

CHAPTER 2 - AERIAL SURVEYS AND MAPPING

2.1 INTRODUCTION

These guidelines shall be used as the standard for all computer-aided mapping produced by and for the Survey Office in the Design Division of the Tennessee Department of Transportation. Mapping submissions shall be in accordance with this manual and/or modifications contained in the consultant's contract or as prescribed by the Aerial Survey Manager.

2.2 CORRESPONDENCE

All correspondence for support should be addressed to:

Tennessee Department of Transportation
Office of Aerial Surveys
521 Olen Taylor Drive
Nashville, TN 37217-2512

2.3 STANDARD PARAMETERS

In order to establish standard parameters by which maps are to be created, the following guidelines have been established:

- The accuracy of a design file will be in direct correlation with the working units and the state plane coordinate system. This provides direct correlation of mapping and design data to the field control points.
- Standard level, color, style, and weight assignments of elements are assigned according to the type of map or sheet being generated. The user is referred to the CADD Guidelines published by the Design Division for these standards as well as other CADD standards such as font and cell files at the following website: http://www.tdot.state.tn.us/Chief_Engineer/assistant_engineer_design/design/v8/V8design.htm.

The user shall refer to the CADD Guidelines for the following standards:

- File extensions to be used
- Line styles to be used
- Color tables to be used
- Font files and font sizes to be used
- Seed files to be used
- The standard cell library is STDS.CEL. Cells shall be scaled inversely proportional for mapping scales (i.e. AS=50 for 1"=50'; AS=100 for 1"=100'; and AS=200 for 1"=200'). The weight shown in the level structure is the weight at which the cell is drawn.
- Map features shall be digitized in a point-to-point mode.

Standard mapping width is as follows:

- 1"= 50' scale – 750' each side of proposed centerline
- 1"= 100' scale – 1,500' each side of proposed centerline
- 1"= 200' scale – 3,000' each side of proposed centerline

2.4 GROUND CONTROL PREPARATION

2.4.1 PRE-FLIGHT TARGETING

When a project is to be mapped photogrammetrically, targets shall be placed on the ground at predetermined strategic points, marked with a reinforcing bar or other suitable metallic material and driven flush with the ground.

All known and recovered horizontal and vertical control monuments that exist inside the band of mapping shall be targeted. These monuments shall have been generated by an accepted surveying agency, preferably National Geodetic Survey (NGS) or TDOT.

In most instances a pre-flight targeting diagram can be furnished by the Aerial Surveys Division that considers the scale, model gain and side-lap geometry of the exposed format. Target placement on the ground shall follow the diagram as close as feasibly possible.

Targets generally used by TDOT are constructed from unbleached muslin cloth and are placed on the ground to form a right angle with the point of observation being the inside corner of the target. On pavement, targets may be painted (Refer to Figure A-18 in the Appendix for an example).

The size of the targets varies with the scale of the photographs (Refer to Figure A-18 in the Appendix for examples). After the project has been flown the target material shall be removed but the reinforcing bar or other reference material shall remain.

2.4.2 HORIZONTAL CONTROL

Project control monuments, in addition to and between Tennessee Geodetic Reference Network (TGRN) tie monuments (Refer to Section 3.2.1), shall be established along the mapping band as close as possible to the proposed centerline. These points are to be used for positioning horizontal photo control and for projecting the proposed alignment. This monumentation for project control shall be semi-permanent, usually reinforcing bars with a stamped disk. An adequate description and “to-reach” shall then be written and retained for future needs. These monuments shall be in place before each project photo flight. They can be pre-flight targeted and will substantially strengthen the horizontal and vertical photo control survey.

The coordinate values of these monuments will be datum adjusted Tennessee State Plane Coordinates. Since TGRN tie monuments (with datum adjusted coordinates) are used for the origin and terminus of each leg of the project control traverse, no further datum adjustment is necessary.

The position of these monuments will be established by either total station traverse or Global Positioning System (GPS) methods.

All observations shall be performed with equipment whose specifications meet Federal Geodetic Control Committee (FGCC) standards for geodetic surveys.

All project control surveys shall originate and terminate at TGRN tie monuments (Refer to Section 3.2 and 3.3).

All project control surveys for photogrammetry shall meet Second (2nd) Order Class II Standards, 1:250.

After raw field data has been compiled, computed and minimum standards met, project control traverses between adjacent pairs of TGRN tie points shall be adjusted to those points by either least squares adjustment or compass rule adjustment methods.

Each leg of the project control survey (between adjacent pairs of TGRN tie points) shall be considered and adjusted independently.

When aerial photographs have been obtained, picture points are then selected. Often, these are the targets that were in place when the exposures were made. Picture points are chosen to form a geometric pattern suitable for orienting, leveling and scaling, and to rectify the aerial photograph. When the targets are not in place, natural images must be carefully selected instead. Natural images can be fence posts, parking stripes, etc. The horizontal picture points are enclosed by triangles on the front and back of the photos. The precise picture point is designated by a line pointer to the exact spot observed during the survey. An exact duplicate of each photograph shall be kept on file in the Regional Survey Office or the Consultant Firm's office to facilitate field checking for errors.

After picture points are chosen for the horizontal scheme, they are positioned by supplemental survey ties from the main scheme control network. These points shall be surveyed with Global Navigation Satellite System (GNSS) or Total Station standard procedures as directed by the Regional Survey Supervisor.

As stated in the paragraph above, all computed points, both project control monuments and picture points, are datum adjusted Tennessee State Plane Coordinate values and require no further adjustment. These coordinates are written on the back of selected photographs beside the designated number of the point. The points can be labeled as H-1, H-100, H-101 or HV-110 if, for example, both positions (horizontal and vertical) are known for a picture point.

2.4.3 VERTICAL CONTROL

Vertical survey control is as important to photogrammetric surveys as horizontal control. All known and acceptable Bench Marks, preferably NGS, TDOT, or Tennessee Valley Authority (TVA), which appears in the band of photography shall be pre-flight targeted.

If there are too few known Bench Marks appearing on the photos to satisfy the vertical photo control geometry, Bench Marks shall be established along the proposed alignment. The Bench Marks shall be horizontal control monuments as well as vertical control monuments. These Bench Marks can be used throughout the project survey and construction and shall be adequately described and referenced for future use. All vertical photo control points shall originate and terminate on, or be looped back to Bench Marks that have been established to Third (3rd) Order FGCC criteria (Refer to Table A-5 in the Appendix and Section 5.2 for additional information on accuracy).

Vertical control instruments shall meet specifications required by the FGCC for Third Order accuracy.

In some instances, vertical photo control may be established by trigonometric leveling with Total Station procedures. GNSS procedures may be allowed at the discretion of the Regional Survey Supervisor.

Vertical control points are marked on the front and back of selected photographs with a circle. Natural images for vertical photo control can be: corners of sidewalks, intersections of streets and roads, fence corners, etc. Vertical points shall be in a fairly level area and precisely designated and described on the back of the photo. Vertical photo points shall be designated with "V" as V-1, V-9, etc. The precise picture point is designated by a line pointer to the exact spot that was observed during the survey. If a point is both a horizontal and vertical control, it shall be designated HV.

2.5 AERIAL MISSION

In order to establish standard parameters by which aerial photography is to be obtained, the following parameters have been established:

- Aerial Photography shall be undertaken only when well-defined images can be obtained. Photography shall not be attempted when the ground is obscured by haze, smoke or dust, snow or ice, or when cloud or cloud shadows will occur on more than five percent of the area of any one photograph. Photography shall not contain shadows caused by topographic relief and sun angle except when these shadows fall on a portion of the photograph not in the area of interest, which will not prevent the use of the remainder of the photograph for photo interpretation, measuring and mapping. Photography will not be undertaken when the sun angle is less than thirty degrees above the horizon. Super-wide angle, convergent or low oblique photography will not be acceptable.
- Overlap on all photography in the direction of the line of flight shall be sixty percent, unless otherwise specified, and overlap in the direction of the line of flight of more than sixty-five percent or less than fifty-five percent shall be cause for rejection of the photography. In the case where parallel flights are necessary, the side lap of flights shall be thirty percent or more and any side lap less than fifteen percent shall be cause for rejection of the photography.
- Tip and tilt of the photography shall be kept to an absolute minimum. Tip and tilt in any case shall not exceed four degrees. Tip and tilt in excess of four degrees shall be cause for rejection of the photography.
- Crab of the photography in excess of three degrees is undesirable and crab in excess of five degrees in two or more of the photographs shall be cause for rejection of the photography.

The required ground sample distance for photography to be used for digital photogrammetric compilation shall be:

Airplane – Digital

Extreme Detail (Old 1" = 50' scale mapping)

1.667 inch pixel size or GSD of 0.14'

Design Mapping Detail (Old 1" = 50' scale mapping)

3 inch pixel size or GSD of 0.25'

Planning Detail (Old 1" = 100' scale mapping)

6 inch pixel size or GSD of 0.41'

Wide Area Planning Detail (Old 1 = 200' scale mapping)

12 inch pixel size or GSD of 0.82'

The aerial camera to be used in photography, unless otherwise specified, will be a Vexcel Ultracam X, Vexcel Ultracam Xp, Intergraph DMC, or any equally precise camera. The camera must feature a resolution across the flight path of no less than 13,500 pixels, and a resolution along the flight path of no less than 7,500 pixels. All cameras must be calibrated within a two-year period prior to the beginning of the project work order. If it is desired to use a camera or resolution different than above, it will be required that special permission be obtained in writing from the Office of Aerial Surveys. In order to obtain permission to use a camera other than those listed above, it will be required that the complete specifications, including a current

calibration report of the camera be submitted to the Photogrammetry Supervisor at the Office of Aerial Surveys.

2.6 PHOTO PRODUCTS

After completion of the aerial mission, the CONSULTANT shall furnish the following to the Office of Aerial Surveys for final custody in the Aerial Surveys Office:

- All images collected as part of the flight, in both RGB color and in near-infrared (NIR) false-color imagery, unless otherwise specified by the Office of Aerial Surveys. Image color bit depth to be no greater than 8 bits per channel. Images to be provided in either TIF (.TIF) format with lossless (LZW) compression, TIF format with 100% quality JPEG compression, or JPEG (.JPG) format with 100% quality setting, on DVD(s) or non returnable external hard disk drive unit(s) if the number of DVDs necessary to hold the images exceeds 10 DVD(s) or external drives to be in a format compatible with the current version of the Microsoft® Windows operating system.
- An ASCII text file on the first DVD or external drive consisting of a list of geographic coordinates of the horizontal and vertical control points as specified in Sections 2.4.2 and 2.4.3.

Camera center information from airborne GNSS for the project on the first DVD or external drive, in ASCII text format should contain the following:

- Photograph #, Latitude and Longitude in degrees, minutes, and seconds.

2.7 ANALYTICAL AERIAL TRIANGULATION

Analytical Aerial Triangulation may be used to supplement horizontal and vertical controls where necessary. Either a strip adjustment program or bundle adjustment program may be used. Accuracy of these programs must meet National Map Accuracy Standards for the specified scale in the project work order. The Office of Aerial Surveys shall be provided with a CD or DVD compatible with the current version of the Microsoft® Windows operating system in ASCII text format.

2.8 DIGITAL MAPPING FILE REQUIREMENTS

In order to establish standard parameters by which digital mapping is to be obtained, the following parameters have been established:

- All digital data must be recorded directly as a function of stereoplotter operation. Post-compilation (board) digitizing of graphic compilation **will not** be permitted.
- All mapping data must be compiled directly in (or translated to) MicroStation® Design File Format. Production and delivery of 100% clean, edited digital data in MicroStation® Design File Format compatible with the Office of Aerial Surveys' Intergraph configuration is required. CONSULTANT's software must be compatible with the Office of Aerial Survey's current version of Microstation®.

Files shall be merged to contain a maximum of 15 megabytes of data. Individual stereomodels shall not be separated into more than one file, regardless of size. All design files shall be submitted to the Office of Aerial Surveys as 3 dimensional (3-D) files. The files shall be delivered as follows:

- Files containing planimetric feature information shall be left at the collected elevation with a file extension of **.MFC**.
- Files containing digital terrain model information with a file extension of **.DTM**.

- Files shall be compiled with coordinate values to the nearest one-thousandth (1/1000) of a foot. Coordinate values for all features shall be based on the ground coordinates indicated by the control data.
- A merged **.MFC** and **.DTM** file with the **.DTM** file triangulated with all information.
- All files shall be delivered on compact disc compatible with the current version of the Microsoft® Windows operating system.

2.9 MAP COMPILATION TECHNIQUES

In order to establish standard parameters for map compilation, the following parameters have been established:

- Features shall be identified with the following MicroStation® element types as appropriate: cell, line, line string, connected (complex) string, linear patterns, area patterns, simple shapes, complex shapes, ellipses (including circles) and text strings. The following element types shall not be used: **Arcs and Shared Cells**.
- Features are to be labeled only as required for clarification. Labels shall be oriented along linear features or parallel to the flight line of the stereomodel being compiled, so that the project beginning shall be at the left and the project end shall be at the right. The project beginning and end points are identified on the project work order.
- Road alignments shall be carefully compiled and consist of tangent line strings. Irregular curve compilation will be permitted only on meandering irregular alignments.
- Compilation on adjacent files shall butt match exactly.
- Each deliverable file shall be identified by the file name. The file names shall have the extension **.MFC** for the planimetric files and **.DTM** extension for the digital terrain model files.
- A Job Model Index shall be produced for each project. The CONSULTANT shall add each file name to the index.

2.10 MAP CONTENT

The following section parameters have been established for map content:

2.10.1 CONTROL POINTS

GNSS and Traverse Points shall be shown with their coordinate values, properly symbolized and labeled.

2.10.2 PLANIMETRIC DETAIL

All stereo compilation, whether planimetric only or topographic, shall show all planimetric features that are visible and identifiable or interpretable on the aerial photography and in accordance with the appropriate standards as outlined in Section 2.3.

Particular attention shall be given to include all transportation and transportation-related features such as roads, railroads, bridges, canals, streams, dams, utilities and drainage ditches, etc., as well as other features along transportation corridors.

The widths of roads and streets shall be shown as the separation between curb faces or hard surface edges (white fog lines) as appropriate.

2.10.3 TOPOGRAPHIC DETAIL

2.10.3.1 CONTOURS

Contours shall be generated from the DTM's at the interval specified in the project work order. No contours or spot elevations are required for planimetric only stereo compilation.

Contours shall accurately portray the shape of the terrain within specified accuracy standards. Special attention shall be given to contours at transportation and transportation-related features. Accuracy standards for contours notwithstanding, contours shall clearly reflect the crown or cross-slope of all paved areas, including roads, paved ditches, and curbs, and shall truly depict all drainage ways, sinkholes, and dikes.

In areas obscured by tree cover or heavy vegetation, contours shall be omitted and the area labeled "GROUND OBSCURED".

2.10.3.2 SPOT ELEVATIONS

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

Spot elevations shall be shown at the following points and only in **.DTM** files:

- At all road and road/railroad intersections.
- On the road centerline at each end of bridges and similar structures.
- On the road centerline over all culverts.
- At the crest of all closed contours.
- At the lowest point of all closed depression contours, significant saddles, cuts, and depressions.

The surface elevation of all open water bodies shall be indicated by one or more water elevation readings near the center of the water body, or the portion of the water body shown on that map. **Show** only in the **.DTM** file.

Spot elevations shall also be shown in other areas with sufficient frequency so that there is a maximum map distance of two inches in any direction between contours and/or spot elevations.

All spot elevations shall be labeled with decimal values giving their elevation to the nearest one-tenth of a foot. Labels shall be placed parallel with the bottom of the sheet and positioned so that they do not obscure other map detail.

2.11 DIGITAL TERRAIN MODEL PRODUCTION

The following standard parameters are to be used for DTM production:

- DTM information should be contained in dedicated DTM files, which should contain **nothing else!** There should be **no text at all** in a DTM file. The points should be true points (lines of zero length), **not** symbols.
- DTM's shall be compiled in a format that is 100% compatible with the state's GEOPAK® design package.
- Generation of DTM's using previously collected contours will **not** be allowed.
- Information collected for the DTM's shall be stored in a standard MicroStation® 3D/DTM design file.

DTM's are to be collected from the stereomodel in the following forms:

- Break lines
- Ridges
- Drains
- Spot elevations
- X, y, & z coordinate points identified at regular intervals along parallel lines.

DTM's compiled from helicopter flights should pay particular attention to the following:

- Outside edge of paved shoulders
- Roadway white fog lines
- Center of lane white lines
- Any ruts in roadway, including tops and bottoms
- Top and bottom of curbs or curb and gutter
- Ramps, bridges and cross-roads
- Spot elevations at high points and low points

All DTM files must be able to be merged and triangulated together.

2.12 MAP ACCURACY STANDARDS

The following standard parameters for mapping accuracy have been established.

- Ninety percent of all planimetric features shall be collected so that their position on the completed map shall be accurate to within at least one fiftieth (1/50) of an inch of their true coordinate position as determined by the test survey. None of the features tested shall be misplaced on the final map by more than one twenty-fifth (1/25) of an inch from their true coordinate position.
- The position of GNSS points and traverse points shall be mathematically correct in the design file.
- Ninety percent of the elevations of contours generated from the DTM shall be accurate with respect to true elevation of one-half contour interval or better and the remaining ten-percent of such elevations shall not be in error of more than one contour interval. Contours shall not be generated in areas obscured by dense cover.
- Ninety percent of all spot elevations placed on the maps shall be accurate to within one-fourth contour interval, and the remaining 10 percent shall be accurate to within one-half contour interval.

Collection parameters for Digital Terrain Models are shown in the following table:

Map Scale	Contour Interval	Profile Distance	Station Distance
Airplane Flight			
1"=50'	2'	25'	25'
1"=100'	5'	25'	50'
1"=200'	10'	50'	100'
Helicopter Flight			
1"=50'	0.25'	10'	10'

Table 2-1
Collection Parameters for Digital Terrain Models

2.13 FEATURE DESCRIPTIONS

2.13.1 SPOT ELEVATION

Supplemental elevation used in conjunction with contour information should be embedded in the DTM file.

2.13.2 WATER ELEVATION

Elevation on the surface of the water.

2.14 SURVEY CONTROL INFORMATION & MANUSCRIPT DATA

2.14.1 TRAVERSE/ GNSS POINT

Place at coordinates and label with point name, coordinates, and elevation.

2.14.2 MAPPING LIMITS LINE

Digitize mapping boundary; pull all detail cleanly to line. Do not plot line on final plots.

2.14.3 TITLE BLOCK

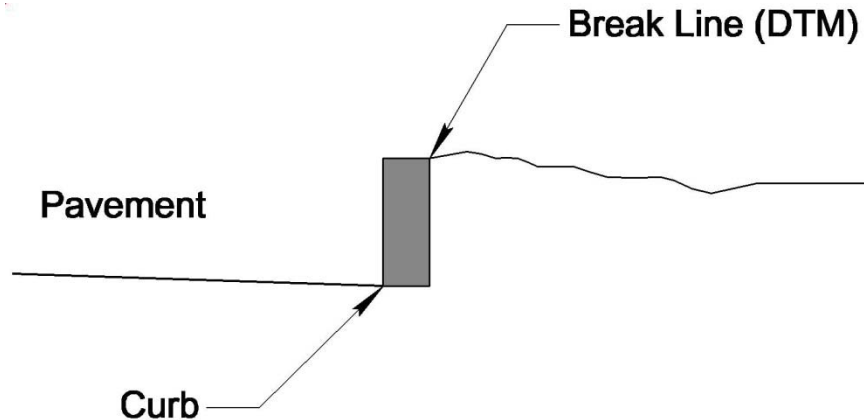
Place title block on each file and properly fill in required information.

2.14.4 EXISTING TRANSPORTATION FEATURES

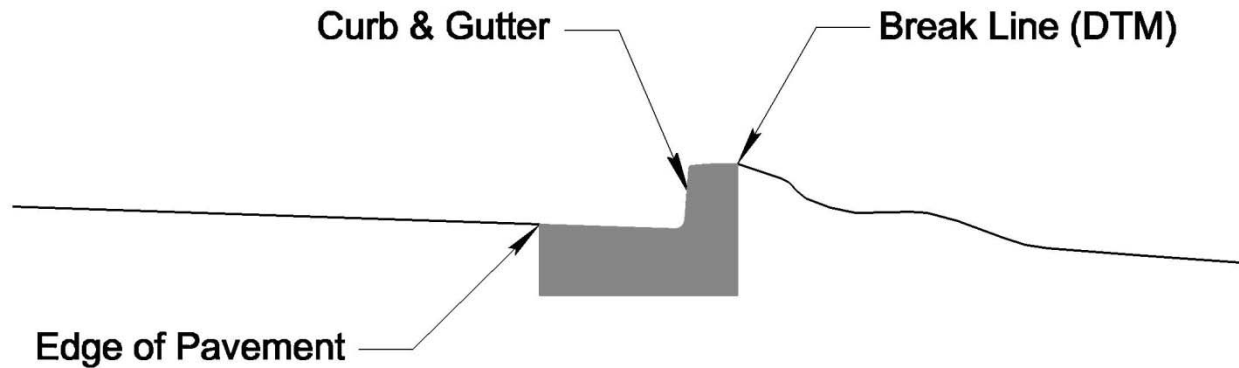
AIRPORT RUNWAY & HELIPORT - Airport pavement used for takeoff, landing, or taxiing of airplanes. The edges shall be digitized. "Runway" also includes heliports. Unpaved runways shall be shown.

BIKE PATH - If paved, digitize each edge. If unpaved digitize the centerline of the bike path. Label as "BIKE PATH". All transportation features have precedence over bike paths.

CURB - Raised edge-defining edge of pavement, parking lot islands, etc. Digitize the lower edge of the curb. Label as "CURB". Curbs have precedence over edge of pavement lines. Retaining walls have precedence over curbs. **Do not** snap to the sides of curb.



CURB & GUTTER - Raised edge with gutter-defining edge of pavement. Digitize the edge of pavement and the lower edge of the curb. Label as "C&G". Retaining walls have precedence over curb and gutter. **Do not** snap to the sides of curb and gutter.



HANDICAP RAMP - Digitize a corner of the ramp in the sidewalk and place the cell to fit the actual handicap ramp. **Do not** label.

PAVED DRIVEWAY - Defined by the edge of pavement. Paved drives have precedence over unpaved roads, unpaved drives, sidewalks and slabs. Paved roads and retaining walls have precedence over paved drives. Paved shoulders should join cleanly with paved drives. Paved shoulders should not stop for unpaved drives. Cap the end of paved drives.

PAVED PARKING LOT - Digitize the edge of pavement of parking lots and parking lot islands. Curbs and retaining walls have precedence over paved parking. Paved drives shall join cleanly with paved parking. Paved parking has precedence over unpaved drives and unpaved parking lots.

PAVED ROAD - Defined by edge of pavement, excluding paved shoulders, curbs, and curb and gutter. Paved road edges have precedence over paved drives and paved parking lots, and the edge of pavement should remain unbroken where drives or parking lots intersect the road.

PAVED SHOULDER - Pavement between the edge of the paved road and the edge of total paved surface. Curbs and guardrails have precedence over paved shoulders. Paved shoulders should be broken for paved drives and paved parking lots. **Do not** show unpaved shoulders.

PUBLIC SIDEWALK - Show the edges of sidewalks. Sidewalks should not continue across paved drives unless they do so visibly on the photography. Paved drives, paved parking lots, and paved roads have precedence over sidewalks. Sidewalks have precedence over unpaved drives, unpaved parking lots and slabs. Show steps in sidewalks.

RAILROAD - Digitize the centerline of all rails (the line will be patterned to depict the railroad tracks). Show all sidings and spurs (tracks for storage etc.). **Do not** delineate old railroad grades with no tracks intact.

RAILROAD SWITCH STAND - Digitize the center of the switch stand. Orient the stand properly with the railroad tracks.

TRAIL - Dirt passageway that is permanent in nature. Digitize the centerline of trails. Label as "TRAIL". Trails are not maintained as well as dirt roads; field roads shall be shown as trails. All transportation features have precedence over trails.

TUNNEL - Concrete walls on each end of a tunnel. Digitize the outside edge of the tunnel wall. Label as "TUNNEL".

UNPAVED DRIVEWAY - Defined by the edge of the graded surface or the edge of tire wear lines, whichever is appropriate. Edge of pavement of any kind has precedence over unpaved drives. **Do not** cap the end of unpaved drives.

UNPAVED PARKING LOT - Define unpaved parking lot by the edge of graded surface or the edge of tire wear lines, whichever is appropriate. Edge of pavement of any type has precedence

over unpaved parking lots. Unpaved drives should join cleanly with unpaved parking lots. **Do not** show islands in unpaved parking lots. **Do not** open paved shoulder for unpaved parking lots.

UNPAVED ROAD - Dirt or gravel road maintained as a thoroughfare. Unpaved roads are frequently found in rural areas or in suburban areas. Unpaved alleys are depicted as unpaved roads. Define by the edge of the graded surface, or edge of tire wear lines, whichever is appropriate. Unpaved road edges have precedence over unpaved drives and unpaved parking lots. Where the unpaved road edge intersects a paved surface, the edge of pavement line has precedence, including slabs and sidewalks.

2.14.5 EXISTING ROADSIDE BARRIERS AND TEXT FOR LEVEL # 7 & 8

GUARDRAIL - Single beam, corrugated steel, wooden, or cable guardrails. Guardrails are usually located along road edges near hazards. Digitize the centerline of the rail in the direction of traffic (the line will be patterned to depict the guardrail).

IMPACT ATTENUATOR - An impact-absorbing device usually placed around solid objects near the roadway. Digitize around the outside edge of the impact attenuators. **Do not** label.

JERSEY BARRIER - Short wall erected between traffic lanes. Digitize each side of the wall (at bottom).

MEDIAN DIVIDER GUARDRAIL - Double-sided beam guardrails. These guardrails are located in medians of roads. Digitize the centerline of the rail (the line will be patterned to depict the guardrail).

RETAINING WALL (ROADWAY & NOISE) - Fixed structure either retaining earth or for noise pollution along thoroughfares. Digitize each side of the wall, and then close the ends. If the retaining wall has a fence, digitize the centerline of the fence (the line will be patterned to depict the fence). Label as "RW". Retaining walls have precedence over curbs, fences, edge of pavements, and/or residential and commercial retaining walls.

TEXT - Label as specified in these guidelines.

2.14.6 EXISTING NON-TRANSPORTATION FEATURES

AREA UNDER CONSTRUCTION - Digitize the outline of the entire area under construction as a closed shape. Show any roads under construction as unpaved roads. Digitize building outlines, including foundation slabs or basement remains under construction, and any feature that has been completed (e.g. curb or completed building). Label as "AREA UNDER CONSTRUCTION" or "AREA U/C". **Do not** show debris or storage within the area outline. **Do not** contour.

BOULDER - Digitize the center of identifiable large boulders sitting on the ground.

BUILDING (ODD SHAPED OR ORTHOGONAL) - "Buildings" includes barns, residential and commercial buildings, residential and commercial trailers, and well houses. Include covered porches, permanent overhangs, carport roofs, covered sidewalks, etc. as part of building. All buildings are to end at the mapping limit boundary. **Do not** show common rooflines (e.g., between townhouse) or interior rooflines (e.g., dormers).

CEMETERY - Delineate the cemetery boundary only if not bounded by a fence line. Show paved and unpaved drives and buildings. Label using the cemetery cell. **Do not** show headstones or sidewalks.

CHIMNEY - Outline industrial chimneys or smokestacks only when they standalone. **Do not** show ones attached to houses or businesses.

DAM OR SPILLWAY - Barrier across river, creek, or swamp to regulate or obstruct water flow. Visible beaver dams large enough to affect water flow shall be outlined. Label as "DAM". Spillways shall be outlined and labeled as such.

DEBRIS AND JUNKYARD - Debris is scattered or unsorted material covering the ground. Digitize the outline of the area as a closed shape and label as "DEBRIS". Outline junkyards and label as "JUNKYARD". **Do not** contour either feature.

FENCE POST - Digitize the center of the posts. Intended for use only for misplaced individual posts.

FLAG POLE - Digitize the center of the pole. Look for a slab at the base.

GOLF COURSE / ATHLETIC FIELD - Outline fields only if not depicted by a fence. Show permanent basketball goals, football goal posts, etc. as miscellaneous posts. Show paved or unpaved tracks as paved or unpaved drives. **Do not** show tennis court nets or posts for tennis court nets. Label as "ATHLETIC FIELD". Show outline of golf courses only if not bounded by a fence. Show all paved and unpaved drives (cart paths) that are permanent in nature. Show all hydrology and natural features. Label as "GOLF COURSE" with only enough frequency for identification. **Do not** digitize tees, greens, sand traps or flags except upon special request.

LEVEE - Earth wall for fluid retention, usually found along rivers or canals. Digitize the outline of the levees on planimetric maps only (contours define levees on topographic maps). Label as "LEVEE".

LIQUID PROPANE TANK - Digitize the center of the tank. Orient the tank to correspond to its true position.

LONG FENCE LINE - Digitize the centerline of all visible cross-country fences (the line will be patterned to depict the fence). **Do not** differentiate between fence and gate. If the gate closes across the road, pull the fence across the road. **Do not** show individual fence posts in fence lines.

MAILBOX - Digitize the center of the mailbox. Orient the face of the mailbox to correspond to its true position.

MISCELLANEOUS POST, BASKETBALL GOAL, ETC. - Pole or post greater than 10 feet in height, including basketball goals and unidentifiable poles or posts. Digitize the center of pole or post.

PIER - Piers are structures extending into navigable water. Digitize the edge of the pier. Label as "PIER". **Do not** show private piers behind residential homes.

PIPELINE - Cross country above ground pipelines used for transportation of liquid, gas, or matter, usually found near industrial areas or public utility plants. Digitize edge; label as "PIPELINE". **Do not** show supporting structures. **Do not** show pipes that do not touch the ground, such as between buildings.

PIT OR QUARRY - Mining areas. No distinction is made between rock (consolidated) material mines and loose (unconsolidated) material mines. Show natural features present within quarries and pits. Digitize quarry and pit outlines as a closed shape and label as "QUARRY" or "PIT" with only enough frequency to identify the feature. **Do not** contour active quarries. Contour inactive quarries and pits only. Place spot elevations at lowest points of each.

PRIVATE SIDEWALK - Show the edges of sidewalks. Paved drives, paved parking lots, and paved roads have precedence over sidewalks. Sidewalks have precedence over unpaved drives, unpaved parking lots and slabs. Show steps in sidewalks.

RADIO, CELL PHONE, OR TV TOWER - Digitize the center of the tower.

RETAINING WALL (RESIDENTIAL & COMMERCIAL) - Fixed structure-retaining earth not located along a thoroughfare. Digitize each side of the wall, and then close the ends. If the retaining wall has a fence, digitize the centerline of the fence (the line will be patterned to depict the fence). Label as "RW". This retaining wall has precedence over curb, fence, edge of pavement, and hydrology. Roadway and noise retaining walls have precedence over residential and commercial retaining walls.

RIPRAP - Outline areas of riprap and close as a shape. Pattern using appropriate area pattern.

SATELLITE DISH - Digitize the center of commercial and private satellite dishes. Broadcast antennas have precedence over satellite dishes. **Do not** show satellite dishes on the top of buildings.

SHORT FENCE LINE - Digitize the centerline of all visible fences enclosing houses, barns, etc. (the line will be patterned to depict the fence). **Do not** differentiate between fence and gate. If the gate closes across the road, pull the fence across the road. **Do not** show individual fence posts in fence lines.

SLAB, PATIO, OR DECK - Any miscellaneous concrete slab, such as a flag pole base or concrete around a swimming pool. Also, use slab for patios and decks. If slab is imbedded in a paved surface, outline as change of pavement. Slab has precedence over unpaved roads.

STAIRWAY - Outline stairways and show individual steps which are built of concrete, stone, etc. **Do not** show wooden steps unless they are the main entrances to a building.

STONE FENCE & ROCK WALL - Digitize the centerline of stone fences and rock walls (the line will be patterned to depict the fence or wall).

STORAGE PILE - Stacked material or piles of dirt, sand, gravel, salt, etc. Digitize the outline of the area as a closed shape and label as "STORAGE". Retaining wall symbology has precedence over storage outline. **Do not** contour storage piles or areas stacked so that the ground is not visible.

STREAM GAUGE - Stream gauges shall be outlined as a building and labeled.

SWIMMING POOL - Digitize interior edge of concrete around built in pools, and centerline of walls in above ground pools. Label as "POOL". Also, use pool for aeration pools in industrial areas. Pool has precedence over slab and sidewalk symbology.

TANK/SILO (FIXED) - Outline fixed public utility tanks, industrial storage tanks, and silos. Label as "TANK", "TANKS" if grouped together or "SILO" or "SILOS" if grouped together.

TEXT - Label as specified in these guidelines.

WELL - Digitize the center of the well.

2.14.7 EXISTING NATURAL DRAINAGE FEATURES

IRRIGATION DITCH - Digitize the centerline of irrigation ditches (remember this is also a break line).

LAKE - A large inland body of fresh water. Show manmade reservoirs as lakes. Digitize the shoreline. Join the lake outline cleanly with rivers or creek lines. Label with name.

POND - A body of standing water much smaller than a lake, often manmade. Digitize the shoreline. Join the pond outline cleanly with streams.

RAPID OR WATERFALL - Place the cell representing waterfalls and rapids as necessary to depict these areas.

RIVER - Navigable stream. Digitize the shorelines. Label with name.

SPRING - Place cell at the apparent origin of flowing water. Let arrow point in the direction of flow. Continue from arrowhead with stream symbology.

STREAM - Navigable stream. Digitize the shorelines. Digitize the shorelines of streams wider than 5 feet, and digitize the centerlines of streams narrower than 5 feet. Join creeks cleanly with ponds, rivers, and lakes.

SWAMP CELL - Place swamp cells within the swamp area.

SWAMP LINE - Area of spongy, wet ground, usually harboring vegetation. Digitize any river, lake, pond, or creek outline within the swamp. Digitize the outline of swamps and place swamp cells in the swamp area. No distinction is made between a swamp, marsh, or inundated area. Show all vegetation within the swamp area.

TEXT - Label as specified in these guidelines.

2.14.8 EXISTING VEGETATION FEATURES

BRUSH LINE - Group of brush too close together to allow individual plotting. Digitize the edge of brush mass by following outline along the outer edge of the brush (the line will be patterned to depict the brush). Brush lines cannot cross over any double wide linear feature (e.g. vehicular trail, creek over 10 feet) or any railroad line, regardless of canopy spread. If ground cannot be seen, label as "GROUND OBSCURED".

BUSH - Single bush less than 10 feet tall. Digitize the center of the bush. If many bushes are aligned together, use hedge line symbology. The bush cell does not reflect width of the bush. **Do not** show single bushes within a hedge line. **Do not** show groups of flowers that may be interspersed with decorative bushes.

GROUND OBSCURED LINE - In areas where ground cannot be seen, outline area by digitizing points on ground (must be a closed shape) and label as "GROUND OBSCURED".

HEDGE LINE - Line of bushes close together, usually neatly maintained. Digitize the center of the hedge line (the line will be patterned to depict the hedge).

TEXT - Label as specified in these guidelines.

TREE - Single tree over 10 feet tall. Digitize the center of the tree trunk. No distinction is made between coniferous and deciduous trees. Tree cell does not reflect extent of tree canopy. **Do not** plot single trees within an area outlined as woods.

WOODS LINE - Group of trees too close together to allow individual plotting. Digitize the edge of tree mass by following outline along the outer edge of the tree trunks (the line will be patterned to depict the woods). Woods lines cannot cross over any double wide linear feature (e.g. vehicular trail, creek over 10 feet wide) or any railroad line, regardless of canopy spread. If ground cannot be seen, label as "GROUND OBSCURED".

2.14.9 EXISTING BRIDGES & DRAINAGE STRUCTURES

BOX CULVERT - Digitize the outside edge of culvert endwalls and label as "EW".

BRIDGE - Structures erected over an obstacle or depression. "Bridge" includes automotive bridges, railroad bridges, footbridges, and viaducts. Digitize the edge of the bridge. Stop the edge of paved roads at bridge ends. Carry guardrail across bridge if it continues on the bridge. **Do not** contour bridges.

ENDWALL & CONCRETE APRON - Concrete wall on the end of a pipe culvert or box culvert. Digitize the outside edge of endwalls and label as "EW". Digitize the outside edges of concrete

aprons and label as "CONC. APRON". **Do not** digitize the ends of pipes, which have no endwalls.

PAVED DITCH FOR ROADWAYS - Digitize each side of the paved ditch, and then cap the ends or join cleanly with endwalls. Label as "CONC. DITCH". Retaining walls have precedence over paved ditches. Paved ditches have precedence over sidewalks and slabs. **Do not** show the water lines inside the ditches.

TEXT - Label as specified in these guidelines.

2.14.10 EXISTING STORM DRAINAGE

BOX CULVERT - Digitize the outside edge of culvert endwalls and label as "EW".

CATCH BASIN & DROP INLET - Small rectangular or square drainage grate. Digitize the center of the grate and align it properly with the curb or edge of pavement. Label as "CB" or "DI".

MANHOLE - A hole through which one can enter a sewer, conduit, etc. Manholes can be located on paved or unpaved surfaces. Digitize the center of the manhole. Label as "MH".

TEXT - Label as specified in these guidelines.

2.14.11 EXISTING SIGNS & TRAFFIC CONTROL

BILLBOARD & OVERHEAD SIGN - Digitize the center of each post, regardless of number of posts, and show the billboard face. Label as "BB". Overhead signs can be single or multi-post signs. Digitize the center of each post and show the sign face. Label as "OH".

PAD MOUNTED CONTROLLER - Digitize the center of the controller for traffic lights. Orient the cell to face its true position.

POLE MOUNTED CONTROLLER - Digitize the center of the controller for traffic lights. Orient the cell to face its true position.

RAILROAD CROSSING SIGNAL (GATES LOWER AND LIGHTS FLASH) - Signal along railroad tracks to warn vehicles of railroad track intersections with roads. Digitize the center of the signal post. Orient the cell to face its true position.

RAILROAD CROSSING SIGNAL (NO GATES WHICH LOWER BUT HAS LIGHTS THAT FLASH) - Signal along railroad tracks to warn vehicles of railroad track intersections with roads. Digitize the center of the signal post. Orient the cell to face its true position.

SIGN (1 POST) - Digitize the center of the signpost. Orient the face of the sign to correspond to its true position.

SIGN (2 POSTS) - Digitize the center of the sign. Orient the face of the sign to correspond to its true position.

SIGN (DOUBLE SIDED) - Sign with a face on each side. Digitize the center of the signpost. Orient the sign to correspond to its true position.

STRAIN POLE FOR TRAFFIC SIGNAL SUPPORT - Digitize the center of the metal post supporting the traffic lights. Traffic signal symbology has precedence over light pole symbology if post has a dual purpose. **Do not** show signals suspended over roads.

TEMPORARY BARRICADE - Temporary concrete barriers used in areas of road construction. Digitize the center of the barrier and orient the face of the barrier to correspond to its true position.

TEXT - Label as specified in these guidelines.

WOOD POLE FOR TRAFFIC SIGNAL SUPPORT - Digitize the center of the wood pole supporting the traffic lights. Traffic signal symbology has precedence over light pole symbology if post has a dual purpose. **Do not** show signals suspended over roads.

2.14.12 EXISTING UTILITIES (GROUND & UNDERGROUND)

CABLE TV BOX - Digitize the center of the box. Orient the cell to correspond to its true position.

FIRE HYDRANT - Digitize the center of the hydrant. Orient the face of the hydrant to correspond to its true position.

GAS METER - Digitize the center of the meter.

GAS VALVE - Digitize the center of the valve.

LIGHTING CONTROL CENTER - Control box on a pad for lights or luminaries (usually located at directional interchanges). Orient the cell to correspond to its true position.

PULL BOX - Digitize the center of the in ground circuitry box. Orient the cell to correspond to its true position.

TELEPHONE BOOTH - Digitize the center of the booth. Orient the cell to correspond to its true position.

TELEPHONE BOX - Digitize the center of the post holding the telephone box. Orient the cell to correspond to its true position.

TELEPHONE PEDESTAL - Digitize the center of the above ground circuit box. Orient the cell to correspond to its true position.

TEXT - Label as specified in these guidelines.

UTILITY BOX - Digitize the center of the utility box.

WATER METER - Digitize the center of the meter.

WATER VALVE - Digitize the center of the valve.

2.14.13 EXISTING UTILITIES (OVERHEAD)

GUY WIRE - Place the cell so that it points to the pole to which it is attached.

HIGH MAST POLE LUMINAIRE (FULL CIRCLE OF LIGHTS) - Utility pole from which full luminaries are suspended (usually located in directional interchanges). Digitize the center of the pole.

HIGH MAST POLE LUMINAIRE (HALF CIRCLE OF LIGHTS) - Utility pole from which half luminaries are suspended (usually located in directional interchanges). Digitize the center of the pole and orient it to the direction in which the luminaries are facing.

LIGHT POLE - Pole from which a light is suspended (usually located in yards or close to houses for security purposes). Digitize the center of the pole and orient it to the direction in which the light arm is facing.

LIGHT POLE WITH POWER - Utility pole from which power and a light are suspended. Digitize the center of the pole and orient it to the direction in which the light arm is facing. Traffic signal poles have precedence over light poles with power.

LIGHT STANDARD (SINGLE & DOUBLE) - Pole supporting a street light or light in parking lots, business areas, etc. Digitize the center of the pole and orient it to the direction in which the light arm (or arms) is facing.

OFFSET LUMINAIRE POLE - Utility poles which have an offset for the luminaire are suspended in the direction of the interchange. Digitize the center of the pole and orient it to the direction in which the luminaire is facing.

POWER & TELEPHONE POLE - Utility pole from which electrical and telephone lines are suspended. Digitize the center of the pole and orient it to the direction in which the major power supply is running. Traffic signal poles have precedence over power and telephone poles.

POWER POLE - Utility pole from which electrical lines are suspended. Digitize the center of the pole and orient it to the direction in which the major power supply is running. Traffic signal poles have precedence over power poles.

SUBSTATION - High voltage units grouped together, usually within a fence. Digitize the outline if not enclosed by a fence. Show large structures within substations as miscellaneous buildings. The substation outline has precedence over slabs, unpaved drives, and trails. Label as "SUBSTATION". **Do not** show individual poles, pipes, or transformers within substation boundary.

TEXT - Label as specified in these guidelines.

TRANSMISSION LINE TOWER - Large structure for supporting power lines across long distances. Digitize around the base of the tower and place diagonal lines from corner to corner.