORT	5	5	2		LINESTRING
5		FOUNDATION - RUINS	7	3	2		LINESTRING
5		MOBILEHOME - BLEACHER	168	0	2		SHAPE SQUARED
6		DOUBLE STRIPING	0	DBLINE	1		CUSTOM LS
6		BUTTONS TWO WIDE	0	2BUTS	1		CUSTOM LS
6		BUTTONS SET OF FOUR	0	4BUTS	1		CUSTOM LS
6		BUTTONS DOUBLE SET OF FOUR	0	2x4	1		CUSTOM LS
6		STRIPING	0	0	1		LINESTRING
6		LEFT TURN ARROW	0		1	ALT	SYM ROTATED
6		RIGHT TURN ARROW	0		1	ART	SYM ROTATED
6		LEFT TURN / STRAIGHT ARROW	0		1	ALS	SYM ROTATED
6		RIGHT TURN / STRAIGHT ARROW	0		1	ARS	SYM ROTATED
6		STRAIGHT ARROW	0		1	AS	SYM ROTATED
6		SINGLE BUTTON	0		3	PB	SYMBOL
6		EXIT	0		1	PE	SYM ROTATED
6		ONLY	0		1	PO	SYM ROTATED
6		STOP	0		1	PS	SYM ROTATED
6		DESIGNATED BIKE LANE	0		1	BL	SYM ROTATE SCALE
6		DESIGNATED BIKE LANE	0		1	BIKE	SYM ROTATE SCALE
7		EARTHWORK - PITS-BERM	4	4	2		LINESTRING
7		DIKES	4	DIKE	2		CUSTOM LS

MAP FEATURE CODES

LV	SYMB	DESCRIPTION	CO	LC	WT	AC	CLASS
26		SINGLE POLE NO RAY	4		0	POR	SYM ROTATED
26		SINGLE RAY POLE	4		0	P1R	SYM ROTATED
26		DOUBLE RAY POLE	4		0	P2R	SYM ROTATED
26		FOUR RAY POLE	4		0	P4R	SYM ROTATED
26		GUY WIRE	4		0	PGUY	SYM ROTATE SCALE
26		RAY ONLY	4		0	PRAY	SYM ROTATED
26		MULTI FOOTING POLE LINE	0		0	TRANS	SYM ROTATE SCALE
27		TRAFFIC SIGNAL	4		0	SL	SYM ROTATED
27		TRAFFIC SIGNAL ON ARM	4		0	SGNL	SYM ROTATED
28		ELECTRIC BOX	0		0	EB	SYMBOL
28		ELECTRIC PULL BOX	0		1	EPB	SYMBOL
28		ELECTRIC VAULT	0		1	EVL T	SYMBOL
28		GAS METER	231		0	GM	SYMBOL
28		GAS VALVE	231		0	GV	SYMBOL
28		MANHOLE CONC APRON	152		0	MH	SYM SCALED
28		MANHOLE	152		0	MHP	SYM SCALED
28		SEWER MANHOLE	152		0	MS	SYM SCALED
28		STORM DRAIN MANHOLE	152		0	MSD	SYM SCALED
28		COMM. MANHOLE	152		0	MT	SYM SCALED
28		COMM. PULL BOX	6		1	TPB	SYMBOL
28		COMM. VAULT	6		1	TVLT	SYMBOL
28		WATER METER	1		0	WM	SYMBOL
28		WATER VALVE	1		0	WV	SYMBOL
28		UTILITY UNKNOWN W/TEXT	0		0	UTL	SYM SCALED
29		WATER / STOCK TANKS	1		0	T	SYM SCALED
30		CATCH BASIN W/ELEV	95		0	CB	SYM ROTATE SCALE

LV	SYMB	DESCRIPTION	CO	LC	WT	AC	CLASS
30		DROP INLET W/ELEV	95		0	DI	SYM ROTATE SCALE
33		BRUSH - HEDGE LINE	2	HDG	0		CUSTOM LS
33		TREE CANOPY	2	TL	0		CUSTOM LS
33		TREE	2		0	TREE	SYMBOL
33		PINES - PALMS NON DECIDUOUS TREE	2		0	PINE	SYMBOL
41		INTERMITTENT FLOW	9	6	0		LINESTRING
41		CANALS - RIVERS	9	0	2		LINESTRING
41		LAKES - POOLS - PONDS	9	0	1		LINESTRING
41		MARSH - SWAMP	2		0	SWAMP	SYM ROTATE SCALE
47		REINFORCED CONC BOX	3	0	0		LINESTRING
47		CULVERT PIPE - CMP	6	0	0		LINESTRING
50		SPOT ELEVATION W/TEXT	1		0	SX	SYM ROTATED
58		OBSCURED AREA	6	3	1		LINESTRING
10		POINTS	3		3	POINT	SYMBOL
14		RIDGE LINE	6	0	0		LINESTRING
23		BREAK LINE	2	5	0		LINESTRING
41		FLOW LINE	9	6	0		LINESTRING
43		EXTERIOR BORDER	0	0	0		LINESTRING
1		GRID TICKS	168		0	GRDTK	SYMBOL
1		NORTH ARROW	0		0	N	SYM ROTATE SCALE
2		STATE ROUTE SHIELD	0		0	SNV	SYM ROTATE SCALE
2		160 STATE SHIELD	0		0	S160	SYM ROTATE SCALE
2		US ROUTE SHIELD	0		0	SUS	SYM ROTATE SCALE
2		395 US SHIELD	0		0	S395	SYM ROTATE SCALE
2		50 US SHIELD	0		0	S50	SYM ROTATE SCALE



# NDOT MAP CHECKS

**Planimetric Horizontal & Vertical Accuracies  
Based upon  
National Standard for Spatial Data Accuracy**

*Engineering Standards based on NSSDA*

Final Map Scale	Engineering Map Scale	Minimum Contour Interval	Horizontal ASPRS Feet 68%	Vertical ASPRS Feet 68% SPOTS	Vertical ASPRS Feet 68% TOPO	Horizontal NMAS Feet	Vertical NMAS Feet	Horizontal NSSDA Feet 95%	Vertical NSSDA Feet 95% SPOTS	Vertical NSSDA Feet 95% TOPO
360	30.0	0.62	0.30	0.10	0.21	1.00	0.31	0.73	0.20	0.40
<b>500</b>	<b>41.7</b>	<b>0.89</b>	<b>0.42</b>	<b>0.15</b>	<b>0.30</b>	<b>1.39</b>	<b>0.45</b>	<b>1.02</b>	<b>0.29</b>	<b>0.58</b>
600	50.0	1.06	0.50	0.18	0.35	1.67	0.53	1.22	0.34	0.69
<b>1000</b>	<b>83.3</b>	<b>1.77</b>	<b>0.83</b>	<b>0.29</b>	<b>0.59</b>	<b>2.78</b>	<b>0.89</b>	<b>2.04</b>	<b>0.58</b>	<b>1.16</b>
1200	100.0	2.12	1.0	0.35	0.71	3.33	1.06	2.45	0.69	1.38
<b>1700</b>	<b>141.7</b>	<b>3.00</b>	<b>1.42</b>	<b>0.50</b>	<b>1.00</b>	<b>4.72</b>	<b>1.50</b>	<b>3.47</b>	<b>0.98</b>	<b>1.96</b>
2000	166.7	3.54	1.67	0.59	1.18	5.56	1.77	4.08	1.15	2.31
2400	200.0	4.24	2.0	0.70	1.41	6.67	2.12	4.90	1.38	2.77
3600	300.0	6.36	3.0	1.06	2.12	10.00	3.18	7.34	2.07	4.15
4000	333.3	7.07	3.33	1.17	2.35	11.11	3.54	8.16	2.30	4.61
4800	400.0	8.48	4.0	1.41	2.82	13.33	4.24	9.79	2.76	5.53
5000	416.7	8.84	4.17	1.47	2.94	13.89	4.42	10.20	2.88	5.77
6000	500.0	10.60	5.0	1.76	3.53	16.67	5.30	12.24	3.45	6.92
7200	600.0	12.72	6.0	2.11	4.24	20.00	6.36	14.69	4.14	8.30
10000	833.3	17.68	8.33	2.93	5.89	27.78	8.84	20.40	5.75	11.54
<b>12000</b>	<b>1000.0</b>	<b>21.22</b>	<b>10.0</b>	<b>3.52</b>	<b>7.07</b>	<b>33.33</b>	<b>10.61</b>	<b>24.48</b>	<b>6.90</b>	<b>13.85</b>
20000	1666.7	35.37	16.67	5.87	11.78	55.56	17.69	40.80	11.51	23.09

*GIS Standards based on NMAS*

24000	2000.0					<b>40.00</b>				
50000	4166.7					<b>83.33</b>				
63360	5280.0					<b>105.60</b>				
100000	8333.3					<b>166.67</b>				
250000	20833.3					<b>416.67</b>				
500000	41666.7					<b>833.33</b>				

Note:

- Maximum contour Interval is determined using a "C" factor = 1980, a maximum 7X enlargement ratio and a camera with a 6" lens.
- ASPRS classification is for a class 1 RMSE map. Class 2 and 3 are multiples of RMSE.
- NDOT standards are ASPRS-based, converted to NSSDA Standards and are in **bold**.
- 20 well defined points with a higher accurate position are the minimum number needed for testing as described by the Positional Accuracy Handbook at [www.mnplan.state.mn.us/press/accurate.html](http://www.mnplan.state.mn.us/press/accurate.html)
- NMAS (National Map Accuracy Standards) are shown for reference and include both large and small-scale specifications.