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INTRODUCTION

PURPOSE

This handbook sets forth basic guidelines for performing surveys for the Department. It is not intended to be a comprehensive technical manual. For specific project instructions, see the district surveying department.

AUTHORITY

Chapter 20, sec.23(3)(a), F.S.
Surveying Procedure, Topic No. 550-030-101a

DISTRIBUTION

This handbook is available at the following web site:

<http://www.dot.state.fl.us/surveyingandmapping/data.htm>

SUGGESTED MODIFICATIONS AND IMPROVEMENTS

All users are encouraged to suggest modifications and improvements to this handbook. Some modifications to the handbook are the direct result of changes in specifications, Department organization, and other requirements or as a result of recent experiences and technological advances. Other improvements or proposed revisions may be suggested by users. Suggestions to improve or revise the handbook should be transmitted to the Surveying & Mapping Office.

TRAINING

There is no training mandated by this handbook.

PUBLIC RELATIONS

All surveying personnel must be public relations conscious. You should not provoke a confrontation with a land owner or occupant. Chapters 337 and 472, F.S., grant to surveyors certain authority to enter upon private land for the purpose of performing a survey. The law does not grant permission to move, remove, or damage anything on the land without the explicit permission of the land owner or occupant, nor to leave anything behind such as trash or litter. Notify the land owner and occupant in advance of the day when you would like to enter, and thereafter keep them informed of your movements.

PRECISION AND ACCURACY GUIDELINES

Precision and accuracy requirements are project specific. For detailed instructions, see the district surveying department.

NOTES AND NOTE KEEPING

Whether recorded electronically or by hand, the notes may be used by persons who are not familiar with the locality, and who must rely on what is recorded in the notes. For this reason, the notes must contain all necessary information and they must be recorded in a form that will allow for easy interpretation. All field notes must be recorded in the field. Sketches may be invaluable in clarifying electronically collected data.

The current practice for the Department is to collect survey data electronically. Topography, cross-section, terrain and other similar data can be collected and stored electronically. See Appendix A. After processing and field verification, the database is exported to Department approved design software.

The method of collecting the data should be reviewed with the Department before the project is begun to assure the compatibility of the digital data with Department formats, notation and other essentials.

Electronic data may be supplemented by notes and sketches in traditional, bound field books. If field books are submitted as part of the survey record, some general guidelines apply:

- On the front of each field book, indicate in ink the project number, the county in which the survey is made, and contents of the book, e.g. Bench Levels and Cross Sections. On the back edge ink the book number and project number. (See Figure 1 below)
- Sample field book certification. (See Figure 2 below)
- Pages shall not be removed from a field book. Incorrect or obsolete notes should be marked "VOID", dated, and initialed. Numerical data shall not be erased. If a number is in error, a single line should be drawn through it, and the correct number written above.
- On the inside fly sheet of each standard bound field book will be a prestamped form with the book number and spaces for other essential identification information which the user is required to fill in, including the job description exactly as it appears in the Department's Financial Management System. (See Figure 1 above)
- The next page after the identification information will be page 1. To assure adequate space, pages 1-5 should be reserved for indexing and other information. The numbering of the pages is continued from page 1 throughout the field book, numbering the upper right hand page only.
- Cross reference all incomplete items when revisions or continuations are made. Make all subsequent corrections and additions to notes in red.
- At the completion of the survey, all field books containing data for the project shall be collected, organized and delivered to the district surveying authority.

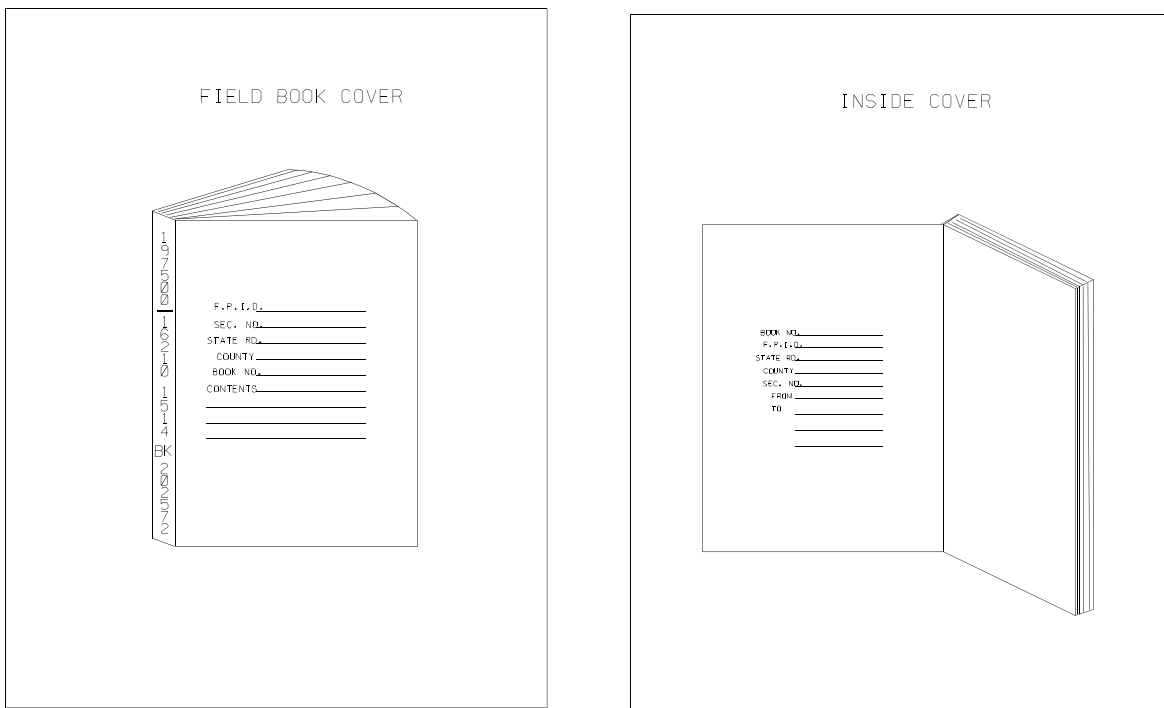


Figure 1

CERTIFICATION:

I hereby certify that as of the date shown below all data recorded in field book number _____ is a true representation of the field survey made under my responsible charge and that to the best of my knowledge said field survey is in compliance with the minimum technical standards adopted by the Florida Department of Business and Professional Regulation, Board of Professional Surveyors and Mappers.

CERTIFIED

(Sign) _____

(Print Name) _____

Florida Professional Surveyor & Mapper No. _____

Page(s) _____ Date _____

Figure 2

HORIZONTAL PROJECT NETWORK CONTROL (27.1)

Horizontal positions are referred to the Florida State Plane Coordinate System, North American Datum of 1983 (NAD83), 1990 or later readjustment. Some existing projects may be referred to the North American 1927 Datum. When two or more datums are encountered on a project, additional survey may be required to determine their relationship.

In some jurisdictions there are control points which are on a local or regional datum. Exercise caution when using a local or assumed datum. A local or assumed datum shall be used only with written authorization.

VERTICAL PROJECT NETWORK CONTROL (27.2)

Elevations are referred to the North American Vertical Datum (NAVD) of 1988 or the National Geodetic Vertical Datum (NGVD) of 1929. When two or more datums are encountered on a project, additional survey may be required to determine their relationship.

In some jurisdictions there are bench marks which are on a local or regional datum. Exercise caution when using a local or assumed datum. A local or assumed datum shall be used only with written authorization.

ALIGNMENT (27.3)

For the purpose of this document, alignment refers to a geometric line consisting of such elements as stations, bearings, and curve data to which existing and proposed improvements, right of way, and topography should be referenced. This line may be known as Survey Line, Center Line, Base line of Survey, Centerline of Survey, Survey Base Line, Center Line Alignment, Center Line of Construction, Center Line of Right of Way.

RETRACEMENT

The suggested order of importance of evidence is:

1. Existing alignment monumentation as shown on previous Department surveys or right of way maps.
2. Reference points from previous projects.
3. SRD or FDOT right of way monuments (usually found at PC, PT, POT, and setbacks or transitions in the right of way lines.)
4. Subdivision corners and land lines shown on previous Department surveys.
5. Significant improvements shown on the existing construction plans. These may include pavement, bridges, culverts, cross drains, median breaks, and sidewalks.
6. Survey points along the right of way not shown on previous Department surveys.

SUBMITTAL/APPROVAL

The deliverables may consist of:

- a sketch or map of the preliminary alignment. The data should include the alignment geometry with bearings, distances, and coordinates. This includes complete curve data.
- descriptions of all points found.
- the comparison of the field data to the record data.

- a report or narrative describing the process by which the alignment was retraced.

When the preliminary alignment has been approved, a final alignment can be shown in the field book with complete geometry and pertinent notes.

ALIGNMENT MONUMENTATION (27.3) AND REFERENCE POINTS (27.5)

Set suitable marks at PC's, PT's, PI's, POT's and POC's at +/- 1000 ft. interval, and reference these points as required. Whenever possible, the reference points should be established at right angles to the survey line.

STATIONING (27.3)

The survey stationing proceeds from the south to the north, or from the west to the east. The prevailing direction of the route in a particular county governs the direction of the survey and the stationing. Thus all surveys for a particular route in a county are stationed in the same direction.

If the survey begins on an existing route, the existing stationing is normally used. If the survey is a continuation of, or continued to, an existing route, the survey must overlap both ends of the project. The amount of overlap and the stationing interval will be specified in the scope of services.

DEFINITION OF CURVATURE

The arc definition of curvature is normally used on Department surveys. This definition defines the degree of curve as the angle subtended by an arc of 100 ft. Chord definition curves were once used by the Department. The degree of curvature of a chord definition curve is the angle subtended by a chord of 100 ft. Where chord definition curves are encountered on existing maps, it is necessary to convert the curve data to the arc definition. This cannot be done holding all the elements of the chord definition curve. Some curve element will have to change. The most practical method is to compute new curve data using arc definition, holding the record radius. The central angle is fixed by the existing tangents. Because the two definitions produce different values for the length of curve for the same curve on the ground, new stationing or an equation may be required. (See Figures 3 & 4 below)

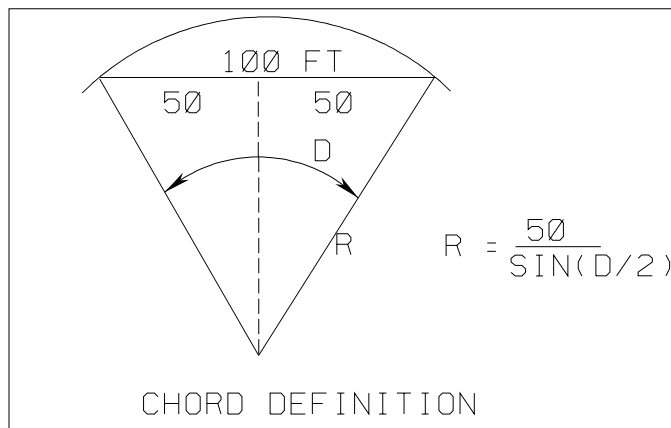


Figure 3

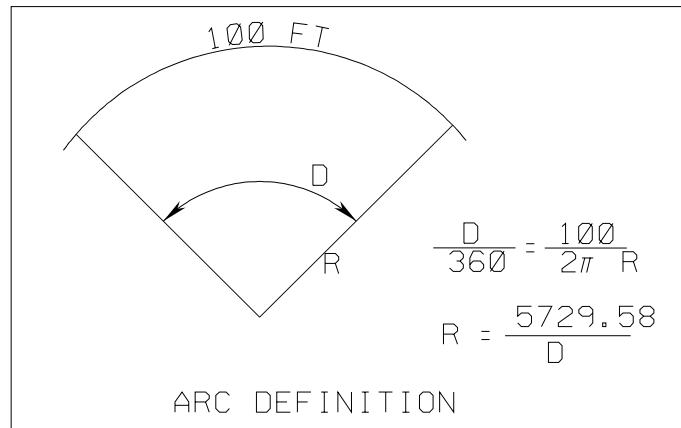


Figure 4

TOPOGRAPHY (27.6, 27.7)

FIELD DESCRIPTIONS

All surfaces should be identified, for example, sod, pavement (kind), rock and soil. Be specific in the description. Identify the kind of pavement, for example, concrete, asphalt, surface treatment, etc. Buildings and improvements within 50 feet for urban projects, or 100 feet for rural projects, outside of the existing or proposed right of way line should be located, unless otherwise instructed. Buildings (include overhangs) should be listed by type, use, and street address.

When locating fences describe the kind, type, height, and condition, since these fences are usually moved, salvaged or rebuilt during construction.

Woods lines, changes in type of cultivation, and breaks in the terrain should be indicated.

In orchards and groves where trees are spaced in rows, it is necessary to locate the trees affected by the design. Indicate the type of trees and diameters. Measure trees at the diameter breast high (4½ feet above ground, on the uphill side.) All ties are to be made to the center of the tree.

Locate all landscaping, such as shrubs, flower beds, and hedgerows.

When measuring to any improvement which is circular, e.g., poles, manholes, tanks, fire hydrants, etc., ties should be made to the center. Record the diameter and label the object.

PHOTOGRAMMETRY CONTROL (27.4)

Aerial photogrammetry is currently being used in many ways by the Department.

Control requirements vary with different projects and, in general, will be determined by the photogrammetrist.

Photo control points should be:

- easy to reach on the ground.
- accurately described.

- well defined and easy to identify.
- on a level surface at or near the ground.

TOPOGRAPHY BY PHOTOGRAMMETRIC METHODS (28.14)

Topography which is visible from the air may be obtained by photogrammetry. However, those features which are not visible from the air, such as those under cover of vegetation, overhanging roofs, or under water must be obtained on the ground by field methods.

DIGITAL TERRAIN MODEL (DTM) AND DIGITAL ELEVATION MODEL (DEM) (27.7)

A digital terrain model is derived from points and break lines whether collected by ground survey or aerial survey.

A digital elevation model is derived from a data set without break lines.

Check cross sections (27.8) should be performed to verify the accuracy of the model.

ROADWAY CROSS SECTIONS (27.8)

Cross sections provide information for

- checking surface models
- cross slope correction
- sign placement
- typical sections
- elevations at particular points
- side street returns
- generating contours
- calculation of earthwork
- bathymetry

UTILITIES (27.10)

Utilities on a project whether above or below the ground surface, within the survey limits, should be located. The horizontal and vertical location of the utilities, size, use, material, identification, and ownership should be shown.

The following identifies the level of utility locates in ascending order of effort:

- 1. Level D** Information obtained solely from a review of utility records. The comprehensiveness and accuracy of such information is highly limited. Even when existing information for a utility in a particular area is accurate, there are often other underground systems that are not shown on any records. Level D may be appropriately used early in the development of a project to determine the presence of utilities.

- 2. Level C** Information obtained to augment Level D information. This involves topographic surveying of visible, above-ground utility features (e.g., poles, hydrants, valve boxes, circuit breakers, etc.) and entering the topographic data into the CADD system. Level C may be appropriately used early in the development of a project and will provide better data than Level D information alone. Designers must be very cautious when working on projects using information for underground utilities that is based only on Levels D and C locates.

- 3. Level B** Information obtained through the use of designating technologies (e.g., geophysical prospecting technologies). This is an application using scanning technologies, most of which have very specific capabilities. Applying a variety of techniques is essential to the process of preparing a comprehensive *horizontal* map of utilities and other underground structures on the site. Designating technologies are capable of providing good horizontal information but provide limited vertical information.

- 4. Level A** Provide the highest level of accuracy of utility locations in three dimensions. This level may apply manual, mechanical or nondestructive (e.g., vacuum excavation) methods to physically expose utilities for measurement and data recording. Levels B, C, and D locates are incorporated in Level A locates. The designer should obtain Level A locates at highway/utility conflict points where verified information is necessary.

OUTFALL SURVEYS (27.11)

The survey may be for a pipe, open ditch, or improvement of an existing ditch. The same information as required under design surveys and right of way surveys will be obtained.

DRAINAGE SURVEYS (27.12)

Record the size of the structure. Locate the flow line at each end of culvert pipes horizontally and vertically. Indicate the size, material, and condition. It is most important to show the nominal pipe size. Do not give skew width, nor the bell diameter.

To fully understand the drainage information required on a particular job, discussion with the District Surveyor and the District Drainage Engineer may be required.

BRIDGE SURVEYS (27.13)

Surveys for bridges and large culverts may be performed as part of a design survey for a roadway job, but are sometimes separate surveys. If performed as a separate survey, a location sketch may be included in a field book. Requirements for bridge data surveys are project specific.

Contact other agencies regarding jurisdiction of water boundaries and sovereignty lands.

CHANNEL SURVEYS (27.14)

Surveys for channels may be performed as part of a design survey for a roadway job, but are sometimes separate surveys. If performed as a separate survey, a location sketch may be included in a field book. Requirements for channel surveys are project specific and may vary by jurisdiction.

Contact other jurisdictional agencies regarding surveying within water boundaries.

RIGHT OF WAY AND OTHER LAND SURVEYS

SECTION LINE TIES (27.19)

After section line retracement has been accomplished, ties to the alignment can be made. Ties should be made showing station plus and direction of these lines by angles or bearings and distances from the alignment to section corners. This information will be used to prepare the certified Right of Way Control Survey. See Figure 5 for an illustration.

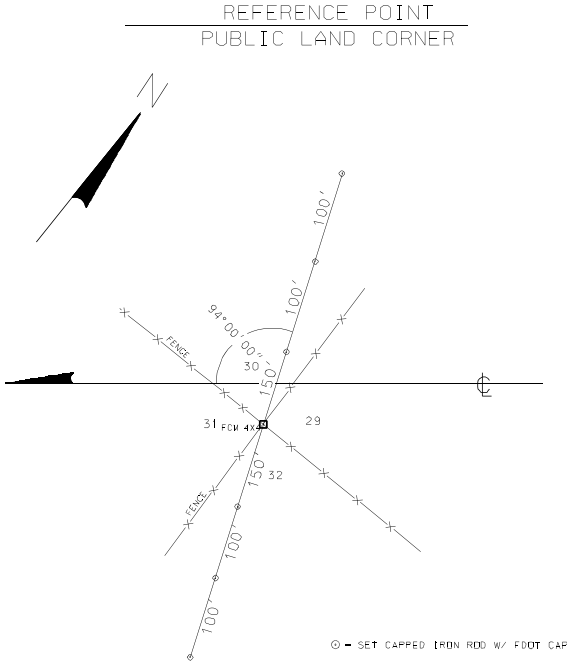


Figure 5

Occupational corners and evidence of occupation should be identified and tied.

Comply with the provisions of Chapter 177.501 through 177.510, F.S., requiring certified corner records to be filed. Section corners that may be disturbed should be referenced according to Figure 5.

SUBDIVISION AND OTHER TIES (27.20)

Ties should be made to sufficient monumentation where each subdivision crosses the alignment or adjoins the right of way. This information will be used to prepare the certified Right of Way Control Survey. See Figure 6 below for an illustration.

Cemeteries may require additional surveys to locate the fences, gates, entrances and each grave.

The boundaries of national parks and national forests, government reservations, city limits, county lines, bulkhead lines, etc. should be tied to the alignment.

Occupational corners, evidence of occupation, and open and notorious evidence of easements should be identified and tied.

TOWNSHIP 28 SOUTH, RANGE 20 EAST
HILLSBOROUGH COUNTY, FLORIDA

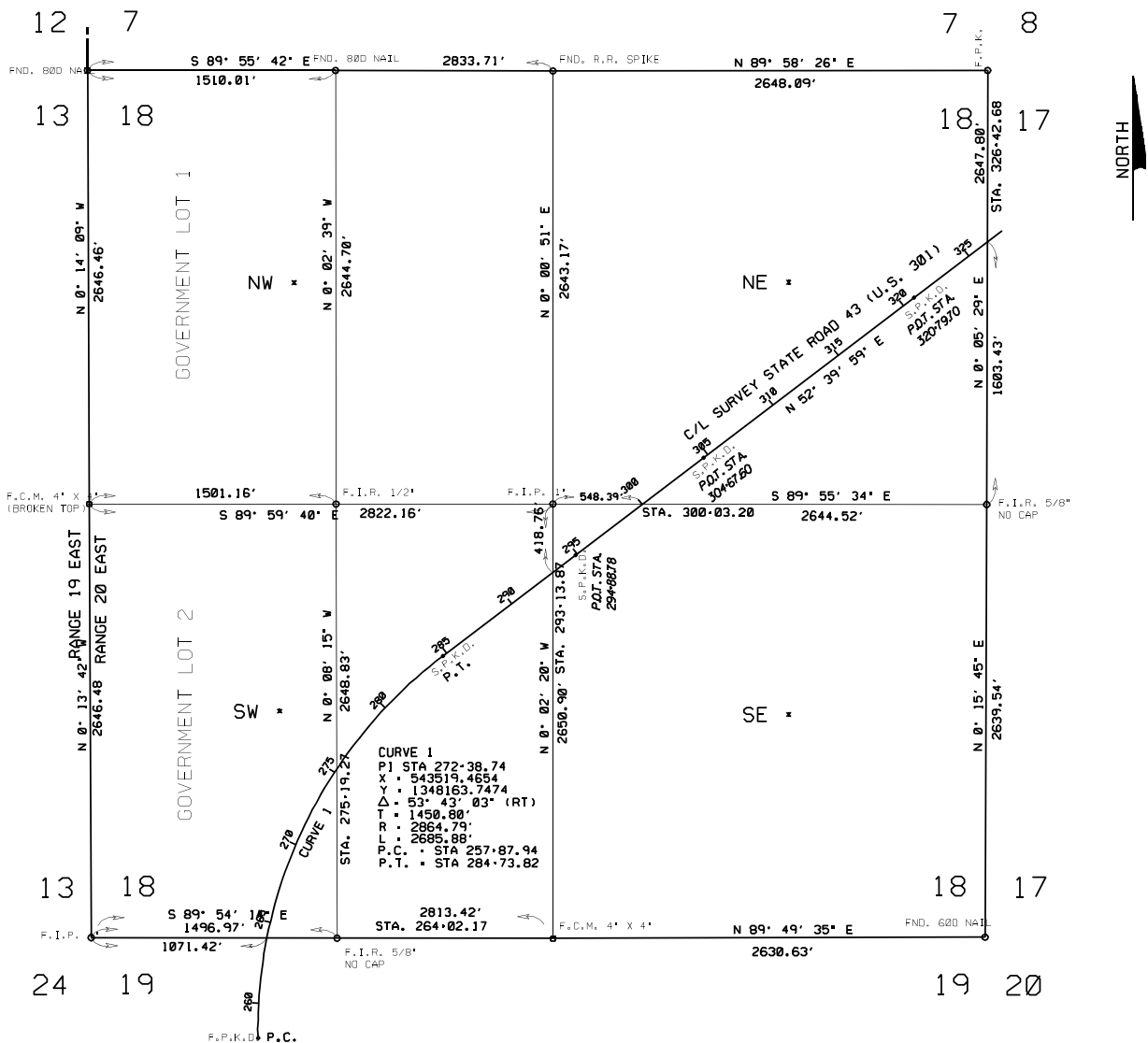


Figure 6

MAINTAINED RIGHT OF WAY SURVEYS (27.21)

The state holds many miles of roadway corridor for which there is no evidence of procurement by formal instrument.

Section 95.361, F.S. and the *Right of Way Mapping Procedure* outline the requirements for certification and filing of maintenance maps in the office of the clerk of the circuit court.

BOUNDARY SURVEYS (27.22)

A boundary survey for the acquisition or disposal of a parcel of land may be required. Specifications for this work will be as defined by the Minimum Technical Standards adopted by the Florida State Board of Professional Surveyors and Mappers.

RIGHT OF WAY MARKING (27.24)

Most projects that require the acquisition of additional right of way will require the staking of some portions of the new right of way lines.

Right of way staking may be performed in order to assist

- the owner in moving fences, trees, buildings, and other improvements;
- the appraiser for evaluating the property to be taken;
- the court for viewing by the jury in cases of condemnation suits;
- in the marking of buildings for cutoff at the right of way line.

MONUMENTING AFTER CONSTRUCTION (27.25)

After construction is completed on the project, monument the right of way, section and other corners. A survey supporting the Right of Way Monumentation Map, showing all changes of direction in right of way lines, should be performed.

Verify that the alignment points and references described under Alignment Monumentation (27.3) and Reference Points (27.5) above are in place. Reset any alignment points or references that have been obliterated.

WORK ZONE SAFETY (27.27)

Work should not begin at the site until proper traffic control devices, such as signs and cones, have been placed and other safety precautions taken.

Appropriate MOT certification should be maintained.

Department employees witnessing a highway accident should offer reasonable assistance.

Every employee should watch for hazards along the highway, and if one is noted should act to eliminate it promptly. If it cannot be eliminated, appropriate traffic control devices should be placed to protect traffic.

The Survey Safety Handbook outlines the Department's survey safety program. The Survey Safety Handbook is available at:

<http://www.dot.state.fl.us/surveyingandmapping/data.htm>

MISCELLANEOUS SURVEYS (27.28)

On occasion, it may be necessary to perform surveys other than those previously covered. Specifications for this work will be as defined by the Minimum Technical Standards adopted by the Florida State Board of Professional Surveyors and Mappers.

ELECTRONIC SURVEY DATA COLLECTION 1

FIELD SURVEY AND DATA ANALYSIS 1

TOPOGRAPHY, DTM, AND R/W CONTROL SURVEY DATA 1

HVD MODE 1

HD MODE 1

SOR MODE 1

CERTIFIED FIELD BOOK 1

FIELD WORK BOOK 2

CALIBRATION 2

HVD OBSERVATIONS 2

TOPOGRAPHY 2

BREAK LINES 2

CHAINS 2

POINTS 3

CHECK IN TO CONTROL 3

SOR OBSERVATIONS 3

CHECK CROSS SECTIONS 4

SEGMENTING 4

DATA PROCESSING 4

GRAPHICAL ANALYSIS 5

QUALITY CONTROL 5

DELIVERABLES 5

ELECTRONIC SURVEY DATA COLLECTION

Electronic survey data collection applies to all methods of field survey that utilize electronic means to make measurements relating to land information, including storing, analyzing, processing, and archiving of that information. This commonly involves the use of GPS, total stations, data collectors, and software such as, but not limited to, EFB, CEFB, CAiCE, GEOPAK, VectorNT, and MicroStation.

FIELD SURVEY AND DATA ANALYSIS

Horizontal angle, zenith angle, slope distance (HVD) observations should not be greater than 500 ft. in length to ensure accurate trigonometric elevations.

Secondary horizontal and vertical control points should be established from the Project Network Control. These control points will serve as the setup points for collecting topographic, right of way, property, and DTM data, etc.

TOPOGRAPHY, DTM, AND R/W CONTROL SURVEY DATA

Topography and DTM surveys should be performed in HVD mode and SOR mode.

Right of way control surveys may be collected in HVD or HD mode.

HVD MODE

Mode of measurement, normally with a total station, in which the horizontal circle reading (H), the zenith circle reading (V), and the slope distance (D) are recorded. Horizontal angles are measured clockwise to the right. Zenith angles are measured from the zenith at zero (0) degrees. Height of instrument (HI) and height of target (HT) are also measured and recorded. These measurements combine to process the horizontal and vertical position of a point or a series of points.

HD MODE

Mode of measurement, normally with a total station, in which the horizontal circle reading (H) and the horizontal distance (HD) are recorded. Height of instrument, unnecessary for processing the horizontal position of the setup point, is still measured and recorded in case more than one measurement mode is used on a particular setup. Height of target is not measured and is not used in the processing.

SOR MODE

Mode of measurement, normally with a level, level rod, and tape, in which an alignment station value (S), offset right or left of the alignment (O), and level rod reading (R) are recorded. The horizontal and vertical position of a point or a series of points is processed based on the alignment position and a controlling elevation.

CERTIFIED FIELD BOOK

A Certified Field Book may be kept to record the following information:

- Baseline alignment and references.
- Bench Levels and Benchmark index.
- DTM check cross sections.

FIELD WORK BOOK

A segment/project Field Work Book may be kept to record important information. This information includes but is not limited to the following:

- project Network Control, DTM Survey, and R/W Control Survey axis test repetitions, network/traverse repetitions, and Control Point index/references.
- height of instrument and height of target for each setup.
- a sketch of the topography chains, including DTM break line chains, with labels and pertinent point names to store the chains.
- a list of chains containing chain point lists as an aid in chain revision during post processing.
- notes to aid in post processing such as modifications to a series of points.

CALIBRATION

Axis tests should be performed as defined in the EFB User Guide. The EFB User Guide is available for download in portable document format (.pdf) within the file "EFB.ZIP" at:

<http://www.dot.state.fl.us/surveyingandmapping/data.htm>

HVD OBSERVATIONS

Refer to the EFB User Guide for feature coding and attributing of points and chains.

TOPOGRAPHY

All topographic features such as roadbed, asphalt aprons, curb and gutter, utility poles, trees, etc. should be observed in HVD mode. All points and chains relating to the ground surface model have a "G" attribute. Only those points and chains on the ground surface are used in computing the DTM.

BREAK LINES

A break line is a profile along a distinct topographic feature or along a distinct interruption in the continuity of the ground surface. The ground topographic chains are 3-D break lines for the DTM. Some examples include the roadbed, curb and gutter, sidewalks, shoulders, top of endwalls, top of slopes, ditch bottoms, etc.

CHAINS

The first step in collecting DTM data is locating all ground topographic chains. This is accomplished by radially observing all points along each chain (see Ground Points below). Each point along a specific chain is observed recording horizontal angle, zenith angle, slope distance, and target height. These points are the horizontal and vertical breaks along the chain and contain "P" (point) geometry or "C" (curve) geometry.

- Ground

Ground survey chains are all those break lines, as defined above, that lie on the ground surface. Ground chains are profiles along the distinct

breaks in the ground surface model. Ground chains will contain only ground points.

- Feature

Feature survey chains are those topographic features that are not a part of the ground surface and thus will not be used to generate the DTM. An example is a concrete slab that projects above the natural ground surface and does not need to be shown in cross section. Other examples include the top of guard rail chains or the top of fence chains. Endwalls can be ground, feature, or a combination of ground and feature chains depending on the natural ground surface surrounding the structure. Also, a feature chain may contain ground points as in an aerial telephone line chain made up of points observed at the base of the telephone poles.

POINTS

- Ground

Ground points are all those X, Y, Z positions that lie on the ground surface. Ground points include ground chain points as well as random ground positions needed to accurately generate a DTM. Once the chain points have been recorded, the random ground points are observed. These random ground points can be observed while the chain points are being collected, since a unique naming convention is used to differentiate between ground chain points and random ground points.

- Feature

Feature survey points are those X, Y, Z positions that will not be used in the DTM generation. An example is a fire hydrant located by placing the target rod on the top of the hydrant. The elevation of this point will not be used when computing the DTM although this elevation is determined during post processing.

- Spot Elevations

Spot elevations are the random ground surface observations needed to fill the remaining areas not covered by the ground chains. These observations should be made at the high and low points in the remaining areas. Spot elevations are critical in the generation of an accurate DTM. The location of these points is left to the PLS in responsible charge's judgment based on the project requirements, on the existing ground surface, and on knowledge of the data collection/DTM system.

CHECK IN TO CONTROL

Control should be reobserved in direct and in reverse telescope, recording horizontal angle, zenith angle, and slope distance as a check. To ensure that the setup is not disturbed, checking back in to control must be done more frequently in high risk areas.

SOR OBSERVATIONS

Set up the level and record an observation to a BM or TBM. Measure and record the required offsets and the corresponding level rod readings.

SOR observations are useful when locating topographic features and taking traditional cross sections on small special purpose projects and on resurface projects where large cross section intervals are employed and a DTM will not be computed.

CHECK CROSS SECTIONS

To ensure an accurate DTM, independent check cross sections should be taken. These check cross sections may be recorded in the certified field book and may also be recorded electronically using HVD mode or SOR mode. For further instructions, see the EFB User Guide. The surveyor in responsible charge should meet with the district survey department to set the check section requirements.

SEGMENTING

Survey projects involve many points, chains, etc. To keep the data set manageable, the project is divided into segments.

Segmenting can occur in the field by one of two methods. One is to collect the data on a portable personal computer in which segmenting is accomplished as outlined above directly on the PC. The second method involves creating the next segment on the data collector and exiting the data collection program. Now two segments exist on the data collector, the previously collected segment and the newly created segment. By copying *filename.PRE* and *filename.CPX* files from the previous segment over the new *filename.PRE* and *filename.CPX*, segmenting is resolved, and the data collection program is activated to begin data collection in the new segment.

When creating and switching between various segments, avoid point naming conflicts. One method to avoid point naming conflicts on large projects employing multiple crews is to use the Party Chief's initial (or a suitable crew designation) as a prefix to the segment names, point names and chain names. If a crew is assigned a different project, end the segment in the field by checking in to control and uploading and archiving the partial segment. Upload each crew's data at least daily.

DATA PROCESSING

Processing begins with uploading the segment data files to a pc or equivalent and backing up the files. The data should be uploaded to a separate directory and archived unedited. Copy the files to the working directory for processing. The EFB field files are as follows:

- *filename.CHN* Binary chain file containing all the stored survey chains for the segment.
- *filename.CPX* ASCII chain prefix file listing the last chain number recorded for each alphabetic chain prefix.
- *filename.PRE* ASCII point prefix file listing the last point number recorded for each alphabetic point prefix.
- *filename.RAW* Binary observation file containing all the recorded data in the segment.
- *filename.TAP* Binary taping file containing all the tape points recorded in the segment.

The binary observation file *filename.RAW* is translated to an ASCII file *filename.OBS* file. A control file *filename.CTL* is created and these two files are used to process the

survey data. Revisions are made and documented in *filename.OBS* and when this file is correct, a least squares adjustment is performed. Obvious revisions need not be documented. Revisions are documented in *filename.OBS* by adding remark records at the corresponding revisions. This procedure insures an electronic audit trail for quality control. The final result of the least squares adjustment is *filename.XYZ*. This ASCII file contains X, Y, Z coordinates and all the pertinent attribute data for each point in the segment. The results of SOR observations are stored in an SOE (Station, Offset, Elevation) file *filename.SOE*. For a more detailed discussion of processing EFB data, see the EFB User Guide and the Electronic Field Book Processing System Handbook.

The *filename.XYZ* file is then imported or merged into a coordinate geometry database. The binary chain file *filename.CHN*, the ASCII chain prefix file *filename.CPX*, the point prefix file *filename.PRE*, the binary observation file *filename.RAW*, and the binary taping file *filename.TAP* are also imported into the database. The project alignment and other important alignments are computed and/or stored in the database. The SOE file *filename.SOE* is imported into the database after the proper alignments are stored.

GRAPHICAL ANALYSIS

The DTM Survey chains are analyzed and edited to ensure accuracy. The survey chains with ground (G) attribute are DTM breaklines. Intersecting ground chains must have a common point. Other things to look for during survey chain edits are proper attributes, proper chain lists, and proper orientation.

View the data in 3D to confirm that the survey chains are properly oriented vertically. For example, a vertical spike in an edge of pavement chain will not be apparent in plan view. If apparent discrepancies are noted, the project should be referred back to the person in responsible charge for further action.

Once the survey chains have been verified and the DTM database has been created, compute the DTM triangles. The most common method to check the DTM is by the use of the check cross sections. Compare the computed cross sections with the check cross sections. Discrepancies must be investigated and corrected.

QUALITY CONTROL

Quality control and quality assurance should be performed in accordance with the requirements of the district and the project quality control plan.

DELIVERABLES

Specific deliverables are defined in the project scope of services. In general, the deliverables may include:

- The raw, unedited, field data files.
- An .OBS file produced from the raw, unedited, field data.
- A second .OBS file showing any corrections to the field data.
- The project .CTL and .XYZ files.

At the completion of the work, all files are transferred to the Department with an itemized transmittal letter.

No project will be considered complete until all deliverables are received and approved by the district surveying authority.